Dec. 16, 1958 E. A. HILTON ET AL 2,864,307

PRINTER

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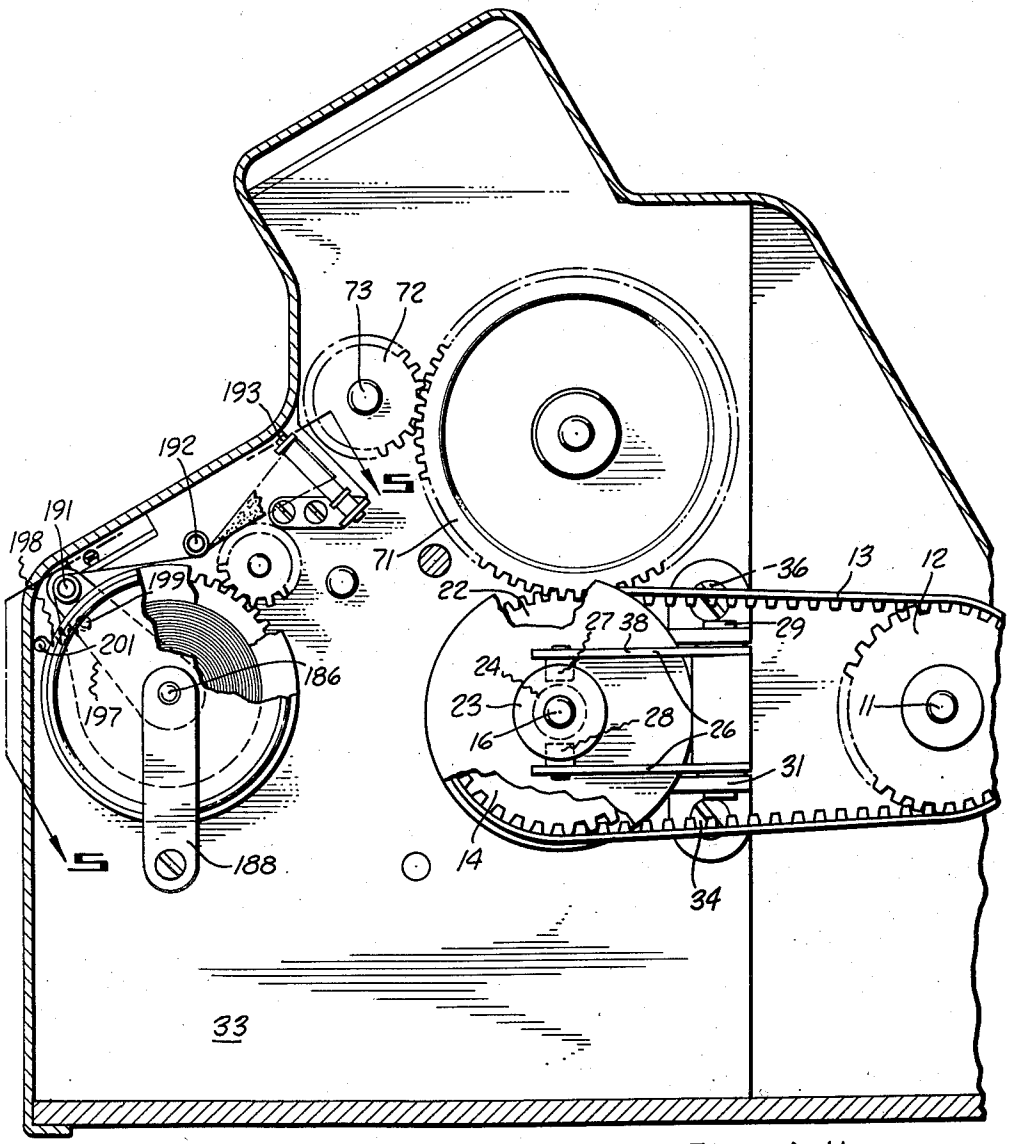

FIG. 1

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Filed March 9, 1956 6 Sheets-Sheet 2

