United States Patent

Robbins et al.

[15] **3,686,678**

[45] **Aug. 22, 1972**

[54] **DUAL MODE ELECTROSTATIC PRINTING**

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[21] Appl. No.: **805,695**

[52] **U.S. Cl.** .....**345/74 ES**, 178/30

[51] **Int. Cl.** **G01d 15/06**

[58] **Field of Search**.....95/4.5; 355/3, 7; 346/74 ES, 346/74 E, 74 CH, 74 S, 74 SB, 74 SC; 197/183; 178/30

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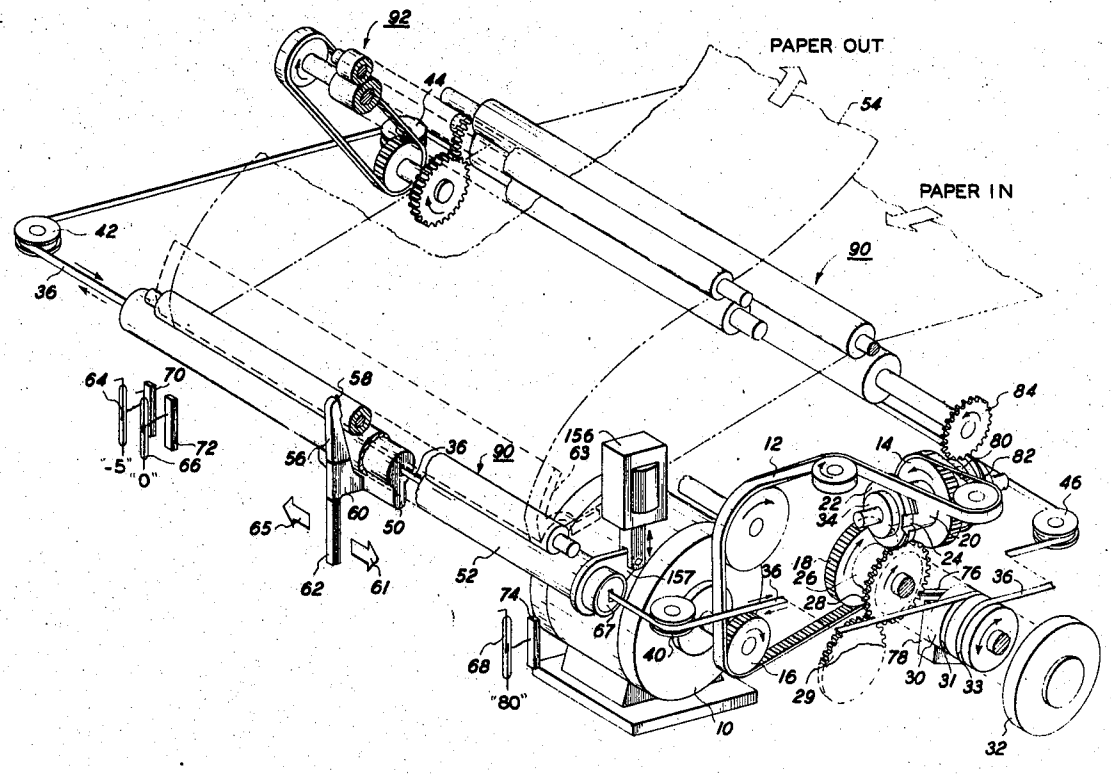
[57] **ABSTRACT**

A dual operating mode electrostatic printer wherein input information from a remote apparatus is printed a line at a time at high speeds in a first operating mode and wherein information from a keyboard is printed a character at a time in a second low speed operating mode.

