

[54] **AXIALLY AND ROTATIONALLY
MOVEABLE PRINT HEAD**
[75] Inventors: **Steven P. Cahill**, Revere;
Constantine J. Pateuk, Natick, both
of Mass.
[73] Assignee: **Honeywell Information Systems Inc.**,
Waltham, Mass.

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Related U.S. Application Data

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abandoned.
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74/31
[51] Int. Cl. **B41j 1/32**
[58] Field of Search **197/55, 49; 178/34; 74/31**

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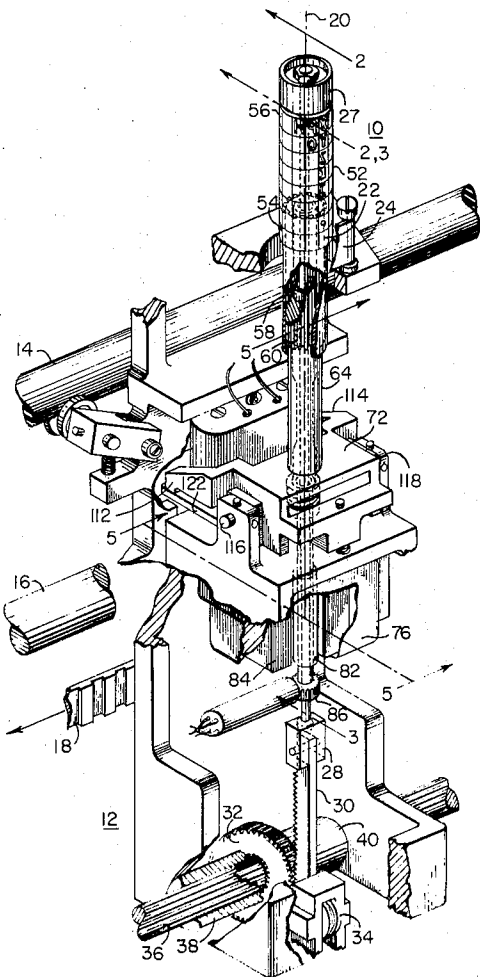
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Primary Examiner—Robert E. Pulfrey
Assistant Examiner—Eugene H. Eickholt
Attorney, Agent, or Firm—William F. White; Ronald
T. Reiling

[57] **ABSTRACT**

A novel carriage apparatus for a high speed serial printer is herein disclosed. The carriage apparatus comprises a rotatable and axially positionable print head with an associated positioning structure that provides a rigid and quickly responsive drive to the print head. The drive is achieved by a series of interconnecting rotational and axial shaft motions. The combination drives emphasize a relatively small number of moving parts and in some instances embody direct magnetic drives from associated motors. One embodiment of the invention provides for an internal drive within the shell of the print head itself.