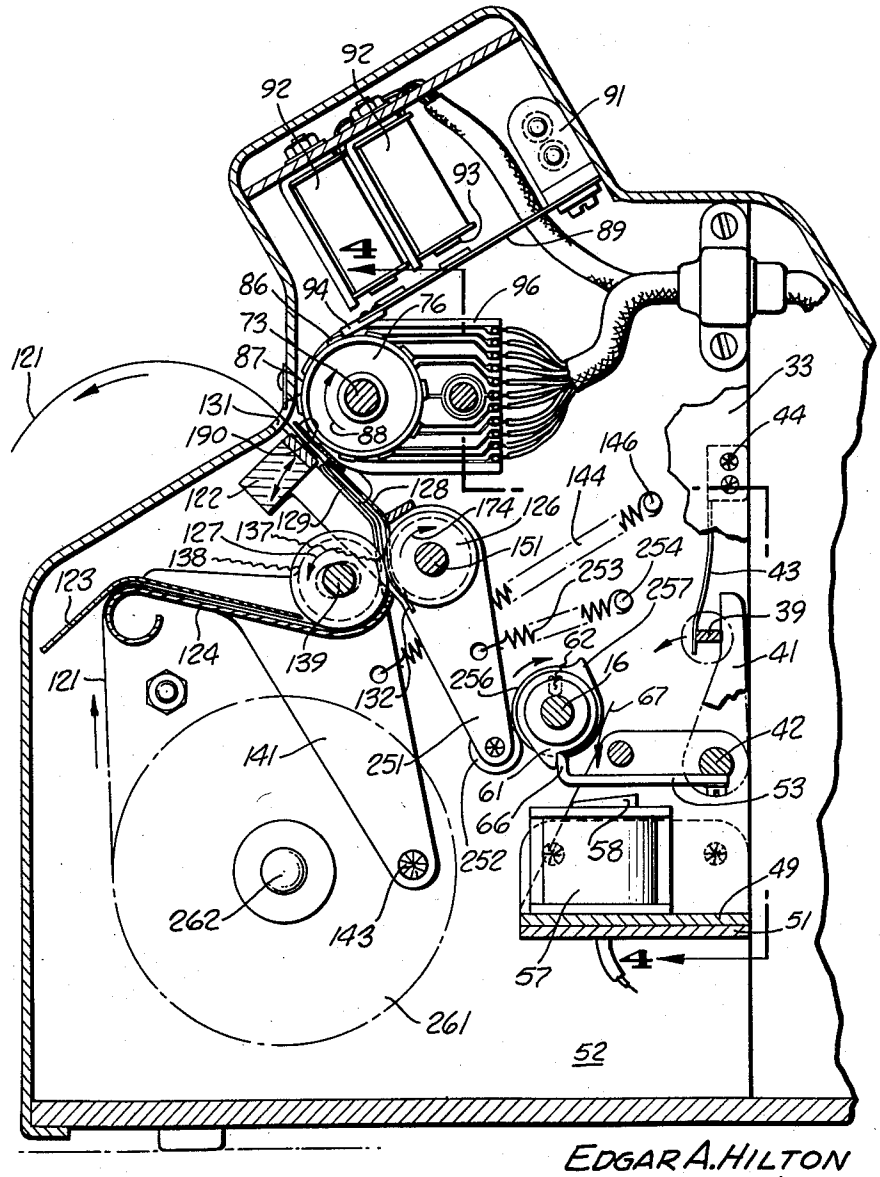

FIG. 2

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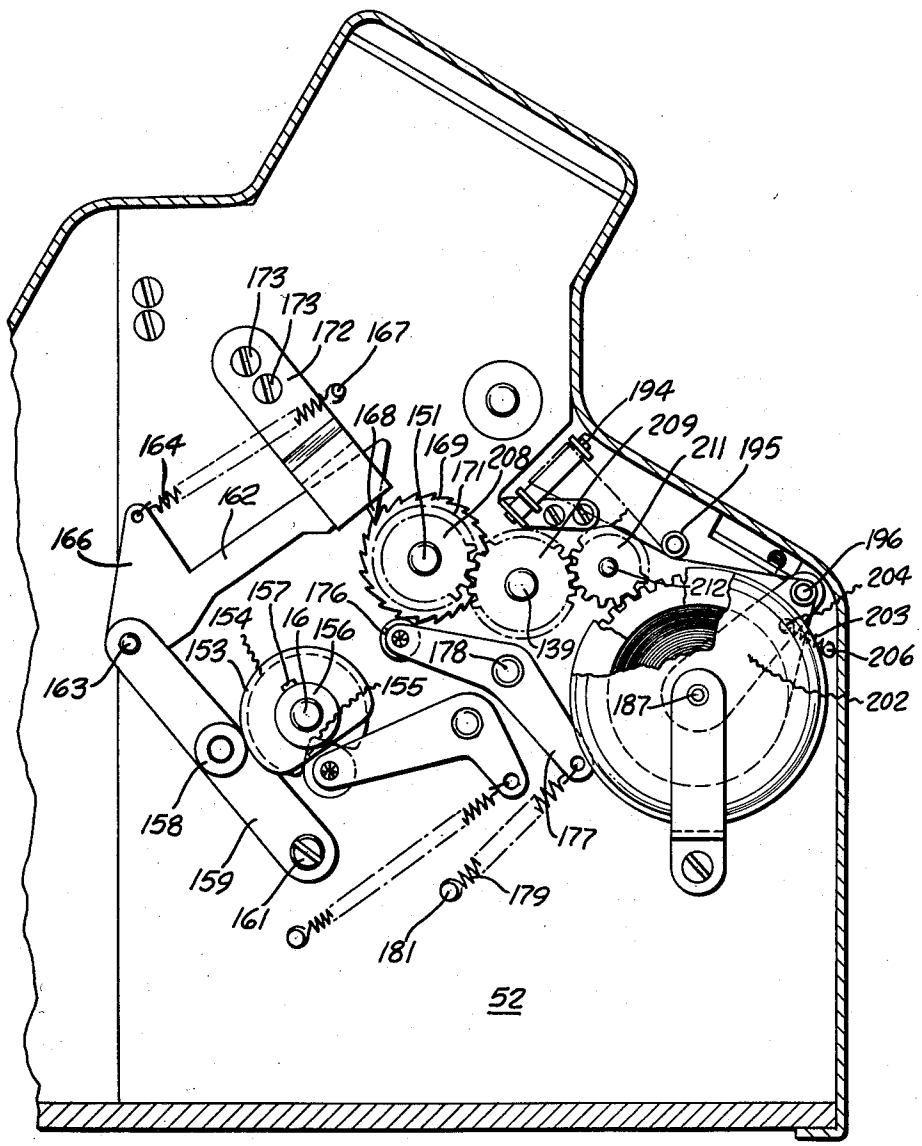

FIG_3

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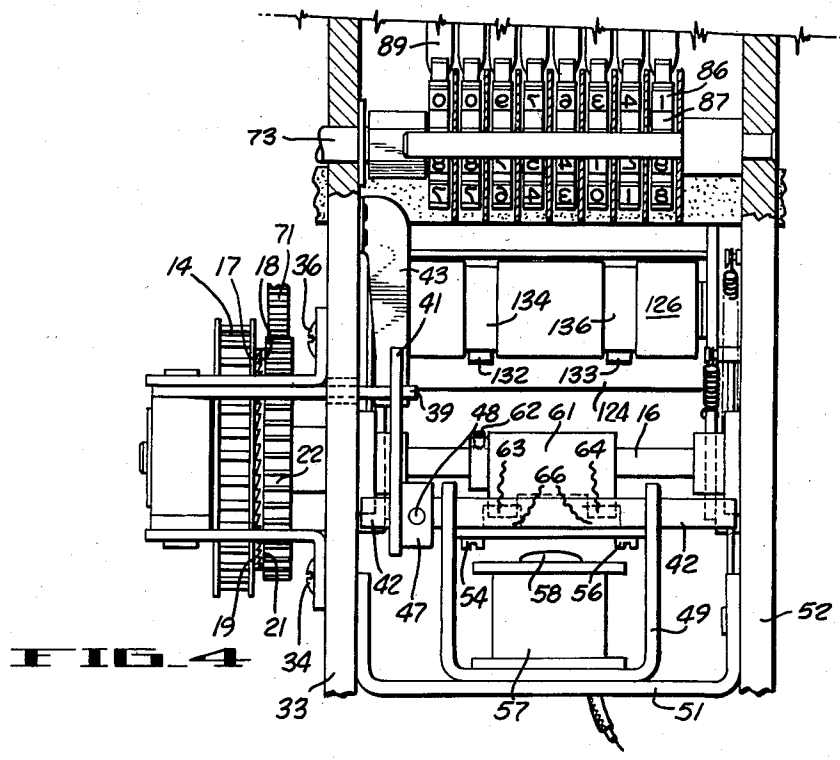

FIG. 4

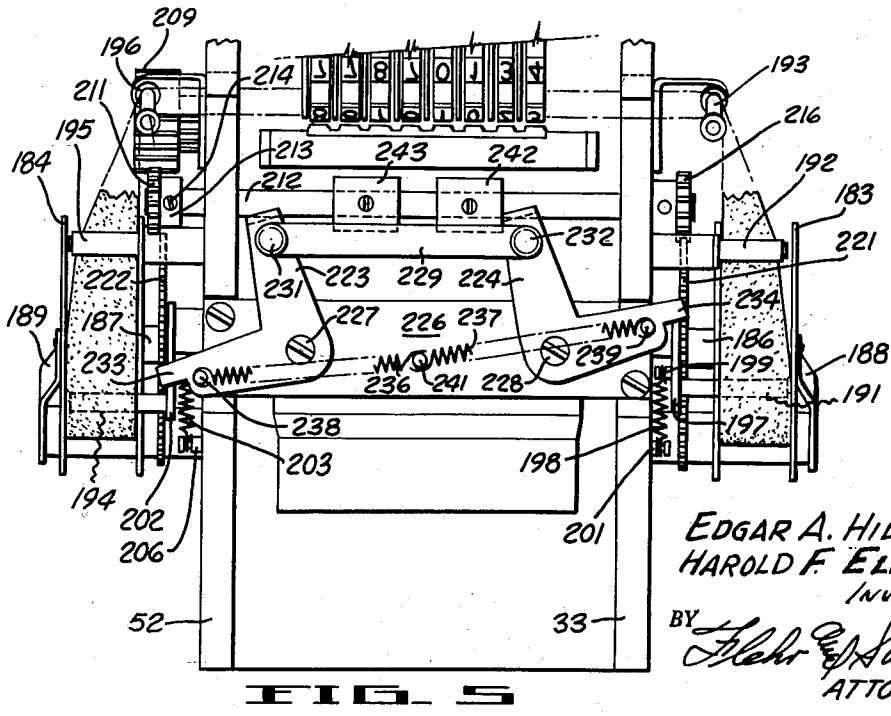

FIG. 5

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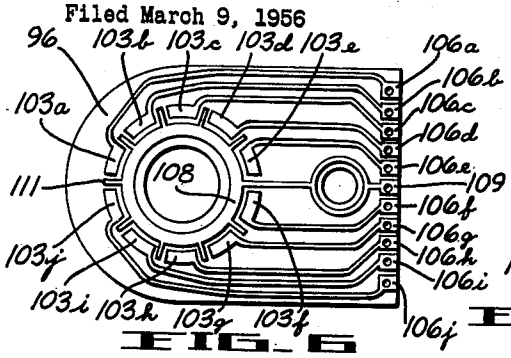