18 Claims, 6 Drawing Figures



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3 Sheets-Sheet 1

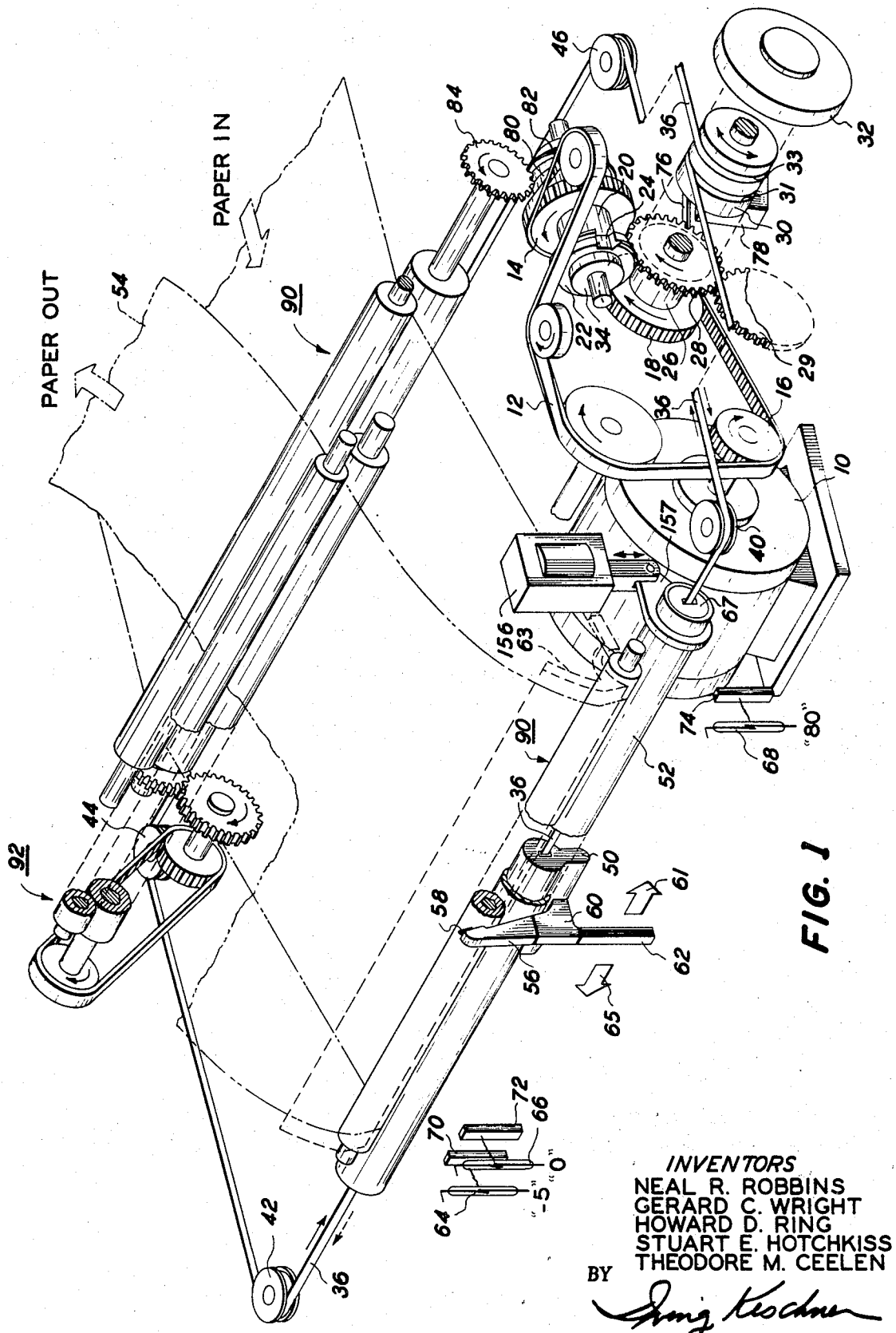

FIG. 1

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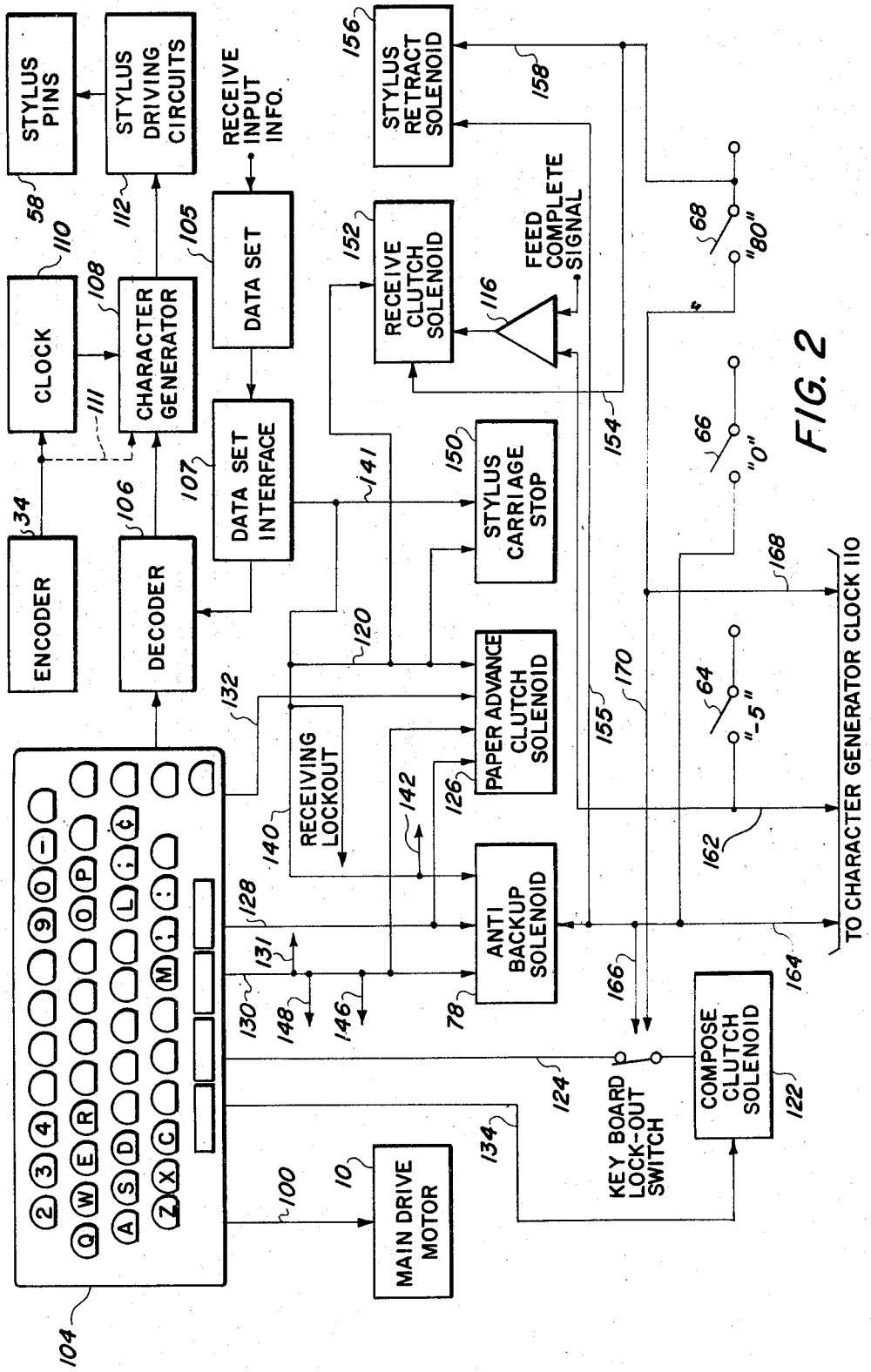
STYLUS PINS
STYLUS DRIVING CIRCUITS
RECEIVE INPUT INFO.
STYLUS RETRACT SOLENOID
CLOCK
CHARACTER GENERATOR
DATA SET
RECEIVE CLUTCH SOLENOID
FEED COMPLETE SIGNAL
"80"
"0"
"-5"
ENCODER
DECODER
DATA SET INTERFACE
STYLUS CARRIAGE STOP
PAPER ADVANCE CLUTCH SOLENOID
RECEIVING LOCKOUT
ANTI BACKUP SOLENOID
MAIN DRIVE MOTOR
KEY BOARD LOCK-OUT SWITCH
COMPOSE CLUTCH SOLENOID
TO CHARACTER GENERATOR CLOCK 110