15 Claims, 9 Drawing Figures



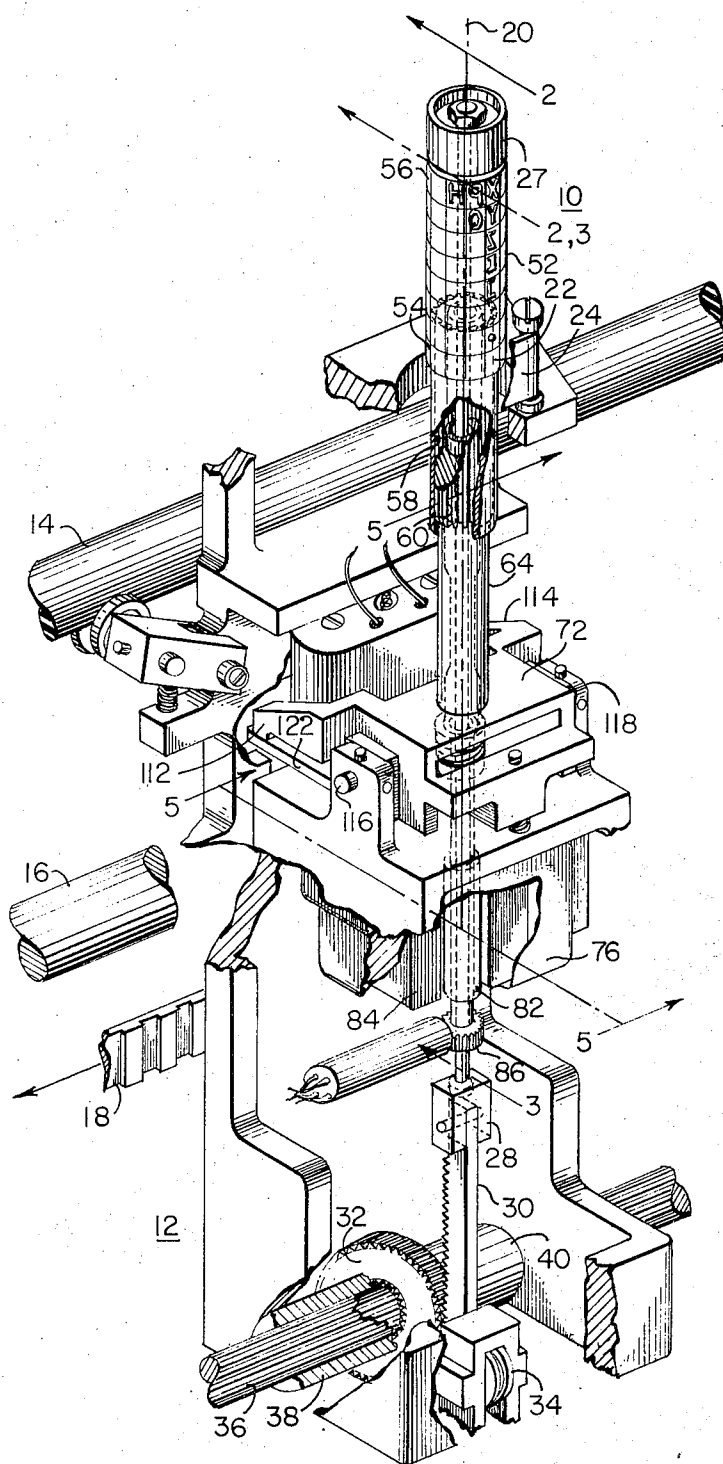


Fig. 1

INVENTORS

Steven P. Cahill

Constantine J. Pateuk

By *John D. Brine*

Attorney

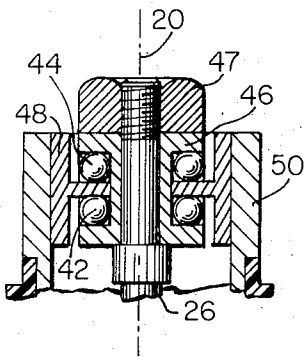


Fig. 2

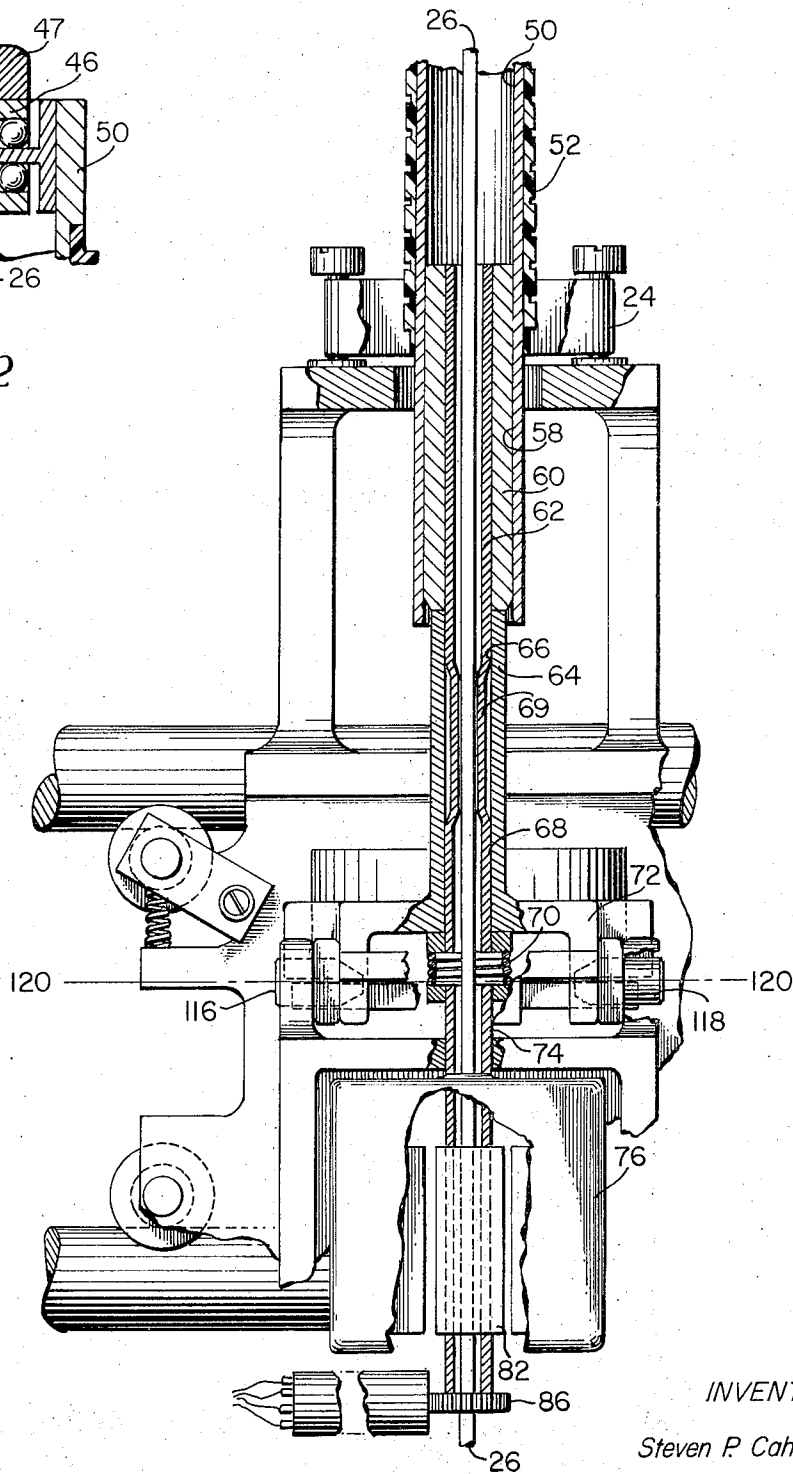


Fig. 3

INVENTORS

Steven P. Cahill

Constantine J. Pateuk

By *Andrew R. Brine*

Attorney

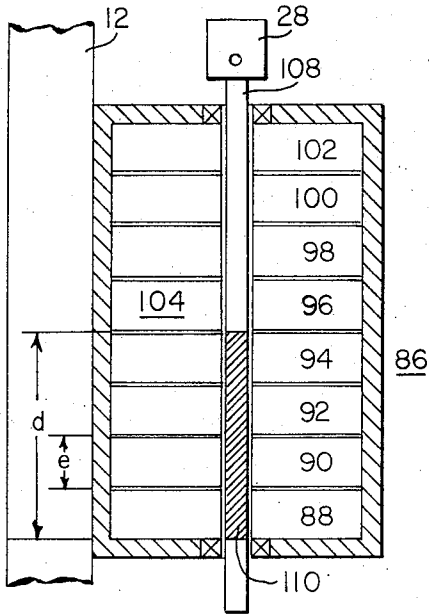


Fig. 4a

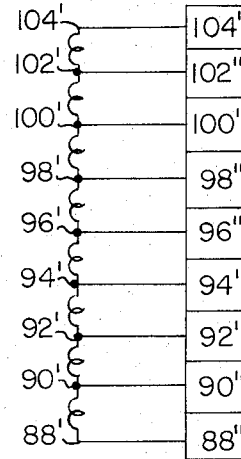


Fig. 4b

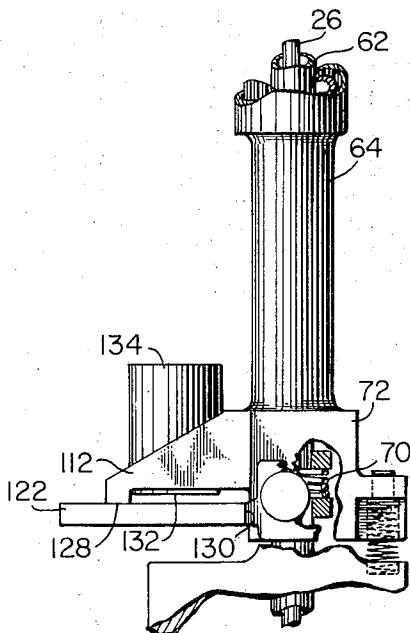


Fig. 5

INVENTORS

Steven P. Cahill

Constantine Pateuk

By *Robert B. Brink*
Attorney