FIG. 6

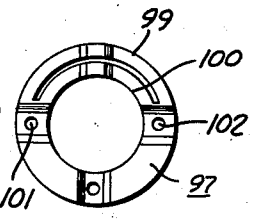


FIG. 7

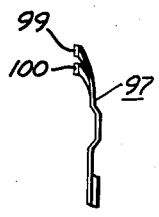


FIG. 8

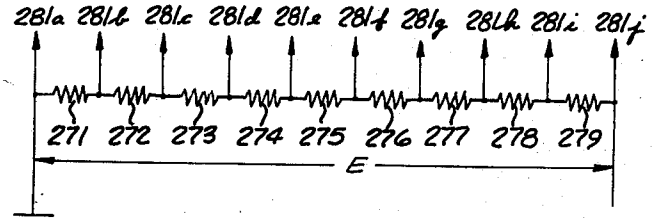


FIG. 10

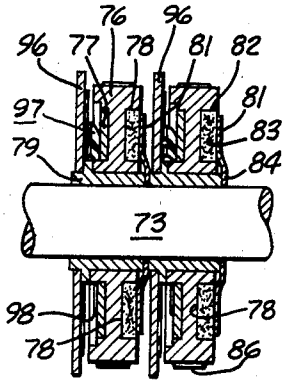


FIG. 9

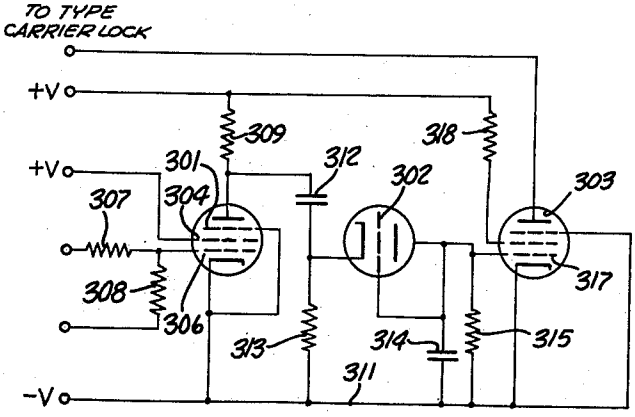
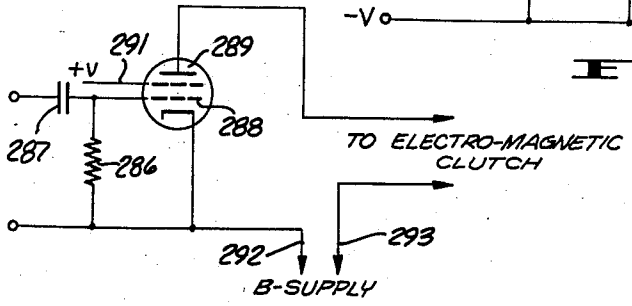


FIG. 12

FIG. 11



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Dec. 16, 1958 E. A. HILTON ET AL 2,864,307

PRINTER

Filed March 9, 1956 6 Sheets-Sheet 6

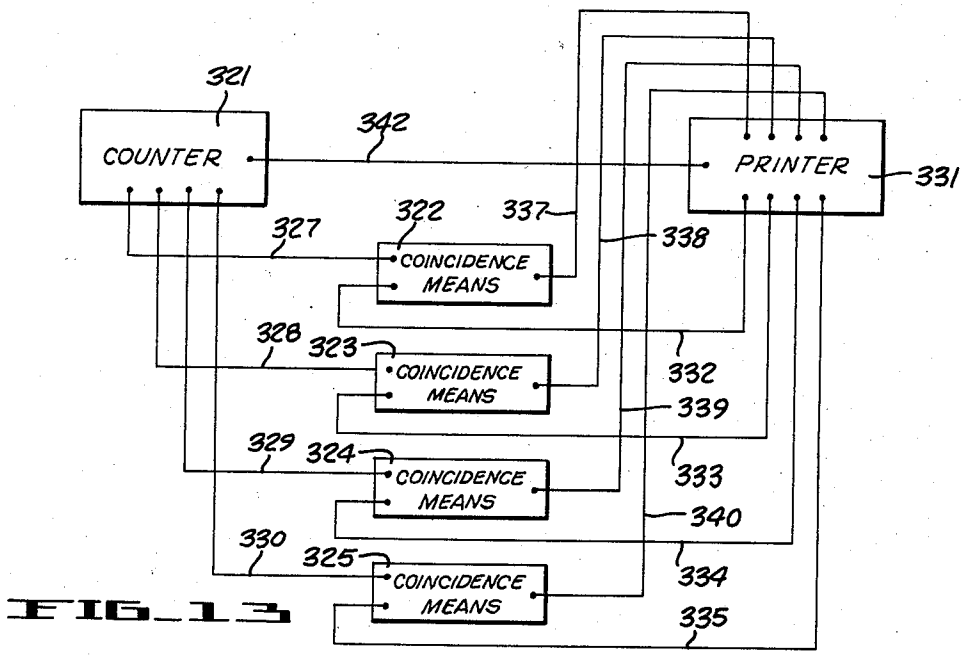

FIG. 13

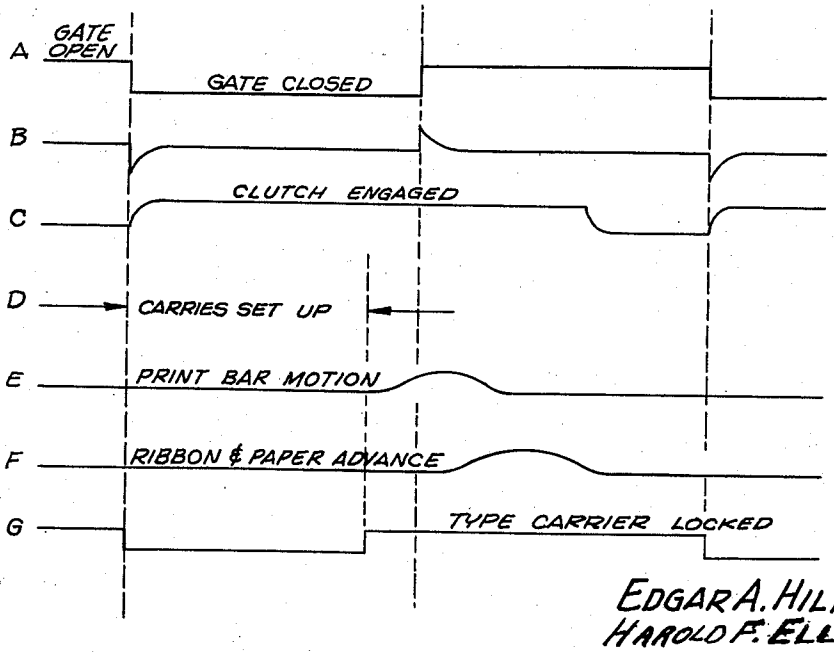

FIG. 14

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United States Patent Office 2,864,307 Patented Dec. 16, 1958