FIG. 2

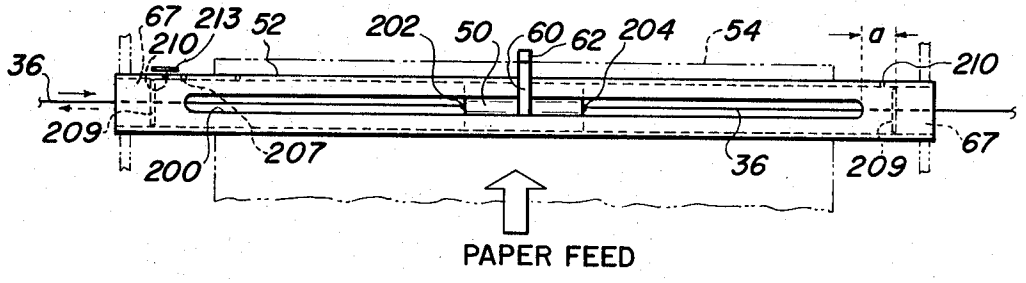

FIG. 3

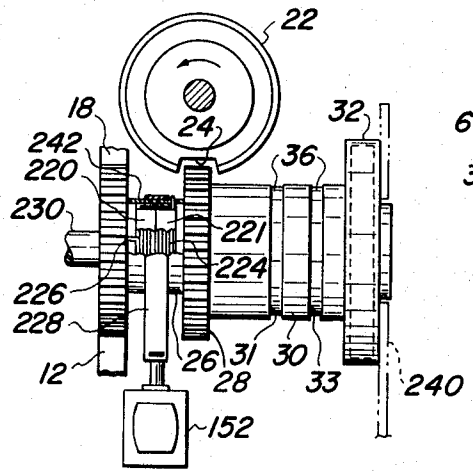

FIG. 4

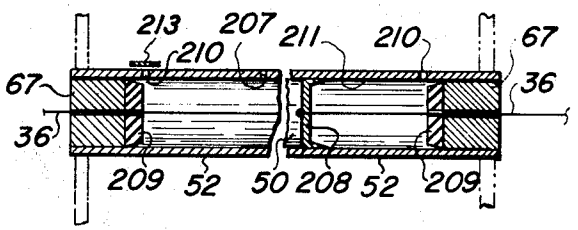

FIG. 3A

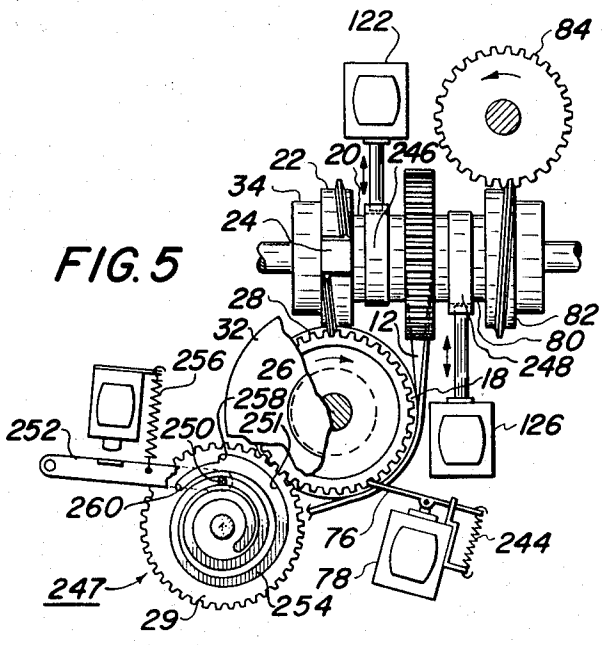

FIG. 5

DUAL MODE ELECTROSTATIC PRINTING

BACKGROUND OF THE INVENTION

Electrostatic printing may be generally characterized as involving a plurality of closely spaced electrodes, or styli, opposed to a wide electrode across which an electric potential is selectively applied sufficient to ionize the air, gas, or other fluid therebetween. An insulating web or sheet is passed between these electrodes, or alternately the electrodes are passed over the insulating web or sheet, and when the electrodes are energized an electrostatic charge is deposited on the web or sheet in the electrode configuration on the area between the energized electrodes. In this manner, a charge pattern is formed on the dielectric material in accordance with the presence, absence, or intensity of the potential applied across the electrodes. This charge pattern, or electrostatic latent image, may then be developed into visual form by the application to the web or sheet of an electroscopic powder, which adheres in conformance with the charge pattern. The resultant developed image, may, if desired, be converted into a permanent record by, for example, the application of heat, if either the dielectric web or the powder is heat softenable, or by coating the charge bearing surface of the web with a fixative, or by softening the web and/or the powder with a solvent vapor. The printing electrodes may comprise a plurality of pins arranged to produce characters through a selective time energization of the pins, the pins being physically separated and electrically isolated from each other.

High operating speed, which is generally desirable in any type of printing apparatus, is critically important in apparatus which directly record the output of electronic computers, telemetering receivers, and the like, because of the high rate with which data for printing are produced by such apparatus. The prior art printing apparatus which utilize the electrostatic printing technique are usually limited in speed due to the displacements of movable members or material masses occurring in the printing operation. The mechanical inertia of such members or masses and the transit times of the required movements are factors inherently limiting their operating speeds. This undesirable characteristic of prior art printing apparatus is caused in part in the mechanism which drives the carriage supporting the pins across the recording member to print alphanumeric characters and other symbols a line at a time.

It is therefore desirable to develop printing apparatus whose high operating speed makes it compatible with high speed data transmission systems. It is also desirable to develop printing apparatus having a dual mode of operation, the high speed mode referred to hereinabove, and a compose mode therein activation of a keyboard will incrementally produce characters a character at a time on a recording medium.

SUMMARY OF THE INVENTION

This invention provides a novel drive mechanism for use in printing apparatus and in particular to a dual mode stylus drive system wherein a high speed mode is utilized for receiving and printing transmitted information from remote apparatus and wherein the low speed mode, or compose mode, is utilized to incrementally produce characters a character at a time as the stylus traverses the width of a recording medium in response to a locally generated input.

It is an object of the present invention to provide a drive mechanism capable of effecting accurately timed reciprocation of a stylus across the surface of a recording medium.

It is a further object of the present invention to provide a high speed stylus drive mechanism for use in an electrostatic printer.

It is still a further object of the present invention to provide a dual mode stylus drive mechanism wherein the first mode input information may be printed at very high speeds and wherein in a second, or compose mode, characters are selectively printed a character at a time.

It is an additional object of the present invention to provide a novel stylus support member which provides means to dampen the speed of the stylus carriage near the ends of the support member and further provides a method for reducing dirt contamination in the carriage drive mechanism.

It is another object of the present invention to provide a novel stylus drive mechanism for use in electrostatic printing apparatus which enables high speed printout of received information in one mode and operates to selectively compose, or type, information on a recording medium in a second mode.