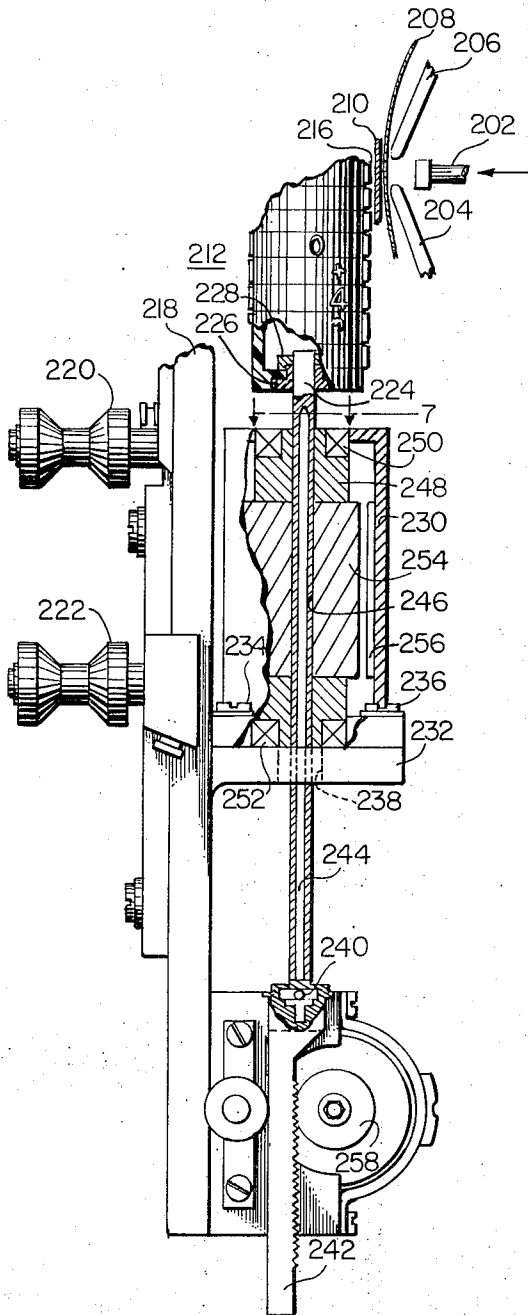


Fig. 6

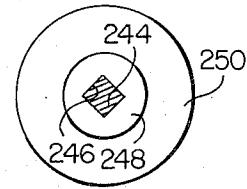


Fig. 7

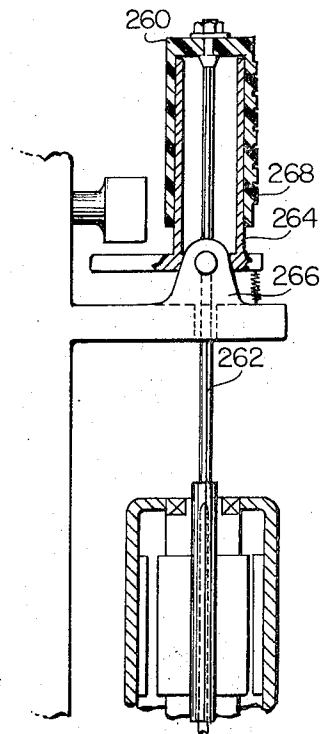


Fig. 8

INVENTORS

Steven P. Cahill

Constantine J. Pateuk

By *Constantine J. Pateuk*

Attorney

AXIALLY AND ROTATIONALLY MOVEABLE PRINT HEAD

This is a continuation of application Ser. No. 94,144, filed Dec. 1, 1970 now abandoned.

BACKGROUND OF THE INVENTION

The present invention relates to improvements in high speed impact printers, and more particularly, to the rotatable and axially displaceable type of print head assembly used in serial printers.