2,864,307

PRINTER

Edgar A. Hilton, Los Altos, and Harold F. Elliott, Menlo Park, Calif., assignors to Hewlett-Packard Company, Palo Alto, Calif., a corporation of California

Application March 9, 1956, Serial No. 570,553

13 Claims. (Cl. 101—93)

This invention relates generally to a printer and more particularly to a printer which is especially suitable for printing data such as displayed by electronic counters.

In co-pending application Serial No. 527,907 filed August 12, 1955 and entitled "Printing Method and System," now abandoned of which this is a continuation-in-part, there is described a printing system which serves to print data which is represented by distinctive data potentials. The system employs a printer which is provided with a plurality of type carriers each having a plurality of type characters corresponding to the data. A plurality of reference potentials are formed each corresponding to a particular type character. The reference potentials are scanned as the print characters are brought into printing position. Coincidence circuits receive the reference and data potentials and generate signals which serve to lock the respective type carrier to thereby hold the character corresponding to the data in print position. The data is then printed.

A system of the above character is particularly adaptable to printing data such as is displayed on electronic counters, frequency meters, time rate indicators, etc. In general, in these systems the data is displayed for a predetermined interval of time and then the apparatus is re-cycled to obtain a new set of data. A printing mechanism for use with a system of the above character must be capable of rapid operation whereby the data is printed during the period that the data is displayed.

It is an object of the present inention to provide a printer which is adaptable for use in systems of the above character and in which a cycle of operation is of relatively short duration.

It is another object of the present invention to provide a printer in which the type carriers are carried and driven by a single shaft.

It is another object of the present invention to provide an electromagnetically-controlled cyclically operated printer which is capable of rapid positive operation.

It is still another object of the present invention to provide an electromagnetically-controlled cyclically operated printer in which the type carriers are set up during a first portion of the cycle of operation and impressions of the characters taken during the second portion of the cycle.

It is still another object of the present invention to provide a novel commutator of the type which is adaptable for use in printers of the above character.

It is still another object of the present invention to provide a printer which has relatively few moving parts, which is compact, and which is relatively simple to assemble and maintain.

It is still another object of the present invention to provide a printer in which the speed of operation does not depend upon the number of digits in the data, and in which any predetermined number of digits may be supplied.

These and other objects of the present invention will

appear more clearly from the following description taken in conjunction with the accompanying drawings.

Referring to the drawings:

Figure 1 is a side elevational view of the printer.

Figure 2 is a side view with the cover removed and showing certain of the parts in section.

Figure 3 is a side elevational view of the opposite side of the printer.

Figure 4 is a view taken along the line 4—4 of Figure 2.

Figure 5 is a partial view taken along the line 5—5 of Figure 1 and showing the ribbon transport mechanism.

Figure 6 shows a commutator suitable for deriving reference potentials.

Figure 7 is a plan view of a brush which may be employed to scan the commutator of Figure 6.

Figure 8 is a side elevational view of the brush of Figure 7.

Figure 9 is a side elevation view in section of a type carrier assembly showing the commutator and brush and driving means.

Figure 10 shows suitable means for forming a reference potential for application to the commutator.

Figure 11 shows a circuit suitable for operating the electromagnetically operated clutch.

Figure 12 shows a suitable coincidence circuit which may be employed in conjunction with the printing mechanism and which serves to provide signals for locking the type carriers.

Figure 13 is a block diagram of a printing system in which the printer may be employed.

Figures 14*a*–14*g* show the sequence of operation of the printer.

In general, the printer serves to print data which may be represented by distinctive source potentials. One source of such potential may, for example, be an electronic counter. Counters of this type display the data for a predetermined interval of time. They also generate a voltage which is distinctive of the displayed count.

The printer is provided with a plurality of type carriers or wheels, each carrying a plurality of characters corresponding to the data to be printed. A power shaft serves to rotatably mount the carriers. Friction drive means is associated with each of the type carriers or wheels and serves to transmit power from the shaft to the respective carrier. A plurality of commutators, one for each of the type carriers, are provided. Each of the commutators has a plurality of contacts, the number corresponding to the number of type characters carried by the carriers. Means are provided for applying a distinctive reference potential to each of the contacts. A sensing means is associated with each of the type carriers and is adapted to rotate therewith. The sensing means serves to sense the potential at each of the contacts sequentially as the carriers are rotated by the shaft. The sensed potential is indicative of the character in printing position.

A plurality of electromagnetic means, one for each of the type carriers, serves to lock the associated type carrier or wheel against rotation when the character corresponding to that digit of the data is in print position. These electromagnetic means are controlled through a suitable circuit, for example, a coincidence circuit of the type described in said co-pending application. The coincidence circuit serves to receive both the reference potential which is sensed by the sensing means and the data potential which is generated by the counters and generates a signal which controls the electromagnetic means to lock the type carriers.

An electromagnetically controlled clutch serves to cyclically apply power to the printer. During each cycle

of operation of the clutch, the power shaft is rotated. During the first portion of the cycle of operation the type carriers are set up or locked to bring all of them in line in printing position. During the second portion of the cycle of operation, an impression of the characters in print position is taken to give a printed record of the data displayed by the counter. Means are also provided for cyclically advancing the paper past the printing platen.

Referring now particularly to Figures 1, 2 and 3, a suitable electromagnetically-controlled means for supplying power to the printer is shown. A motor (not shown) serves to rotate the shaft **11** which carries the gear **12**. The motor, for example, may be any suitable alternating or direct current motor which has sufficient power to operate the printer. The motor serves to continuously rotate the gear or pulley **12** which drives the belt **13**. The belt **13** engages a second pulley **14** which is rotatably mounted on the shaft **16** and adapted to slide axially with respect thereto. A clutch plate **17** (Figure 4) is mounted on the pulley **14**. The clutch plate carries a plurality of teeth **18** on its face. These teeth are adapted to engage the teeth **19** formed on the driven clutch plate **21**. The driven clutch plate **21** is suitably secured to the gear **22** and serves to drive the gear **22** and shaft **16** when the clutch is engaged, i. e., when the teeth **18** and **19** are mated.

A hub **23** having a groove **24** formed therein is suitably secured to the pulley **14** and is adapted to rotate therewith. The fork **26** carries a pair of rollers **27** and **28** which are adapted to ride in the groove **24**. The fork **26** is suitably pivoted on the pin **29** which is carried by the brackets **31** which are suitably secured to the side plate **33** as, for example, by means of screws **34** and **36**. The upper member **38** of the fork **26** has a portion **39** (Figure 4) at right angles thereto and which extends through an accommodating slot formed in the side plate **33**. The arm **39** engages with the arm **41** mounted on the shaft **42**. A spring **43** is suitably mounted on the side plate **33**, for example, it may be riveted **44** to the side plate **33**. The spring **43** urges the arm **39** towards the rear of the printing mechanism whereby the fork **26** is pivoted towards the member **33** to urge the driving plate of the clutch into engagement with the driven plate.