It is still a further object of the present invention to provide means to compensate for the non-uniform speed of a stylus carriage as it is selectively incremented across a recording medium.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the invention as well as objects and further features thereof, reference is made to the following description which is to be read in conjunction with the accompanying drawings and wherein:

FIG. 1 is an exploded view of the novel dual mode stylus drive system in accordance with the present invention;

FIG. 2 is the electrical control circuit for the drive system shown in FIG. 1;

FIG. 3 is a bottom view of the novel stylus support member according to the present invention;

FIG. 3A is a partial cross-sectional view of FIG. 3;

FIG. 4 shows the drum shaft assembly described in FIG. 1; and

FIG. 5 shows the compose shaft assembly described in FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIGS. 1 and 2, there is shown an exploded view of the novel driving mechanism of the present invention with the supporting frame member omitted for clarity and a block diagram representation of the electrical control circuit for the driving mechanism, respectively. Motor **10** is the main mechanical power source in the driving system. A signal on lead **100** rotates the compose and receive timing pulleys from which are driven all active system elements as hereinafter described. Coupled to the motor shaft by timing belt **12** are timing pulleys **14**, **16** and **18**. Timing pulley **14** is coupled to the input hub of a one-revolution spring clutch **20**, the output hub of which is coupled to a cam or worm **22** having a cutout portion **24** thereon. The timing belt **12** also drives timing pulley **18** mounted to the input hub of spring clutch **26**. The

output hub of spring clutch 26 is coupled to gear 28, which is mounted to cable drum pulley 30 having grooves 31 and 33 thereupon. Adjacent to gear 28 and intermeshing therewith is gear 29, the function of which will be described hereinafter. A spring motor 32 is mounted to the other end of drum 30 and shaft encoder 34 is mounted to cam 22. The cable drum 30 wraps and feeds, along grooves 31 and 33, a stylus drive tape 36, the ends of which are anchored to drum 30. The tape 36 is maintained in tension and guided by pulleys 40, 42, 44 and 46. The other ends of the tape 36 are affixed to a carriage structure, or slider, 50 mounted within a slotted portion of carriage support member 52 for motion transverse to recording medium 54 in a reciprocating manner. It should be noted that the tape path for driving carriage slide 50 may be varied from that shown without departing from the spirit of the present invention.

A stylus 56, having a plurality of pins 58 thereon, is mounted to a stylus carriage arm 60 which is affixed to carriage slider 50. The carriage arm 60 serves as a mount for stylus 56 and interposer 62. The carriage support member 52 includes a plug, or cap, 67, at each end with a hole therein to enable the driving tape 36 to be connected to the carriage slider 50. Adjacent the carriage support member 52 is a backing electrode 63, the necessary recording potential being generated between stylus pins 58 and the backing electrode 63. The interposer 62 affects a plurality of reed switches 64, 66 and 68 by shunting associated magnetic field producing means 70, 72, and 74, respectively, as the carriage slider 50 moves within support member 52. An alternate technique of effecting switches 64, 66 and 68 would comprise substituting a magnet for interposer 62, eliminating the necessity of magnets 70, 72 and 74. The switches are located along the carriage slider travel for indicating the column position thereof and are positioned to correspond to "−5", "0", and "80" column positions on recording medium 54 when recording medium 54 is inserted into the apparatus as shown. It should be noted that additional switches may be positioned along the carriage slider travel for indicating additional column positions, as desired. An interposer 76, such as a pawl, engages a tooth space on gear 28 when the interposer is not actuated by solenoid 78, as will be described hereinafter. Recording medium 54 is indexed a row at a time by cam, or worm, 82 and gear 84, the cam and gear combination being coupled to the main motor 10 by a one-revolution spring clutch 80. The pressure and guide rollers, indicated generally at 90, and the roller drive mechanism, indicated generally at 92, are common printer and typewriter elements which may obviously be provided in a form different from that illustrated herein. Other means for supporting these members with relation to one another may be provided in accordance with well known conventional techniques without departing from the spirit and scope of the instant invention which relates more specifically to the means described for effecting drive of the across the recording medium 54 in accordance with the requirements for effecting proper printing.

The operational description of the driving system will now be described in more detail. Motor 10 is the main power source in the drive system and is chosen so that it is near several required system shaft speeds. A motor having a shaft speed of 1,800 revolutions per minute has been successfully utilized. The method of transmission and distribution of the shaft speed is through the timing belt 12. The system has a dual mode of operation as hereinafter will be described.

In the receive operational mode, wherein information is received from remote apparatus, the drive assembly comprises the cable drum 30 for wrapping and feeding the stylus drive tape 36, a wrap spring clutch 26 to drive the stylus in a forward direction, and a spring motor 32 to return the stylus to its initial position, corresponding to the "−5" column position, after a line of alphanumeric characters or symbols are printed electrostatically on recording medium 54. The ends of the stylus drive tape 36 are anchored to cable drum 30. The cable drum rotates through approximately three revolutions which will provide approximately 8 inches of print area per line of characters plus over shoot at both ends required by the stylus carriage slider 50. Alternatively, a cable may also be utilized as the drive element. In this case, the cable drum is modified to include a helical groove along the entire surface thereof to accommodate the cable as it winds and unwinds. The winding and unwinding of a cable on a helically grooved drum for various purposes is a well known technique. The pulleys 40, 42, 44 and 46 guide the tape from the cable drum 30 to the stylus carriage slider 50 and twist the tape into its proper position. The drum contains both ends of tape 36, the tape winding up on itself on groove 31 and unwinding off from groove 33. The wrap spring clutch 26 drives the stylus carriage slider 50 towards the right, or in the forward direction, as indicated by arrow 61, when it is engaged. The input hub of clutch 26 is driven by motor 10 through timing pulleys 16 and 18 at a constant speed. The spring portion of the clutch has one end anchored to the input hub and runs in clearance with the input and output hubs thereof. Clutch 26 is energized by the activation of solenoid 152 upon the closing of switch 64 when carriage slider 50 is at the "−5" column position. The activated solenoid 152 causes an interposer to be pressed against the spring, forcing the spring to drag on the output hub of the clutch add wrap the spring down, locking the input and output hubs of the clutch together, thereby driving the cable drum 30 through connecting gear 28. The deactivation of solenoid 152 by a signal indicating the transmitted information is completed allows the spring to unwind and release the cable drum 30 from the driving motor 10. A return mechanism 32, such as a clock spring, is wound as clutch 26 drives the stylus carriage slider 50 forward from the left, or initial position, corresponding to the "−5" column position, towards the right. When the clutch 26 is disengaged, the spring motor 32 unwinds, driving the stylus carriage slider 50 rapidly back towards the initial position, in the direction indicated by arrow 65. As carriage slider 50 moves reciprocally from left to right, interposer 62 shunts the magnetic fields generated by magnets 70, 72, and 74 effecting reed switches 64, 66 and 68. The effected switches generate electrical signals which are utilized to control various operations of the driving system as will be various operations in more detail hereinafter.