The serial printer concept may be stated quite simply as the rotational and axial displacement of a print head to position a given character on the print head surface. The print head surface contains a number of bands with each band itself containing a number of distinct characters. To position a particular character, the print head must be moved to the particular band and then subsequently rotated to the given character within that selected band. Printing of the positioned character is then accomplished by singularly impacting it with a suitable print medium.

The serial printer concept has particular application in a small computer system wherein speed can be somewhat sacrificed in return for a significant saving in cost. This cost saving can be appreciated when the serial printer is compared to the typical high speed printer utilized in large computer systems. The high speed printer used most often in large systems today is the parallel printer wherein a series of parallel impacting means are provided for a plurality of parallel bands of rotatably positionable characters on a drum surface. This arrangement of providing a number of parallel impacting means allows for the printing of a character without having to move the character drum to a particular band position. This one less movement makes the parallel printer much faster than the serial printer, but at a substantial cost due to the large number of parallel impacting means that are required.

While the serial printer represents a significant cost saving over the parallel printer, it must nonetheless be fairly quick and accurate. One approach to the implementation of serial printing has been to employ a series of belts and pulleys to obtain the desired motions of the print head. Another approach has been to implement the motion of the print head by a series of gearing either alone or in combination with pulley drives. Still another approach has been to transmit both a rotational and axial motion through a flexible cable drive which in turn moves the print head. These systems all possess the draw back of requiring many moving parts to accomplish the desired print head motion. This results in a system with many mechanical dead spaces within the drive itself. Furthermore, the multiplicity of moving parts increases the likelihood of mechanical wear and failure. The problem of obtaining an accurate and quick positioning of the print head is also further complicated by the introduction of flexible elements within the drive which necessarily cause time lags and/or slippage.

The present invention, therefore, has an object to provide a serial printer having a rigid drive whereby an extremely quick and accurate positioning of the print head is achievable.

A further object of the invention is to provide a serial printer having an accurate rotatable drive for the print head.

Yet another object of the invention is to provide a serial printer having an accurate axial drive for the print head.

Still another object of the present invention is to provide a compact carriage device for a serial printer wherein there is a relatively few number of moving parts.

SUMMARY

To achieve the various objects, the present invention provides a rigid and quickly responsive positioning system that contains a relatively few number of moving parts. Quick response and overall system rigidity is achieved by an arrangement of interconnecting shaft motions wherein displacement motions are quickly and accurately transmitted from the drive motors to the print head. The various shaft combinations also contain a small number of moving parts. The shaft members are in some embodiments magnetically driven by electrical motor without any intervening drive elements. One embodiment of the present invention provides for an internal drive structure within the shell of the print head itself. This drive structure allows for accurate positioning of the print head by employing a drive means immediate to the print head.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the present invention reference should be had to the accompanying drawings wherein:

FIG. 1 is a fragmentary perspective view of a serial printer carriage apparatus with a rotatable and axially displaceable print head mounted thereon;

FIG. 2 is a sectional view along line 2—2 of FIG. 1 illustrating the uppermost portion of the print head along with its associated supporting shaft structure;

FIG. 3 is a front sectional view along line 3—3 of FIG. 1 showing the shaft structure extending down from the uppermost portion of the print head through the print head, drive spline arrangement, actuator portion, rotary drive and terminating at the outer end thereof;

FIG. 4a is a sectional view illustratively showing a linear stepping motor which is an alternative axial drive to the rack and pinion of FIG. 1;

FIG. 4b is a schematic showing of the coil arrangement for the linear stepping motor of FIG. 4a;

FIG. 5 is a side elevational view, partly in section, showing the pivoted yoke structure and the flexible coupling portion of the shaft structure;

FIG. 6 is a side elevational view, partly in section, showing an alternative embodiment to that of FIG. 1;

FIG. 7 is a sectional view along line 7—7 of FIG. 6 showing the square peripheral engagement between an axially moving shaft and a rotating armature mount; and

FIG. 8 is a side elevational view, partly in section, showing an alternative embodiment to that of FIG. 6.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 shows a print head 10 mounted at the top of a carriage apparatus 12. The carriage apparatus 12 is movable along guides 14 and 16 by a belt means 18 in the lateral direction as shown. The lateral movement of

the carriage apparatus 12 may be accomplished by any means well known in the art and will therefore not be explained in detail. The carriage apparatus 12 is stepped along in the lateral direction so as to laterally position the print head 10 for printing the next character. The print head 10 is also simultaneously rotated and moved axially along an axis 20 so as to position a given raised character 22 on the print head surface for printing. Impact printing is accomplished by moving the print head 10 toward an ink ribbon 24 causing the positioned raised character 22 to be printed on a medium (not shown) in back of the ink ribbon 24.

Turning first to the manner in which the print head 10 is axially positioned, the print head 10 is shown in FIGS. 1-3 as being connected to an axially movable shaft 26 at a rotatable thrust bearing support structure 27 which will be explained hereinafter. The axially movable shaft 26 extends down through the print head 10, various other surrounding moving parts, and terminates at a coupling 28. The coupling 28 connects the shaft 26 to a rack 30 which is engaged and driven by pinion 32. The rack 30 and the pinion 32 are maintained in alignment by a guide 34 which in turn is joined to the carriage apparatus 12. The pinion 32 is positioned within the carriage apparatus 12 by a pair of sleeve portions 38 and 40 which extend to either side wall of the carriage apparatus 12 as shown in FIG. 1. Pinion 32 is slidably mounted on a splined shaft 36 that is in turn rotatably driven by a motor (not shown). The rack 30 and the pinion 32 are therefore seen to move laterally with the carriage apparatus 12 while simultaneously axially positioning the print head 10 through the coupling 28 and the shaft 26.