The arm **41** is adapted to rotate with the shaft **42**. The arm **41** may, for example, be attached to the collar **47** which is then secured to the shaft **42** by a set screw **48**. The shaft **42** is journalled on the U-shaped member **49** which is attached to the bracket **51** which is suitably secured to the side plates **33** and **52**. The length of the shaft is such that lateral movement thereof is prevented by the side plates **33** and **52**. An armature **53** is suitably attached to the shaft **42**. For example, the armature may be secured to the shaft **42** by means of the screws **54** and **56**. A coil **57** is carried by the U-shaped member **49** and is attached thereto. A magnetic core **58** is disposed within the coil **57**.

Operation of the electromagnetically-controlled clutch is as follows: As shown in Figure 2, the clutch is engaged (Figure 4) and power is being transmitted to the printer. The shaft **16** is rotated. As the shaft **16** rotates through one revolution, the cam member **61** which is attached for rotation therewith, for example, by means of set screw **62** rotates through a revolution. The member **61** carries a pair of cam surfaces **63** and **64** which engage the upturned portions **66** of the armature. Thus, as the shaft **16** rotates through one revolution, the cams **63** and **64** cam the armature downward in the direction indicated by the arrow **67**. This brings the armature into contact with the magnetic core **58**. When the coil **57** is energized, the magnetic force is sufficient to hold the armature down against the tension of the spring **43**. When the coil **57** is de-energized, the armature **53** is released thereby allowing the spring **43** to urge the arm **41** toward the back of the printer whereby the clutch is engaged for a cycle of operation. Thus, it is seen that I have provided electromagnetic means which serves to control engagement of the clutch. The clutch is operated by de-energizing the coil. The camming action of the cams to urge the armature in contact with the core **58** serves to make practicable the use of the electromagnetic means in which the power requirements are at a minimum.

The gear **22** is attached to the driven clutch member and engages the idler gear **71** which drives the gear **72** mounted on the power shaft **73** which carries and drives the type carriers.

Referring particularly to Figures 4 and 9, a plurality of type carriers are shown mounted on the power shaft **73**. The type carriers **76** have a circular groove **77** which carries a brush, to be presently described, and a circular groove **78** which carries a friction driving disc. Each of the type carriers **76** are rotatably mounted on a bushing **79** which makes a slip fit with the shaft **73**. A spring washer **81** is adapted to fit over the shaft and have its inner portion engaged by the end faces of bushings **79**. The face **82** bears against the friction driving disc **83**. A nut **85** is threaded onto the end of the shaft and serves to apply axial pressure to the bushings whereby the inner portion **84** of washers **81** is locked between bushings. The shaft, washers and bushings then rotate together. Friction between the faces **82** of the washers **81** and the discs **83** rotates the type carriers. The friction is such that the type carriers may be locked against rotation, as will be presently described, and the shaft, bushings and washers may continue to rotate.

Each of the type carriers serves to carry a plurality of characters **86** (Figures 2 and 9) on its outer peripheral face. As previously described, these characters may be numbers or other suitable characters which represent the data to be printed. Between characters **86** there is a detent portion **87**. This detent portion is employed to lock the characters when the characters to be printed are in printing position. Referring particularly to Figure 2, the arrow **88** indicates the direction of rotation of the type carriers. A plurality of armatures **89**, one for each print carrier, are located on the upper side of the printing mechanism and attached to the case by a suitable bracket **91** which extends across and is fixed to the side members **33** and **52**.

Each of the armatures **89** is in the form of a spring, which has a normal position which is as shown in the figure. Electromagnetic means **92** are associated with each one of the armature members **89**. Thus, when the electromagnetic coil **92** is energized, the core **93** becomes suitably magnetized to draw the respective armature upwards. When the electromagnetic means is de-energized, the armature moves downward whereby the end portion **94** falls into one of the detents **87** and abuts against the adjacent face of the type character thereby locking the wheel against further rotation. A circuit, to be presently described, is employed for controlling application of electric energy to the various coils **92**.

Suitable means are provided for sensing and relaying the information relative to the character in print position. Thus, a plurality of commutators **96**, one corresponding to each of the type carrier wheels are disposed between type carriers. Referring particularly to Figure 9, a pair of commutators are shown arranged between wheels. The type wheel carries a brush which rides on the contact elements of the commutator and connects it to an external circuit. Thus, as the type carrier is rotated, the brush rotates therewith and contacts with the contacts of the armature to transmit a voltage which corresponds to the type carrier in print position.

Referring now to Figures 8 and 9, a brush **97** which is attached to a washer **98** rides in the groove **77**. The washer is adapted to tightly fit into the groove whereby the brush rotates with the type carrier. The brush shown in the figures comprises an annular member having portions **99** and **100** formed as segments thereof. These

portions act as the brush element and are connected at their ends 101 and 102. The brush 97 is bent as shown in Figure 8 to provide pressure between the brush and the commutator elements with which it is in contact. It is apparent that the brush may be connected directly to the wheel if desired.

The commutator 96 (Figure 6) is formed with a plurality of contacts 103*a*–103*j*, the number of segments corresponding to the number of print characters carried by the type carrier 76. Suitable means are provided for making an electrical connection to the various contacts 103. Referring particularly to Figure 6, the contacts 103*a*–103*j* are connected by the conductors to the terminals 106*a*–106*j*. The annular member 108 is concentric with the plurality of contacts 103*a*–103*j* and is conductively connected to the terminal 109.

The annular member has a plurality of projections or ears 111 disposed between the contacts. Thus, as the brushes 99 and 100 ride over the contact elements 103*a*–103*j* and the ring 108, the segments are successively connected to the ring. If the ears 111 were not present, the brush elements 99 and 100 would bounce. If a predetermined voltage is applied to each of the terminals 106*a*–106*j*, this voltage is successively commutated to the terminal 109 where it is available to indicate the position of the respective type carrier.

Referring to Figure 2, suitable means are provided for advancing paper 121 between the printing bar or platen 122 and the type carriers 76. Thus, the paper 121 passes between the upper guide 123 and the lower guide 124. The guides 123 and 124 are suitably attached to the plate 141. The paper passes between the paper advancer rollers 126 and 127, between a second pair of guides 128 and 129, past the printing bar 122 and thence through the opening 131. The upper guide 128 has a pair of finger-like members 132 and 133 (Figure 4) which are adapted to ride in the grooves 134 and 136 of roller 126. The lower member 129 similarily has a pair of fingers 137 which ride in accommodating grooves 138. These fingers serve to guide the paper into the opening formed between the members 128 and 129. The rollers 126 and 127 may be formed of any suitable material. For example, they may be formed of soft rubber which will frictionally engage and advance the paper. The roller 127 is mounted on a shaft 139. The shaft 139 is journalled on a pair of spaced arms 141 and 142 (not shown), which are spring-loaded. The arms are pivoted 143 on the side plates 33 and 52. The spring 144 urges the roller 127 against the roller 126. The spring is mounted between the arms 141 and the pins 146 which are suitably secured to the respective side plate.