In the receive mode, digitally encoded data is fed from a control computer or other remote apparatus to

a terminal interface, such as standard data set **105**. The term "remote" as used herein is intended to include all apparatus generating information to be rapidly printed other than that generated by keyboard **104**. The data set is a commercially available item commonly employed — as in the present application — as a terminal interface in the transmission of binary encoded data. Essentially the instrument performs as a buffer amplifier, and accomplishes isolation, power amplification, and impedance matching. A suitable instrument of this type is, for example, available from the Bell System under the designation "Model 201A Data Set."

The data set interface section is generally indicated by the numeral **107**. This portion of the present system consists principally of input-output registers and an input router. In addition, conventional timing circuits, including a stable oscillator, electronic counters, and associated logic, are present within the interface section of the system. These elements are not explicitly indicated in view of the fact that the use of such clocking techniques to clock the data in and out of the registers is a technique commonplace and well understood by those skilled in the art of digital data manipulation. The computer furnished data may be considered, for example, as generally made up of successive 10-bit words although in particular instances all of such bits need not be necessarily used in a functional sense. Thus in some typical instances seven bits will represent a character, one bit will be for parity purposes, and two bits will be surplusage. In an illustrative case the data is preceded by a routing word. This first word is decoded by the input router in interface **107** and indicates by its code whether the succeeding data should be routed to decoder **106** or to the solenoid inputs as shown. If routed to decoder **106**, the decoded information is then transmitted to a character generator **108** which, when gated by clock **110**, transmits pulses to stylus driving circuits **112** which drive appropriate stylus pins **58** to generate latent electrostatic alphanumeric characters and symbols on recording medium **54**.

The keyboard **104** for generating characters in the compose mode may be any conventional keyboard for converting an actuated character key into a binary code, as is well known to those skilled in the art of generating digital data. The binary output from the keyboard and the received information from the remote apparatus are routed to decoder **106** which translates pin selection signals and provides a single output pulse for each character to be recorded. The output pulse generated by decoder **106** is fed to character generator **108** which conditions the circuits **112** driving the stylus to effect subsequent energization of associated stylus pins **58**. Character generator **108** is a matrix of switching elements, such as flip-flops or magnetic cores, which operate to distribute the decoder output pulse to the particular switching elements which energize the stylus pins **58** to print a desired alphanumeric character or symbol on recording medium **54**. The details of the decoder **106**, character generator **108** and stylus driving circuits **112** have not been set forth as they are well known to those skilled in the art of digital data manipulation.

When the stylus carriage is at a column position corresponding to "5," the interposer **62** effects switch **64** and a signal, indicating that the stylus **56** is ready for operation, is coupled to one input of gate **116**. A signal, indicating that the paper medium advance has been completed, (generated by means not shown) is coupled to the other input of gate **116** and a signal is produced at the output thereof energizing solenoid **152**, forcing the interposer on clutch **26** to engage the spring thereon, thereby wrapping down the spring and driving the cable drum **30**. The stylus carriage slider **50**, in the receive mode, is brought up to speed by the time the carriage reaches the "0" column position. When the stylus carriage **50** is at the "–5" column position, the signal generated by switch **64** is also coupled to the character generator clock **110**, thereby conditioning the system for character generation when carriage slider **50** reaches the "0" column position.

When a "receive complete" signal is received on lead **120**, clutch **26** is disengaged and the return mechanism **32** drives the stylus carriage slider **50** towards the initial, or "–5" column, position. At the "–5"column position, a ready signal is generated by switch **64** as described hereinabove. The carriage slider **50** may be stopped at position "–5" by a mechanical stop member as will be described hereinafter.

A driving member **28**, such as a worm gear, is mounted to the cable drum to provide an interface with the "compose", or operator input, shaft This provides This provides the second or low speed mode of operation in the novel dual mode drive system of the present invention. The input to the compose drive shaft and the paper feed shaft assembly is timing pulley **14** which is connected to the input hubs of the paper feed one-revolution spring clutch **80** and the compose one-revolution spring clutch **20**. When solenoid **122**, controlling clutch **20**, is pulsed by a signal on lead **124** when an operator actuates a key corresponding to an alphanumeric character or symbol on keyboard **104**, cam **22** is driven through one revolution. The cam **22** drives gear **28**, mounted to the cable drum **30**, moving the stylus carriage slider **50** one column position, or character, towards the right in the direction indicated by arrow **61**. The paper feed clutch **80**, when engaged, drives cam **82** and gear **84**, advancing, or indexing, recording medium **54** one line position. The recording medium advance is initiated by the activation of solenoid **126** which engages the one-revolution spring clutch **80** for any one of the following conditions. Upon activation of a backspace key on keyboard **104**, solenoid **126** is pulsed for one pulse by a signal on lead **128**. Upon activation of a "next line" key on keyboard **104**, solenoid **126** is activated by a pulse appearing on lead **130**. When a "manual paper advance" key is activated, solenoid **126** is energized by a signal appearing on lead **132**, the solenoid being energized until the "manual paper advance" key is inactivated. Finally, the solenoid **126** is energized by a signal on lead **120**, indicating the completion of a transmitted message. The compose clutch **20**, when engaged, moves the stylus carriage slider **50** one column to the right for each actuation thereof. One-revolution clutches **20** and **80** operate as follows. One end of a spring is anchored to the output hub of the clutch. When solenoid **122** is pulsed, an interposer disengages the spring by withdrawing from a dog on a sleeve surrounding the clutch, allowing it to wrap down on the other clutch hub, thereby driving cam **22**. After the pulse is completed, the interposer

returns and re-engages the spring end to limit the clutch to a single revolution. The inertia of cam **22** unwraps and expands the spring, disengaging it from the input hub. An anti-backup device is attached to cam **22** to prevent the backward rotation of cam **22** to inhibit the spring from draging on the input hub. The clutches as described and utilized in this invention are well known to those skilled in the mechanical arts.