Returning now to the rotatable thrust bearing support structure 27 as it is particularly shown in FIG. 2. This structure supports the print head 10 at the top of the axially movable shaft 26. The rotatable thrust bearing support structure 27 comprises both a lower rotatable bearing 42 and an upper rotatable bearing 44 situated within a housing 46 suitably mounted to the shaft 26. The housing 46 is secured in place by a roll nut 47 which threadably engages the axially movable shaft 26. A bearing surface structure 48 is interposed between lower bearing 42 and upper bearing 44. The bearing surface structure 48 is in turn affixed to the inside wall of a long hollow cylinder 50 which extends downwardly around the shaft 26. The long hollow cylinder 50 is free to rotate about the axis 20 and the shaft 26 by virtue of the bearing surface structure 48 freely rotating within the lower and upper bearings 42 and 44 respectively. The long hollow cylinder 50 at the same time moves axially along the axis 20 in response to the axial movement of the shaft 26. This latter motion is accomplished by virtue of the housing 46 being secured to the shaft 26 by the nut 47.

The long hollow cylinder 50 serves as an inner mounting surface for a hollow cylindrical character drum 52 which is suitably affixed thereto. The hollow cylindrical character drum 52 can be molded from any conventional print head material or it can be made from urethane as disclosed in commonly assigned U.S. Pat. application Ser. No. 69,829, to Cheng Hua Wang, filed on Sept. 4, 1970. The surface of the character drum 52 contains a matrix arrangement of raised characters, e.g. 22, formed thereon. The preferred matrix arrangement consists of eight rows and 12 columns. The character drum 52 is so positioned relative to the

hollow cylinder 50 that a last row 54 of raised characters is in printing position directly opposite the ink ribbon 24 when the axially movable shaft 26 is fully extended. A top row 56 of raised character is similarly in printing position directly opposite the ink ribbon 24 when the axially movable shaft is fully retracted. It can be noted at this time that the above mentioned matrix arrangement of raised characters that is formed on the hollow character drum 52, and in turn mounted to the long hollow cylinder 50, constitutes what has heretofore been simply referred to as the print head 10.

Turning now to the manner in which the print head 10 is rotatably positioned, a spline guide surface 58 is formed on the inside wall of the long hollow cylinder 50. The spline guide surface 58 engages a drive spline 60 for a distance equal to one-half the length of the long hollow cylinder 50. This amount of drive spline engagement provides a stiff and rigid backing for the printing of a raised character within any of the matrix rows. FIG. 1 shows the worse possible case of fully extending the print head 10 in the axial direction while still maintaining drive spline engagement in back of the bottommost row of raised characters 54. This amount of drive spline engagement also provides an extremely accurate positioning for the particular row of characters due to the immediate presence of the drive spline behind the subject row.

The drive spline 60 is itself rotated about the axis 20 by virtue of being affixed to a rotatable hollow shaft 62 which begins at the topmost portion of the drive spline and runs down through the center of it. The drive spline 60 terminates at the top of a cylindrical neck 64 while the hollow shaft 62 continues down through it. The hollow shaft 62 is rotatably supported within the cylindrical neck 64 at cylindrical bearing portions 66 and 68. The same hollow shaft 62 thins down to a non-contact, smaller diameter portion 69 between bearing portions 66 and 68. This type of mounting and shaft geometry provides a rigid support for the rotating hollow shaft structure 62 which is in turn reflected in a stiff drive and an accurate positioning of the print head 10. The hollow shaft 62 which has been rotatably supported within the cylindrical neck 64 now extends down out of the neck to a flexible coupling 70. As can be seen from FIGS. 1 and 3, the flexible coupling 70 lies within a pivotal yoke actuator 72 of which the previously mentioned cylindrical neck 64 constitutes a first portion thereof. The flexible coupling 70 provides a limited and well defined bending point that combines with the pivotal yoke actuator 72 to produce an accurate impact printing stroke by the print head 10. This will be further explained hereinafter when the impact printing feature is discussed. The flexible coupling 70 joins the hollow shaft 62 to a lower hollow shaft 74 which extends down through a motor casing 76 as shown in FIG. 3. An armature arrangement 82 is affixed to the hollow shaft 74 and is in turn positioned within a surrounding stator arrangement 84. The stator 84 and the armature 82 provide rotational drive to the hollow shaft 74. The shaft 74 in turn rotates the flexible coupling 70, the hollow shaft 62, the drive spline 60, the spline guide 58 and hence the character drum 52. Stator-armature configurations for the subject rotational drive will be explained hereinafter.

The hollow shaft 74 terminates at a rotational sensor 86 that provides feedback control to the aforementioned stator-armature drive. This marks the bottom-

most point to which the rotating hollow shaft structure extends. It can be seen from FIGS. 1 and 3 that the axially movable shaft 26 extends downwardly from this bottommost point and thereafter joins the previously described rack and pinion drive at the coupling 28. It can furthermore be seen from FIG. 3 that the hollow shafts 74 and 62 and the flexible coupling 70 all have an inside diameter significantly larger than the outside diameter of the axially movable shaft 26. The rack and pinion drive thus freely moves the shaft 26 up and down within the hollow shafting 74, 70 and 62 so as to thereby drive print head 10 through the interconnecting rotatable thrust bearing structure 28. The aforementioned hollow shafting 74, 70 and 62 is at the same time free to rotatably drive the print head 10 through the drive spline 60 and guide 58. The positioning of the axial drive beneath the rotating hollow shaft structure together with the insertion therethrough thus avoids any complicated interferences between the two drives and allows for each drive to function completely free of the other.