The roller 126 is mounted on the shaft 151 and extends through the side plates 33 and 52. The end which extends through the side 33 is provided with a suitable knob (not shown) for manually advancing the paper. The other end is provided with means for advancing the paper a predetermined amount during each cycle of operation of the printer.

Referring to Figure 3, the shaft 16 which is cyclically driven by the clutch extends through the side 52 and has attached thereto a cam 153 and a disc 154 provided with a detent 155. The cam 153 and disc 154 are suitably attached to the shaft for rotation therewith. For example, the cam and disc may be carried on a collar 156 which is suitably locked to the shaft, for example, by a locking screw 157. A roller 158 is mounted on the arm 159 and is adapted to ride on the cam 153. The arm 159 is pivoted 161 to the side frame 52. An arm 162 is pivotally connected 163 to the arm 159. A spring 164 is connected between the projection 166 of the arm 162 and a pin 167 which is attached to the side frame member 52. The spring 164 provides a force which keeps the roller 158 in continuous contact with the cam surface. The forward end of the arm 162 is provided with a hook-like portion 168. This portion is adapted to engage the teeth 169 formed on the wheel 171. The wheel 171 is suitably attached to the shaft 151 to thereby rotate the same.

As the shaft 16 is rotated through one revolution, the arm 159 is caused to pivot about the point 161 drawing the hook-like member 168 in such a direction that the wheel 171 is rotated a predetermined amount, which depends upon the spacing of the teeth and the length of the arm 159. The forward portion of the arm 162 is accommodated by a guide 172 which is suitably attached by means of screws 173 to the side frame member. Rotation of the wheel 171 causes rotation of the shaft 151 which rotates the roller 126. As previously described, the roller 126 rotates in the direction shown by the arrow 174 and serves to advance the paper.

The tooth-like members 169 also act as detents. Thus, the roller 176 is mounted on one end of the arm 177 which is pivoted 178 to the side member 52. The other end of the arm is engaged by the spring 179 which has its free end attached to the pin 181 secured to the side member 52. Thus, as the wheel 171 advances through a predetermined angle of rotation, the action of the roller 176 with the teeth 169 serves to exactly position the wheel 171. When the hook-like member 168 is advanced downwardly, it will positively engage a tooth.

Means are provided for taking the impression of the character in print position. The paper which is employed may carry its own carbon paper whereby when the platen 122 provides pressure between the paper and the print character, the character is transferred onto the paper. However, we prefer to use a ribbon which moves between the paper and the print character and which serves to transfer the character onto the paper. The ribbon may be of the type which is used in typewriters. The ribbon carrying and advancing mechanism is shown in Figure 5. A pair of spools 183 and 184, one located on each side of the printing mechanism, are employed to carry the ribbon. The spools are mounted on the shafts 186 and 187, respectively, and held thereon by the spring members 188 and 189. The ribbon passes over the guides 191 and 192. It is then twisted through 90° and passes over the guide 193 laterally through the printer between the print carriers and paper, as shown in Figure 1, and then over a complementary set of rollers. These rollers are shown in Figure 5 and are labelled 194, 195 and 196.

The roller 191 is mounted on an arm 197 which is pivoted on the shaft 186. Spring 198 is mounted between the pins 199 and 201. The pin 199 is mounted on the arm 197 and the pin 200 is mounted on the side plate 33. The action of the spring 198 is to urge the arm in a direction to maintain the ribbon in tension. Associated with the opposite side of the apparatus and pivoted on the shaft 187 is a second arm 202. The spring 203 is mounted between pins 204 and 206 (not shown). The pin 204 is mounted on the arm 202 while the pin 206 is mounted on the side frame 52. Again the spring tends to urge the arm in a direction to maintain the tape in tension.

A gear 208 is mounted on the shaft 151 for rotation therewith. The gear 208 is engaged with a gear 209 which is mounted on the shaft 139 to drive the roller 127 and which also drives the gear 211 mounted on the shaft 212. The gear 211 is provided with a collar 213. Suitable means are provided for locking the gear to the shaft 212, for example, the lock screw 214 may be employed. A second gear 216 is mounted on the other end of the shaft 212 for conjoint rotation therewith. The gear 216 is adapted to engage the gear 221 which is mounted on the shaft 186 and adapted to rotate the same. The reel 183 is removably mounted on the shaft 186 and adapted to be rotated by the same. The gear 211 is adapted to engage with the gear 222 and to drive the associated removable reel 184 through the shaft 187.

The shaft 212 is journalled on the side frame members 33 and 52, and adapted to move transversely with respect

thereto whereby either the gear **216** or gear **211** is engaged with its associated driven gear **221** or **222**. This arrangement permits driving either of the reels, as will be presently described.

A suitable arrangement is provided for moving the shaft **212** transversely to engage the appropriate pair of gears. This arrangement may comprise a pair of arms **223** and **224** which are pivoted on the member **226** at the points **227** and **228**, respectively. A member **229** is pivotally connected to the ends **231** and **232** of the arms **223** and **224**, respectively. The other ends of the arms **233** and **234** are suitably connected to a pair of springs **236** and **237**, respectively. For example, the spring may be attached to the arms by means of pins **238** and **239**. The other end of the spring is mounted on a pin **241** which is fixed to the member **226**. The springs are so arranged that the arms are adapted to assume one of two positions. Thus, as illustrated, the arms are rotated counterclockwise and urged in this direction by the action of the springs **236** and **237**. By rotating the arms in a clockwise direction they will assume a second position of rest and be urged clockwise by the springs. This is achieved by properly locating the pin **241** whereby the action of the spring in the two positions is to rotate the associated arms in the respective directions. The arms engage the collars **242** and **243** to urge the shaft **212** transversely of the printer. In the direction shown, the end of the arm **224** engages the roller **242** to urge the gear **211** out of engagement with the gear **222** and the gear **216** into engagement with the gear **221**. In this position, the reel **183** acts as a take-up reel. When the ribbon is completely unwound from the reel **184**, the tension of the tape will rotate the arm **202**. The end of the arm **202** engages with the end **233** of the arm **223** and serves to rotate the same in a clockwise direction. The other end of the arm **223** then engages the collar **243** to urge the shaft **212** transversely whereby the gear **211** engages the gear **222**, and the gear **216** is disengaged from the gear **221**. The springs **236** and **237** then act to maintain the gear **211** in engagement. Thus, in this way the reel **184** becomes the take-up reel while the reel **183** becomes the supply reel. When the supply reel **183** is completely unwound, it will urge the arm **197** in such a direction as to disengage the gear **211** and engage the gear **218**. Thus it is seen that I have provided an arrangement in which the function of the reels is automatically interchanged as all of the tape is fed from one to the other.

The gearing may be such that the shaft **73** which carries the type wheels or carriers rotates through two revolutions, while the shaft **16** undergoes a single revolution for a cycle of operation. During the first revolution of the shaft **73**, each of the type carriers is locked in position whereby the appropriate print character is in the print position. During the second revolution, the printing bar is urged upward to print the characters in printing position. This is accomplished by means of the pair of arms which are located at opposite ends of the print bar and which are pivotally mounted on the shaft **151**. It is, of course, apparent that different gearing may be employed. Thus, during the first portion of a cycle the carriers are locked and during the second portion a print is made.