Cam **22** has a gear tooth cross-section and is profiled to provide constant acceleration and deceleration of gear **28**. The cam has a cutout portion **24** of approximately **30°** which is chosen such that it is aligned with gear **28** when clutch **20** is disengaged. This will allow gear **28** to turn freely to return the carriage slider **50** rapidly towards the left if the system is suddenly switched to the receive mode. An encoder **34** is mounted to cam **22** to break the column advance of carriage slider **50** into **7** increments of equal length elements, **5** for character information and **2** for intercharacter spacing in the compose mode. As cam **22** is rotated, the encoder generated pulses are connected to the character generator clock **110** wherein the pulse rate of the clock is reduced from a high rate to the required seven pulses per character. This conditions the character generator **108** to emit character information at the proper time, compensating for the varying velocity of the stylus slider **50** as it moves one column position and preventing distortion of the generated character. Alternately, the output of encoder **34** may be coupled to character generator **108** via lead **111**, the output of the character generator being generated at a time interval directly determined by the output of encoder **34**. Encoder **34** is not necessary in the receive mode since the stylus slider **50** is brought up to constant speed at the "**0**" column position when printing is initiated, as described hereinabove and the character printed will generally not be distorted. Encoder **34** can be constructed in any known manner and can include, for example, a wheel having seven inserts of magnetic susceptible material on its peripheral surface and a magnetic induction sensor adjacent thereto for generating seven pulses for every revolution of the wheel. Alternately, the encoder **34** can take the form of a wheel member composed of seven vanes, each vane actuating an adjacent sensor.

The anti-backup mechanism comprises a solenoid controlled interposer **76**, such as a pawl, for engaging gear **28** and preventing clock spring **32** from returning the carriage slider **50** towards the initial position when clutch **20** disengages after a single revolution. Drive cam **22** advances gear **28** slightly more than one tooth pitch, allowing interposer **76** to drop in behind the next tooth. Since the gear and cutout portion of cam **22** are aligned when cam **22** comes to rest, return spring **32** drives gear **28** back against interposer **76**.

The operation of the drive system in either mode commences with the activation of a key on keyboard **104** connecting a source of power to the main drive motor **10** via lead **100**. The carriage slider **50** is initially at rest in the compose mode at the "**0**" column position. The single revolution, solenoid actuated clutch **20**, located on the compose shaft, is normally disengaged as solenoid **122** is not actuated. Activation of any keyboard character key provides a pulse to solenoid **122**, permitting the engagement of clutch **20**. In the receive mode, the carriage slider is initially at rest at the "**—5**" column position and upon receipt of printing information at data set **105**, clutch **26** is engaged as described previously. In the compose mode, clutch **20** may also be activated by a stylus "advance-repeat" series of pulses, appearing on lead **134** when a keyboard key is actuated, which is utilized after an error on the printed line is corrected to return the stylus to the original location without changing the information stored in the compose memory unit, utilize for storing the information to be printed, in an incremental fashion.

The anti-backup solenoid **78** is activated by signals from any one of three sources as follows. Activating the keyboard backspace key pulses the interposer solenoid **78** via lead **128** which allows the stylus carriage return spring **32** to move the stylus right to left one character space. The backspace solenoid **78** may also be activated via lead **140** during the receive mode when a message is being received from the remote apparatus, permitting free reciprocation of the stylus carriage. The receive signal also starts the character clock **110** via lead **142**. The third condition for activating solenoid **78** is in the compose mode at the completion of the last character of a given line when it is desired to return the stylus carriage to the "O" column position. The solenoid **78**, in this situation, is energized by a "next line" signal on lead **130**. This signal also locks out the keyboard by engaging the keyboard lockout switch shown in FIG. **2**, preventing the entry of any information via the keyboard and inhibits the character clock **110** via leads **146** and **148**, respectively. Solenoid **78** remains in this state until deenergized by a signal generated by switch **66** corresponding to the "**0**" column position.

A stylus carriage stop solenoid **150** is utilized to stop the carriage slider **50** at the "**0**" column position when the system is in the compose mode. The solenoid is energized continuously via lead **141** when the system enters the receive mode. Solenoid **150** is released, or deenergized, when it is signalled via a signal on lead **120** that the receive message is complete. The solenoid, when deenergized, stops the rotation of gear **28** when carriage slider **50** is at column position "**0**." The operation of the stop member will be described in more detail with reference to FIG. **5**, discussed hereinafter.

Solenoid **152** controls the high speed, or receive mode, clutch **26** and is energized and held by the closing of reed switch **64**, corresponding to the "**—5**" column position, provided that the paper advance has been completed. The energizing signal is provided at the output of gate **116** which provides an output signal when the "**—5**" column signal and the feed complete signal (generated by means not shown) appears at the input of gate **116**. The high speed solenoid **152** is released by a signal on lead **154** generated when switch **68**, corresponding to the "**80**" column position, is reached or when signalled via signal on lead **120** that the received message has been completed.

The stylus retract solenoid **156** is energized by a signal on lead **158** and held by the arrival of the carriage slider **50** at column position "**80**" or by a "new line" signal via lead **131**. When solenoid **156** is energized, carriage support **52** is rotated partially to lift stylus **56** off the recording medium **54**. The solenoid **156**

may be linear or rotary and actuates arm **157**, connected to carriage support **52**, which rotates the support. Solenoid **156** is released by a signal generated by switch **66** on lead **155**, corresponding to the "**0**" column position, if the carriage slider **50** is moving from right to left.

The "**−5**" column position switch **64**, in addition to its functions described previously, when triggered by the stylus carriage slider **50**, generates a pulse on lead **162** which must be recognized before character clock **110** can run.

The "**0**" column switch **66**, in addition to its previously described functions, conditions the character clock **110** via lead **164** and also releases the keyboard lockout switch via a signal on lead **166**.

The "**80**" column switch **68**, when activated by the carriage slider **50**, generates a signal on lead **168** to stop the character clock **110** and locks out the keyboard to inhibit further entry of characters or codes via a signal on lead **170**, in addition to its previously described functions.

Apparatus for developing the electrostatic latent characters deposited upon the recording medium **54** has not been shown since it does not form part of the present invention. However, any suitable development system may be used, such as the system disclosed in U. S. Pat. No. 3,289,209. The composition of the recording medium has not been set forth in detail since it does form part of the present invention. However, it should have the characteristic or retaining electrostatic charge deposited on the working surface thereof.

It also should be realized that an electrosensitive medium may be utilized as the recording medium whereby current flow between the stylus pins **58** and the backing electrode **63** causes the surface of the electrosensitive medium to darken or change color where the styli pins engage the medium surface, to provide legible distinct marks thereat. This eliminates the necessity for development apparatus of the type described hereinabove.