Turning now to specific motor drives which can be used for both the axial and rotational motions. It will first be recalled that in connection with FIG. 1, the axial drive depends from a motor (not shown) that rotates the splined shaft 36. It is thus seen that for the FIG. 1 embodiment, both the axial and rotational drives utilize rotary motors. It is furthermore evident that the armature 82, stator 84 configuration which rotates the hollow shaft 74 is of the center-through drive type. A counterpart center-through drive is also to be visualized for driving the splined shaft 36. The first type of motor for both of these center-through drives is a D.C. servo type wherein appropriate feedback sensing allows for a quick and accurate positioning of the center-through shafting.

A second type of motor which is very well suited for incrementally driving the respective rotary and axial shafts is a rotary stepping motor configuration. This type of motor configuration is illustratively shown in U.S. Pat. No. 3,374,410 to D. H. Cronquist et al. and essentially consists of a number of coils positioned around a stator (i.e. 84 of FIG. 1) which in turn surrounds a permanent magnet armature (i.e. 82 of FIG. 1). The coils are so energized as to position the permanent magnet armature in as many positions as are required. In the present invention, a pair of HS-50 Slo-Syn Precision Steppers (manufactured by Superior Electric) with eight and twelve step positioning capabilities are provided to axially and rotatably position the print head 10.

An alternative to the purely rotatable drive suggested thus far for the axial movement is the stepping motor 86 shown in FIG. 4a. The linear stepping motor 86 of FIG. 4a supplants the previously described rack 30 and pinion 32 of FIG. 1. It is first seen that the stepping motor 86 is schematically shown as connected to the carriage 12. This immediate connection to the carriage 12 does away with the need for the splined shaft 36 arrangement of FIG. 1. The stepping motor 86 is also shown connected to the coupling 28 which couples the axial drive means to the axially movable shaft 26 as occurs in FIG. 1.

The stepping motor 86 is seen to comprise a group of eight series connected coils 88-102 individually wound and stacked to form a stator 104. Each coil winding is of a length "l" as shown in FIG. 4a. In addition to the

coils 88-102 being connected in series, each junction 88'-104' is brought out to a respective terminal 88''-104'' within a shift register 104. An axial center-through shaft 108 is positioned within the stacked coils 88-102. The axial center-through shaft 108 contains an armature portion 110 which consists of an iron slug of length "d." Stepping of the armature 110 is accomplished by appropriately energizing any of the terminals 88''-104'' within the shift register 106. When any two of the terminals, e.g. 94'' and 96'' are energized, the coil therebetween, namely, 94 will carry an electric current thereby creating an electromagnetic field which will in turn center the armature 110 within the field. It will be seen that any position can be directly addressed and that each incremental step will be determined by the coil length "l" with a maximum displacement of slug length "d." Since in the instant situation there are eight rows within the character matrix on drum 52, the stepping motor shows a total of eight individual stator coils such as shown in FIGS. 4a and 4b. Each coil thus defines an axial position of the shaft 106 which corresponds to a position of a given row on the character drum 52 relative to the ink ribbon 24.

Impact printing is accomplished in FIG. 1 by moving the print head 10 toward the ink ribbon 24 and causing a positioned character to be printed. The specific manner in which the print head 10 of FIG. 1 is moved toward the ink ribbon 24 is itself considered novel and forms the subject matter of the commonly assigned U.S. Pat. application Ser. No. 94,034, filed Dec. 1, 1970, to Pateuk et al., entitled, "Internal Actuator for a Serial Printer Print Head." It should be appreciated that there are other ways of impact printing of which one particular alternative approach is the impact hammer arrangement disclosed in conjunction with FIG. 6 which will be described hereinafter.

The print head 10 is moved toward the ink ribbon 24 by actuation of the pivotal yoke 72 which, as previously described, supports and retains the hollow shaft 62 within its cylindrical neck 64 at bearing points 66 and 68 respectively. The pivotal yoke 72 furthermore comprises a set of yoke arms 112 and 114 which extend back from a set of pivotal points 116 and 118. Referring to FIG. 3, the pivotal points 116 and 118 define a pivotal axis 120 which intersects and passes through the flexible coupling 70. The flexible coupling 70 constitutes a relatively short portion of the total length of the hollow shafting which consists of shaft 74, coupling 70 and shaft 62. The type of flexible coupling used herein is a Heli-Cal Double Flexing Shaft Coupling 4035D of length .56 inches. This particular coupling adequately absorbs the resulting concentrated bending moment about axis 120 when the desired amount of angular bend is introduced in the shafting to cause the impact printing.

Turning now to FIGS. 1, 3 and 5 and the structural implementation of the pivotal motion of pivotal yoke 72, an armature plate 122 is suspended between the yoke arms 112 and 114 and is connected to each arm at points 128 and 130. The armature plate 122 normally defines a gap 132 (as shown in FIG. 5) with respect to an electromagnet 134. When the electromagnet 134 is energized, the armature plate 122 moves toward the electromagnet 134 thus causing yoke 72 to pivot about the axis 120 through the pivotal points 116 and 118. The pivotal movement of the yoke 72 causes the flexible coupling 70 to bend about the axis 120

thereby allowing the upper shaft 62 and the print head 10 to move toward the ink ribbon 24 for impact printing. While the pivotal motion is occurring, the hollow shaft structure 62 is maintained in an essentially undeformed condition by virtue of the yoke cylindrical neck 64 rigidly holding the hollow shaft 62 at bearing points 66 and 68 respectively. Thus a stiff and rigid structural straight line is defined between the flexible coupling 70 and the print head 10.

FIG. 6 is a side elevational showing of an alternative embodiment to that of FIG. 1. This embodiment differs from that of FIG. 1 in essentially two respects. First, the shaft arrangement used for positioning the print head is different, and secondly, the manner in which the impact printing is accomplished significantly differs from that of FIG. 1.