Referring particularly to Figure 2, the arm **251** which is mounted inside the side plate **52** is shown. A similar arm is mounted just inside the side plate **33** and operates in the same manner. The arm **251** has a roller **252** mounted at one end thereof. The arm is engaged by a spring **253** which is mounted on the pin **254** mounted on the side frame **52**. The spring **253** urges the roller **252** into contact with the cam **256**. The printing bar or platen is mounted on the other end of the arms **251**. Thus when the shaft **16** rotates through one revolution, the cam **256** urges the arm in such a direction that when the roller reaches the point **257** the printing bar is moved to print the characters in printing position. Although I have described a single arm **251** with associated cams and rollers, it is to be understood that a similar arrangement is located on the opposite side of the printer.

The paper may be carried by a roll **261** which is mounted on the shaft **262**, or the paper may be folded and laid on the bottom plate.

A suitable circuit for forming reference voltages for application to the contacts **103***a*–**103***j* is shown in Figure 10. A voltage E is applied across the series resistors **271**–**279**. Leads are connected to the ends of the series combination and to the common junction of each of the resistors. The leads **281***a*–**281***j* are adapted to be connected to the terminals **106***a*–**106***j*. The potential appearing at each of these leads depends upon its position along the series combination. Thus, the voltages applied to the contact members **103***a*–**103***j* will increase step-wise in a clockwise direction. When these contacts are scanned clockwise by the brushes **99** and **100**, the voltage which appears at the terminal **109** will be an increasing step voltage, the particular voltage depending upon the angular position of the type carriers.

As previously described, the printer may be used to print any data which is represented by distinctive potentials. For purposes of illustration only, it will be described with reference to electronic counters. In electronic counters the unknown frequently is applied to the counting circuits when a gate is opened. When the gate closes, the counting circuits display the count for a predetermined controllable period of time. The counting circuits are then reset to zero and the gate is opened for the next count. In general, apparatus of this type may be adapted to provide a plurality of output or source potentials which are indicative of the value of each digit of the count.

As previously described, the printer is adapted to print during the interval that the gate is closed and the count is being displayed. This is accomplished by employing the pulse which serves to close the gate at the completion of the count to de-energize the coil **57** which holds the armature **53**. As previously described, this initiates a print cycle.

A suitable circuit for de-energizing the electromagnetic means in response to a pulse is shown in Figure 11. The RC circuit composed of resistor **286** and capacitor **287** serves to apply a negative pulse to the control grid **288** of the tetrode **289**. The screen grid **291** is connected to a source of screen voltage +V. Plate voltage is applied to the terminals **292** and **293**. The coil **57** of the electromagnetic clutch is connected in the plate circuit. The operating voltages are selected whereby the tube is continuously conducting to keep the electromagnetic means energized. When the gate closes, the RC network develops a negative spike which momentarily cuts off the tube. At this instance, the coil is de-energized and the armature **53** is released whereby the clutch is engaged to drive the printer through one cycle of operation. The tube goes immediately back into conduction whereby the coil **57** is re-energized to engage and hold the armature when it is cammed downward by the cams **63** and **64**.

As previously described, the print characters are locked in a printing position when the electromagnetic means **93** is de-energized to release the arms **89** and then drops down to engage the members **94** with the associated detens **87** formed on the print carriers. Two coincidence circuits which are suitable for controlling the electromagnetic means are shown and described in said co-pending application. These circuits serve to de-energize the electromagnetic means when the source and reference potentials have a predetermined relationship. One of the circuits described in said copending application is shown in Figure 12.

The circuit in Figure 12 operates on a carrier frequency principle. It comprises a first amplifier tube **301**, triode **302** connected as a detector, and a second amplifier **303**. A suitable D. C. voltage is applied to the screen grid **304** of the tube **301**. A carrier signal is applied to the con-

trol grid 306 through the resistor 307. The input signal which is derived by combining the source and reference potential, as will be presently described, is also applied to the grid 306 through the resistor 308. The plate of the tube 301 is connected to a plate supply voltage through the resistor 309. The plate is also connected to the line 311 through the series combination capacitor 312 and resistor 313. The suppressor grid is directly connected to the cathode and to line 311. The cathode of the triode 302 is connected to the common junction of the capacitor 312 and resistor 313. The plate and grid of the tube 302 are connected together and to the line 311 through the parallel combination of capacitor 314 and resistor 315. The control grid 317 of the amplifier tube 303 is connected to the plate of the tube 302. The screen grid is connected to the plate supply voltage through the resistor 318. The suppressor grid is connected to the cathode and to line 311. The plate is connected to the electromagnetic means 92 and serves to provide current to the coils of the same.

The voltages applied to the elements of the tube 301 are such that the tube does not amplify the carrier signal until the reference and source voltages are coincident (have a predetermined relationship). When the voltages are coincident the tube 301 amplifies the carrier signal and the amplified signal is applied to the triode 302 connected as a detector. The detected signal is applied to the grid 317 to cut off the tube 303. The associated electromagnetic means 92 are de-energized and the arms 89 drop whereby the end portion 94 of each engages the detent formed in the associated type carrier and serves to lock the same against rotation. It is noted that when the type carriers are locked in position, the circuits are coincident and all of the electromagnetic means 92 remain de-energized. Each electromagnetic means is again energized during the next cycle of operation of the printer if the data associated therewith has changed.

In certain equipment, the reference and source voltages may vary between different limits. It is desirable to provide a suitable mixing circuit for the reference and source potentials. A suitable circuit which comprises a series combination of resistors with suitable taps is described in said copending application.

Operation of the printer in a system will be more clearly understood with reference to Figures 13 and 14. Referring particularly to Figure 13, which is a block diagram of a printing system, the electronic counter 321, which may include a plurality of decade counters connected in cascade, is shown connected to associated coincidence means 322—325 through lines 327—330. The printer 331 supplies a plurality of reference potentials, which correspond to the print character in printing position, to the coincidence means 322—325 along lines 332—335. A signal is applied by each of the coincidence means to the associated electromagnetic means 92 of the printer along lines 337—340. The signal from each of the coincidence means serves to selectively lock the associated type carrier whereby the data represented by the counter 321 is printed when the printing bar is cammed. The gate voltage which initiates the print cycle is applied to the printer along the line 342.

Referring particularly to Figure 14, the time sequence of operation is graphically illustrated. Curve 14*a* shows the gate voltage. As previously described, the gate is opened for a predetermined period of time. The gate is then closed. When the gate is closed, the count is displayed by the counter. The plurality of source voltages which correspond to the data displayed by the counter are available at the counter. These are applied to the coincidence means 322—325. Figure 14*b* shows the pulse which is applied to the grid 288 of the tube 289. As previously described, the RC network develops a spike which serves to cut off the tube whereby the clutch is engaged, Figure 14*c*.

The printer then undergoes a complete cycle of operation before the clutch drive and driven members are disengaged by the action of the cams 63 and 64 against the armature 53. During the first half of the printing cycle the shaft 73 rotates through one revolution and the type carriers are set up, Figure 14*d*, and locked, Figure 14*g*, with the appropriate type character in print position. During the second half of the cycle the roller 257 is engaged to pivot the arm 251 to urge the printing bar or platen upward to print the data. Shortly thereafter the ribbon and paper are advanced, Figure 14*f*. This makes the data available immediately after it is printed. Each of the plurality of type carriers is operated upon in the manner described. The description was limited, in parts, to a single carrier to simplify the discussion.