Referring now to FIG. **3**, there is shown a bottom view of the stylus support member **52**. Visible in this view is the elongated slot portion **200** extending along a substantial portion of the surface. Drive tape **36** is affixed to the carriage slider **50** at **202** and **204**. Retaining means, or plugs, **67** are inserted at each end of member **52** to form an air compression chamber. Affixed to plugs **67** are resilient bumpers **209**, made, for example, from compressible rubber, to partially absorb the energy of slider **50** as it reaches either end of tube **52**. As the carriage slider **50** is driven from left to right or right to left at a high speed, a flexible cup **208**, shown in more detail in FIG. **3A**, and affixed to the carriage slider **50** at each end thereof, passes relief ports **210**. The air pressure ahead of cup **208** increases, causing cup **208** to expand and the air to compress, decreasing the clearance between slider **50** and the inside of tube **52**. Cup **208** may be eliminated if very close clearances are maintained between slider **50** and tube **52**. The decrease in clearance improves pneumatic dampening and the friction between the cup **208** and the inside wall **210** of tube **52** also acts to slow down the carriage slider **50**. An additional relief port **207** is provided at the left end of tube for slowing the carriage slider **50** when, in the compose mode, it is desired to slow the slider as it reaches the "**0**" column position. The left relief port **210** is closed in the compose mode by actuation of a solenoid. The solenoid, by appropriate linkages, forces a member, such a rubber plug **213**, over left relief port **210**. The air ahead of relief port **207** now is compressed, slowing down slider **50**. In the receive mode, all the relief ports remain open, the carriage slider **50** slowing down as described hereinabove. The solenoid for actuating member **213** is not shown in the figure but is similar to the other solenoids described previously, and may be actuated by the "receive complete" signal described in reference to FIG. **2**. The cup **208** is preferably made of a flexible material, such as urethane, although other materials may be utilized. The volume of the support member **52** in which the air is compressed in the receive mode is indicated by "*1*" and may be considered the air compression chamber. A similar volume, not shown, is present on the left side of member **52**. In the compose mode, the volume on the left side of support member **52** is increased because of the added relief port **207**, as described above. The stylus carriage arm **60** extends through slot **200** and is affixed to carriage slider **50**. The carriage slider **50** is preferably made of plastic although other materials may be used. Slider **50**, by moving inside support member **52**, reduces dirt contamination when compared to an external slider. The carriage member **52**, although illustrated as a cylindrical tube, may be formed in various geometric shapes and is preferably made of aluminum, although other materials may be used. Although not shown in the FIG. **3**, the ends of support member **52** include bearings to enable it to pivot, keeping friction minimal, when it is required to retract the stylus, as described hereinabove. For the sake of clarity, bearing members utilized in the shaft assemblies described above have also been omitted from the drawing.

Referring now to FIG. **4**, the drum, or receive, shaft assembly is shown in detail. The Figure shows the cutout portion **24** of worm **22** aligned with worm gear **28**. The worm **22** attains this position after completing one revolution and when the system is operating in the receive mode. Clutch **26** is shown in partial cross-section to illustrate the operation of a wrap down spring clutch. The clutch **26** comprises input and output hubs **220** and **221**, respectively. A spring **224** has one end **226** anchored to input hub **220** and the other end inserted in an aperture in plastic coating, or sleeve, **242**. When solenoid **152** is energized, a spring biased interposer **228**, or brake strap, is pressed against spring **224**. The pressure of interposer **228** on spring **224** forces the spring to be wrapped down on the input and output hubs **220** and **221**, thereby coupling the hubs together and rotating the drum shaft assembly about shaft **230**. The whole assembly is mounted on a suitable frame or bracket **240**, not shown in FIG. **1**. The plastic coating **242** encapsulates the spring clutch to prevent undue wear thereon.

Referring now to FIG. **5**, there is shown the compose shaft assembly illustrating more clearly the elements on the compose shaft assembly. The interposer, or pawl **76**, is biased by spring **244** to rest behind a gear tooth space. When solenoid **78** is energized, interposer **76** is withdrawn from the tooth space and the gear **28** is allowed to rotate freely as long as the interposer is

withdrawn. The interposers associated with solenoids **122** and **126** are controlled thereby and act to engage and disengage the dogs, or projections, on sleeves **246** and **248**, respectively, effecting the respective one-revolution clutch springs as described hereinabove.

A stop member, such as indicated generally by **247**, functions to stop the carriage slider **50** at the "**0**" column position when the system is in the compose mode. A spiral groove **254**, having arcuate portions **258** and **260** included thereon, is cut into the face of gear **29**. A pin **250** is biased by spring **256** to ride on the inside surface **251** of the spiral groove while the system is in the compose mode. The pin **250** is shown in a position corresponding to the slider position as shown in FIG. **1**. If it is assumed that the carriage slider is returning to the initial, or left position, the pin **250** is traveling in a counterclockwise direction inside the spiral groove **254**. When the pin **250** reaches surface **258**, corresponding to the slider at column position "**0**," the pin is prevented from moving any further, thereby stopping gear **29** and slider **50**. In the receive mode, solenoid **150** is continuously energized and arm **252** moves the pin slightly away from surface **251**. In this situation, the pin **250** is enabled to travel past surface **258** and come to rest at surface **260**. If surface **260** is positioned to correspond to the "**–5**" slider column position, stop member **247** acts to stop slider **50** at the "**–5**" column position in the receiver mode.

When the carriage slider **50** is traveling in the forward direction, or from left to right, the gear **28** rotates in a counter clockwise direction and pin **250** moves freely in the spiral groove **254**. In this case, member **247** may act as a positive stop for carriage slider **50** at column position "**80**" if the length of spiral groove is adjusted accordingly.

The invention described hereinabove provides a novel dual mode printing apparatus compatible with high speed data generation and transmission systems. In the receive mode, speeds of greater than five lines per second have been attained. Assuming an **80** character line, this means that more than **400** characters per second may be printed.

While the invention has been described with reference to its preferred embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the true spirit and scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teaching of the invention without departing from its essential teachings.