The FIG. 6 structure for impact printing begins with an impact hammer 202 positioned behind a pair of paper guide surfaces 204 and 206 upon which a stretched portion of paper 208 is presented for printing. An ink ribbon 210 is interposed between the stretched portion of paper 208 and a print head 212. The print head 212 is similar to that of FIG. 1 in that it consists of a character drum surface 214 with an 8 by 12 matrix arrangement of raised characters. Printing is accomplished by moving impact hammer 202 into the stretched portion of paper 208 which in turn contacts ink ribbon 210 and a given positioned raised character 216. This type of impact printing including the synchronized movement of the impact hammer support (which is not shown here) in conjunction with carriage movement is further explained in U.S. Pat. No. 3,168,182 to Bernard et al.

The FIG. 6 apparatus which positions the print head 212 for the aforementioned impact printing by the hammer 202 is best understood by first looking at the overall carriage structure. The print head 212 is mounted at the top of a carriage apparatus 218 which moves laterally on a double set of guides 220 and 222 in much the same manner as previously discussed with regard to FIG. 1. The print head 212 is also positionable in both the rotational and axial directions, but with a different type of positioning shaft structure than that of FIG. 1.

The positioning shaft structure of FIG. 6 starts with the print head 212 being affixed to a movable shaft 224 by a shaft mount 226 and a securing nut 228. The shaft 224 extends down through a rotational motor 230 which is secured to a cantilevered extension 232 of the carriage apparatus 218 by a set of suitable screws 234 and 236. The shaft 224 further extends through a hole 238 in the cantilevered extension 232 and terminates in a rotatable bearing and mount 240. Rotatable bearing and mount 240 allows for the shaft 224 to rotate above an axially moving rack 242 which will be described hereinafter. For the present, it will be seen that the shaft 224 moves up and down within rotational motor 230 by virtue of the axially moving rack 242.

The structure which allows for the axially moving shaft 224 to be simultaneously rotated is as follows. The shaft 224 has a square cross sectional portion 244 as shown in FIG. 7 which extends almost the entire length of the shaft as shown in FIG. 6. This square cross sectional shaft portion 244 slidably engages a complementary square shaft hole 246 which extends the entire length of a rotatable armature mount 248. The rotatable armature mount 248 is rotatably supported at the

top and bottom of the motor 230 by a set of bearings 250 and 252. An armature 254 is either wound or affixed to the rotatable armature mount 248. The armature 254 is in turn rotatably driven by a stator 256 which surrounds it.

The rotatably driven armature 254 causes armature mount 248 to rotate within the bearings 250 and 252. The rotating armature mount 248 in turn rotates the square shaft portion 244 by virtue of the square periphery of the shaft portion 244 mating within the square periphery of the square shaft hole 246. The shaft 224 is thus seen to rotate by virtue of the aforementioned square peripheral engagement while also moving in the axial direction due to the axially moving rack 242.

The axially moving rack 242 rotatably supports the shaft 224 at the rotatable bearing and mount 240. This thus allows the shaft 224 to freely rotate while also moving axially. The rack 242 is driven in the axial direction by a pinion 258 in much the same manner as the rack and pinion system discussed in connection with FIG. 1. It is furthermore seen that an alternative drive to the rack 242 and pinion 258 would be the stepping motor configuration of FIGS. 4a and 4b. In this latter instance, the rotatable bearing and mount 240 would not be necessary as the center-through shaft 108 would necessarily be free to rotate as well as translate axially.

It should also be appreciated that the form of impacting, namely, the impacting hammer configuration of FIG. 6 can be replaced by the pivotal yoke actuation of FIG. 1. This latter type of actuation necessitates the attachment of a print head 260 at its topmost portion to the shaft 262 as shown in FIG. 8. The print head 260 slidably engages a neck portion 264 of a pivotal actuator 266. A raised character 268 is rotatably and axially positioned by the shaft 262 as is disclosed in the FIG. 6 embodiment. The shaft 262 can either be made flexible enough to bend slightly in response to the yoke pivot, or a flexure coupling can be introduced.

It is furthermore seen that the hollow shaft configuration of FIGS. 1-3 can be combined with the impacting hammer of FIG. 6. In this instance the neck portion 64 of pivotal yoke actuator 72 would be stationary and would act only as a rigid mount for the hollow shaft 62. The pivotal yoke structure and flexible coupling would of course be absent as impacting would be accomplished by the impacting hammer 202 of FIG. 6.

In all of the aforementioned embodiments, a multiple motion has been accomplished that provides heretofore unaccomplished speed and accuracy in the serial printer art. This has been achieved by eliminating a significant number of moving parts while making the remaining parts both rigid and strong. These achievements provide a structural longevity that will be needed in the high speed environment to which these parts are to be exposed. The resulting quick response of the print head is both accurate and devoid of any pause due to either flexing or undue multiple engagements of moving parts.

While the invention has been particularly shown and described with reference to the preferred embodiments, it will be understood by those skilled in the art that other changes in form and details may be made therein without departing from the spirit and scope of the invention.