We claim:

1. A printer which serves to print data which is represented by a plurality of data potentials comprising power means, a driven shaft, an electromagnetically controlled clutch serving to cyclically drive said shaft, a plurality of type wheels each having a plurality of print characters rotatably carried in side-by-side relationship on said shaft, means associated with each of said wheels serving to drive the same, a commutator having a plurality of contacts disposed adjacent each of said wheels, means for applying reference potentials to the contacts, sensing means associated with each of said wheels and adapted to rotate therewith and serving to make contact with the associated commutator to sense the reference potentials to indicate the character in print position, electromagnetic means associated with each of the type carriers serving to selectively lock the associated carriers when the print character corresponding to the data is in print position, and means for taking an impression of the characters in print position.

2. A printer of the type which serves to print data which is represented by a plurality of potentials comprising a plurality of type carriers one for each digit of the data, each carrier serving to carry a plurality of type characters, a driven shaft serving to rotatably mount said type carriers in side-by-side relationship, friction means associated with each of said type carriers, drive means associated with each type carrier and with said shaft and adapted to be driven by the shaft, said drive means serving to engage the friction means to drive said carriers, a commutator associated with each carrier having a plurality of contacts one for each type character of the associated type carrier, means for applying a distinctive potential to each of said contacts, sensing means associated with each type carrier and adapted to be rotated therewith, said sensing means serving to sense the potential of each of said contacts individually and sequentially as the type carrier rotates, the sensed potentials being indicative of the character in printing position, a plurality of electromagnetic means one for each type carrier serving to lock the associated type carrier when the type character corresponding to the data is in print position, an electromagnetically controlled clutch serving to cyclically drive the printer, said type carriers being locked during the first portion of a cycle and remaining locked through the remainder of the cycle of operation, and means serving to take an impression of the characters in print position during the second portion of the cycle of operation.

3. Apparatus as in claim 2 in which said driven shaft undergoes two revolutions during each cycle of operation, and wherein said type carriers are locked during the first revolution and an impression is taken during the second revolution.

4. Apparatus as in claim 2 in which said commutator comprises a plurality of spaced contacts lying on a circle, and a concentric ring disposed adjacent therein, said sensing means comprising a brush adapted to engage one of said contacts and said ring to successively connect the contacts to the ring.

5. A printer which serves to print data which is repre-

sented by a plurality of data potentials comprising a driven shaft, a plurality of type wheels rotatably carried in side-by-side relationship on said shaft, each of said wheels carrying a plurality of print characters, each of said wheels serving to carry a friction disk, a plurality of drive rings each engaging one of said friction disks carried by said shaft and adapted to rotate conjointly therewith, the drive rings serving to frictionally drive the disks and associated wheels, commutating means associated with each of said wheels and serving to derive a potential indicative of the character in print position, electromagnetic means serving to selectively lock each of the type carriers, and means for taking an impression of the characters in print position.

6. A printer which serves to print data which is represented by a plurality of data potentials comprising a driven shaft, a plurality of type wheels rotatably carried in side-by-side relationship on said shaft, each of said wheels carrying a plurality of print characters, a drive disk carried by each of said type wheels, a plurality of drive rings one disposed adjacent to each of said type wheels and adapted to engage the adjacent drive disk, each of said rings being mounted for conjoint rotation with the shaft, said rings serving to frictionally drive the drive disks and wheels, sensing means carried by each of said wheels, a commutator disposed adjacent said sensing means and having a plurality of potentials applied thereto, said sensing means and commutator serving to develop potentials which are indicative of the character in print position, electromagnetic means serving to selectively lock each of the type carriers, and means for taking an impression of the characters in print position.

7. A printer as in claim 6 wherein said commutator has a plurality of spaced contacts arranged on a circle, said commutator being mounted coaxially with the associated wheel, a circular ring disposed adjacent said contacts and concentric therewith, said sensing means being adapted to ride on said ring and individual ones of said contacts to thereby electrically connect the successive ones of the contacts to the ring.

8. Apparatus as in claim 7 wherein said circular ring disposed adjacent the contacts and concentric therewith has a plurality of finger-like elements formed integral therewith and extending radially outward between said contacts.

9. A printer which serves to print data which is represented by a plurality of data potentials comprising a driven shaft, a plurality of type wheels rotatably carried in side-by-side relationship on said shaft, each of said wheels carrying a plurality of print characters, means associated with each of said wheels for frictionally driving the same, commutating means associated with each of said wheels serving to derive a potential indicative of the character in print position, and electromagnetic means serving to selectively lock each of the type carriers.

10. A printer which serves to print data which is represented by a plurality of data potentials comprising power means, a driven shaft, an electromagnetically controlled clutch serving to cyclically connect said shaft to the power means, a plurality of type wheels each having a plurality of print characters rotatably carried in side-by-side relationship on said shaft, means associated with each of said wheels serving to drive the same, a commutator having a plurality of contacts disposed adjacent each of said wheels, means for applying reference potentials to the contacts, sensing means associated with each of said wheels and adapted to make contact with the associated commutator to sense the reference potentials to indicate the character in print position, and electromagnetic means associated with each of said type carriers serving to selectively lock the associated carriers when the print character corresponding to the data is in print position.

11. A printer which serves to print data which is represented by a plurality of data potentials comprising power means, a plurality of type carrying members each serving to carry a plurality of print characters disposed in side-by-side relationship, means associated with each of said type carriers for driving the same to bring the print characters successively into printing position, a commutator having a plurality of contacts disposed adjacent each of said type carriers, means for applying reference potentials to the contacts, sensing means associated with each of said type carriers and adapted to move therewith and serving to make contact with an associated commutator to sense the reference potential and indicate the character in printing position, electromagnetic means associated with each of the type carriers serving to selectively lock the associated carrier when the print character corresponding to the data is in print position, and means for taking an impression of the character in print position.

12. A printer of the type which serves to print data comprising a plurality of type carriers one for each digit of the data, each carrier serving to carry a plurality of type characters, a driven shaft serving to rotatably mount said type carriers in side-by-side relationship, friction means associated with each of said carriers, drive means associated with each type carrier and with said shaft and adapted to be driven by the shaft, said drive means serving to engage the friction means to drive said carriers, a commutator associated with each carrier having a plurality of contacts one for each type character of the associated type carrier, sensing means associated with each type carrier and adapted to rotate therewith, said sensing means serving to sense the potential at each of said contacts individually and sequentially as the carrier rotates, means for receiving said sensed potential and developing a control signal, a plurality of electromagnetic means one for each type carrier connected to receive said control signal and serving to selectively lock the associated type carrier when the type character corresponding to the data is in print position, and means for cyclically driving the printer, said type carriers being locked during the first portion of a cycle and remaining locked through the remainder of the cycle of operation, and means serving to take an impression of the characters in print position during the second portion of the cycle of operation.

13. Apparatus as in claim 12 in which said commutator comprises a plurality of spaced contacts lying on a circle, and a concentric ring disposed adjacent thereto, said sensing means comprising a brush adapted to engage one of said contacts and said ring to successively connect the contacts to the ring.

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