What is claimed is:

1. Apparatus for printing characters in spaces on a recording medium, said apparatus being selectively operable in either a low or high speed mode of operation, comprising:

a carriage slider having a stylus mounted thereon,

support means located adjacent said recording medium for supporting said carriage slider,

a first drive mechanism for selectively driving said carriage slider at a substantially constant rate across the recording medium between a first and second position on said support means, said first drive mechanism being operable in said high speed mode of operation,

a second drive mechanism for selectively driving said carriage slider incrementally across the recording medium between said first and second positions on said support means, said second drive mechanism being operable in said low speed mode of operation,

motor means for selectively driving said first or second drive mechanisms when coupled thereto,

first means responsive to a first control signal for selectively coupling said motor means to said first drive mechanism for a first time period in said high speed mode of operation, said first time period being greater than that required to move said stylus continuously across one of said spaces, said stylus being actuated by a first input signal to print at least one character during said first time period, and

second means responsive to a second control signal for selectively coupling said motor means to said second drive mechanism for a second time period in said low speed mode of operation, said second time period being that required to move said stylus an increment equal to a single one of said spaces, said stylus being actuated by a second input signal to print a single character during said second time period.

2. The apparatus as defined in claim **1** wherein said second input signal is generated by actuation of a single character key on a keyboard.

3. The apparatus as defined in claim **2** wherein said first input signal is generated by means responsive to data transmitted from apparatus remote from said printing apparatus.

4. The apparatus as defined in claim **1** wherein said support means comprises a tubular member having a slot along a portion of the surface thereof, said carriage slider being driven within said slot between said first and second positions.

5. The apparatus as defined in claim **4** wherein said tubular member further includes means for retaining a compressible fluid medium at each end thereof, said medium being compressed within the non-slotted portion of said tubular member as said carriage slider moves towards either said first or second position, the compressed medium slowing the speed of the carriage slider as it nears said first or second position.

6. The apparatus as defined in claim **1** and including means for retracting said stylus from the recording medium during the return of said carriage slider to said first position.

7. The apparatus as defined in claim **1** wherein each character space comprises a plurality of equal length elements and further including means for generating an electrical pulse each time said stylus moves a distance equal to the length of a single element when said motor means is coupled to said second drive mechanism, each pulse actuating the stylus so that a portion of said single character is printed at a corresponding element.

8. The apparatus as defined in claim **1** wherein said first and second coupling means comprise first and second clutch means, respectively.

9. Apparatus for printing characters in spaces on a recording medium comprising:

a carriage slider having a stylus mounted thereon,

support means located adjacent said recording medium for supporting said carriage slider,

a drive mechanism for driving said carriage slider across said record medium between a first and second position on said support means,

means responsive to a control signal for selectively driving said drive mechanism for a period of time required to move said stylus an increment equal to a single one of said spaces, each character space comprising a plurality of equal length elements, said stylus being actuated by an input signal to print a single character during said time period, and

means connected to said responsive means for generating an electrical pulse each time said stylus moves a distance equal to the length of a single element, each pulse actuating said stylus so that a portion of said single character is printed at a corresponding element.

10. The apparatus as defined in claim **9** wherein said input signal is generated by the activation of a single character key on a keyboard.

11. The apparatus as defined in claim **9** wherein said support means comprises a tubular member having a slot along a portion of the surface thereof, said carriage slider being connected for movement within the slot between said first and second positions.

12. Apparatus for printing characters in spaces on a recording medium comprising:

a carriage slider having a stylus mounted thereon,

support means located adjacent said recording medium for supporting said carriage slider, said support means comprising a tubular member having a slot along a portion of the surface thereof, said carriage slider being connected for movement within the slot between a first and second position on said support means, said tubular member further including means for retaining a compressible fluid medium at each end thereof, whereby said medium is compressed within the non-slotted portion of said tubular member as said carriage slider moves towards either said first or second position, the compressed medium slowing the speed of the carriage slider as it approaches said first or second position,

a drive mechanism for driving said carriage slider across said record medium between said first and second positions on said support means,

means responsive to a control signal for selectively driving said drive mechanism for a period of time required to move said stylus an increment equal to a single one of said spaces, each character space comprising a plurality of equal length elements, said stylus being actuated by an input signal to print a single character during said time period, and

means connected to said responsive means for generating an electrical pulse each time said stylus moves a distance equal to the length of a single element, each pulse actuating said stylus so that a portion of said single character is printed at a corresponding element.

13. Apparatus for printing characters electrically on a recording medium comprising:

a carriage slider having a stylus mounted thereon,

support means located adjacent said recording medium and comprising a tubular member having a slot along a portion of the surface thereof, said carriage slider being driven within said slot between a first and second position, said tubular member including means for retaining a compressible fluid medium at each end thereof, whereby said medium is compressed within the non-slotted portion of said tubular member as said carriage slider moves towards either said first or second position, the compressed medium slowing the speed of the carriage slider as it approaches said first or second position,

a drive mechanism for driving said carriage slider across said recording medium between said first and second positions on said support means,

motor means for driving said drive mechanism when coupled thereto, and

means responsive to a control signal for coupling said motor means to said drive mechanism, said stylus being actuated to print characters on said recording medium as the stylus is driven thereacross by said drive mechanism.

14. Apparatus for printing characters in spaces on a recording medium, said apparatus being selectively operable in either a low or high speed mode of operation, comprising:

a carriage slider having a stylus mounted thereon,

support means located adjacent said recording medium for supporting said carriage slider,

means for driving said carriage slider across said recording medium,

motor means for energizing said driving means when coupled thereto,

first clutch means responsive to a first control signal for selectively coupling said motor means to said driving means for a first time period in said high speed mode of operation, said first time period being greater than that required to move said stylus continuously across one of said spaces, said stylus being actuated by a first input signal to print at least one character during said time period, and

second clutch means responsive to a second control signal for selectively coupling said motor means to said driving means for a second time period in said low speed mode of operation, said second time period being that required to move said stylus an increment equal to a single one of said spaces, said stylus being actuated by a second input signal to print a single character during said second time period.

15. The apparatus as defined in claim **14** further including a rotatable driven member connected to said first clutch means and a rotatable driving member connected to said second clutch means, said first clutch means being coupled to said driving means by said rotatable driven member and said second clutch means being coupled to said driving means by the interface of said rotatable driving member with said rotatable driven member.

16. The apparatus as defined in claim **15** further including an actuable interposer for engaging said rotatable driven member when said second clutch means selectively couples said motor means to said driving means and after said stylus moves said one character space, thereby preventing said stylus from returning towards said first position.

17. The apparatus as defined in claim 14 wherein said support means comprises a tubular member having a slot along a portion of the surface thereof, said carriage slider being driven within said slot between a first and second position.

18. The apparatus as defined in claim 17 wherein said tubular member further includes means for retaining a compressible fluid medium at each end thereof, said medium being compressed within the non-slotted portion of said tubular member as said carriage slider moves towards either said first or second position, the compressed medium slowing the speed of the carriage slider as it nears said first or second position.

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