We claim:

1. A high speed serial printer apparatus for serially printing a line of characters on a print medium comprising:

a print head lying along an axis perpendicular to the print line, said print head containing a matrix of characters formed on the exterior surface in a plurality of rows and columns, said print head further containing an internally splined surface;

means for axially positioning a given row of characters relative to said print line comprising an axially moveable shaft and an axial drive means for driving said axially moveable shaft;

means for rotatably positioning a given column of characters comprising:

a rotational drive element that completely encompasses said axially moving shaft and through which said axially moveable shaft completely passes, said rotational drive element being located above said axial drive means for driving said axially moveable shaft said rotational drive element being free to rotate relative to said axially moveable shaft, and

a drive spline affixed to said rotational drive element and engaging the internally splined surface of said print head;

a carriage means for supportably mounting said print head, said means for axially positioning a given row of characters, and said means for rotatably positioning a given column of characters; and

means for guiding said carriage means along a line parallel to said print line whereby said carriage apparatus is incrementally stepped a character position at a time and said print head is both rotated and moved axially to position a given character for impact printing with the print medium.

2. The apparatus of claim 1 wherein said print head is rotatably connected to said axially moveable shaft by a rotatable bearing which is affixed to both the uppermost portion of said axially moveable shaft as well as to the uppermost portion of said print head so as to allow said head to be rotatably driven by said drive spline affixed to said hollow shaft while simultaneously being driven in the axial direction by said axially moveable shaft and said rotatable bearing.

3. The apparatus of claim 2 wherein:

said rotational drive element comprises a hollow shafting with an inside diameter greater than the diameter of the axially moveable shaft.

4. The apparatus of claim 2 wherein said rotational drive means further includes an armature affixed to said hollow shafting and a stator completely surrounding said armature whereby said hollow shafting is caused to rotate in response to the establishment of a magnetic drive force between said stator and said armature.

5. The apparatus of claim 4 wherein said axial drive means comprises a rack and pinion wherein said rack attaches to said axially moveable shaft and said pinion slidably engages a rotatable splined shaft extending along a line parallel to the direction in which said carriage apparatus is stepped.

6. A high speed serial printer apparatus for serially printing a line of characters on a print medium a character at a time comprising:

a print head lying along an axis perpendicular to the print line, containing a matrix of characters formed thereon in a plurality of rows and columns;

means for axially positioning a given row of characters on said print head relative to the print line said axially positioning means comprising an axially moveable shaft and an axial drive means connected to said axially moveable shaft for driving said axially moveable shaft;

means for rotatably positioning a given column of characters on said print head, said rotatable positioning means being located above said axial drive means and comprising:

a rotational drive element encompassing the circumference of said axially moveable shaft and through which said axially moveable shaft completely passes,

an armature affixed to said rotational drive element, and

a stator completely surrounding said armature whereby said rotational drive element is caused to rotate in response to the establishment of a magnetic drive force between said stator and said armature;

a carriage means for supportably mounting said print head, said means for axially positioning a given row of characters on said print head, and said means for rotatably positioning a given column of characters on said print head; and

means for guiding said carriage means along a line parallel to said print line whereby said carriage apparatus is incrementally stepped a character position at a time and said print head is both rotated and moved axially to position a given character for impact printing with the print medium.

7. The apparatus of claim 6 wherein said stator comprises a plurality of energizable coils arranged to rotatably step said armature into the field created by any of said energized coils to thereby position one of the columns of characters on said print head.

8. The apparatus of claim 7 wherein said rotational drive element comprises a hollow shafting with an inside diameter greater than the diameter of the axially moveable shaft and said hollow shafting is free to rotate relative to said axially moveable shaft.

9. The apparatus of claim 8 wherein said rotational drive means further includes a drive spline affixed to the uppermost portion of the hollow shaft and engaging a complementary spline guide affixed to the interior wall of said print head.

10. The apparatus of claim 9 wherein said print head is rotatably connected to said axially moveable shaft by a rotatable bearing which is affixed to both the uppermost portion of said axially moveable shaft as well as to the uppermost portion of said print head so as to allow said print head to be rotatably driven by said drive spline affixed to said hollow shaft while simultaneously being driven in the axial direction by said axially moveable shaft and said rotatable bearing.

11. The apparatus of claim 9 wherein said axial drive means comprises a gear toothed rack which is engagably driven by a pinion gear, said gear toothed rack being connected to said axially moveable shaft.

12. A high speed serial printer apparatus for serially printing a line of characters on a print medium a character at a time comprising:

a print head lying along an axis perpendicular to the print line containing a matrix of characters formed thereon in a plurality of rows and columns;

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means for axially positioning a given row of characters relative to said print line said axially positioning means comprising an axially moveable shaft and an axial drive means connected to said axially moveable shaft for driving said axially moveable shaft;

means for rotatably positioning a given column of characters on said print head, said rotatable positioning means located above said axial drive means and including a hollow shafting which rotates relative to said axial shafting and through which said axial shaft completely passes;

carriage means for supportably mounting said print head, said means for axially positioning a given row of characters on said print head, and said means for rotatably positioning a given column of characters on said print head; and

means for guiding said carriage means along a line parallel to said print line whereby said carriage apparatus is incrementally stepped a character position at a time and said print head is both rotated and moved axially to position a given character for

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impact printing with the print medium.

13. The apparatus of claim 12 wherein said rotational positioning means further comprises a drive spline affixed to the uppermost portion of the hollow shaft and a complementary spline guide affixed to the interior wall of said print head and engaging said drive spline affixed to the uppermost portion of the hollow shaft.

14. The apparatus of claim 13 wherein said print head is rotatably connected to said axially moveable shaft by a rotatable bearing which is affixed to both the uppermost portion of said axially moveable shaft as well as to the uppermost portion of said print head so as to allow said print head to be rotatably driven by said drive spline affixed to said hollow shaft while simultaneously being driven in the axial direction by said axially moveable shaft and said rotatable bearing.

15. The apparatus of claim 14 wherein said axial drive means comprises a gear toothed rack which is engageably driven by a pinion gear, said gear toothed rack being connected to said axially moveable shaft.

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