May 12, 1942. M. ARTZT 2,282,924

PAPER FEED DEVICE

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Fig.2.

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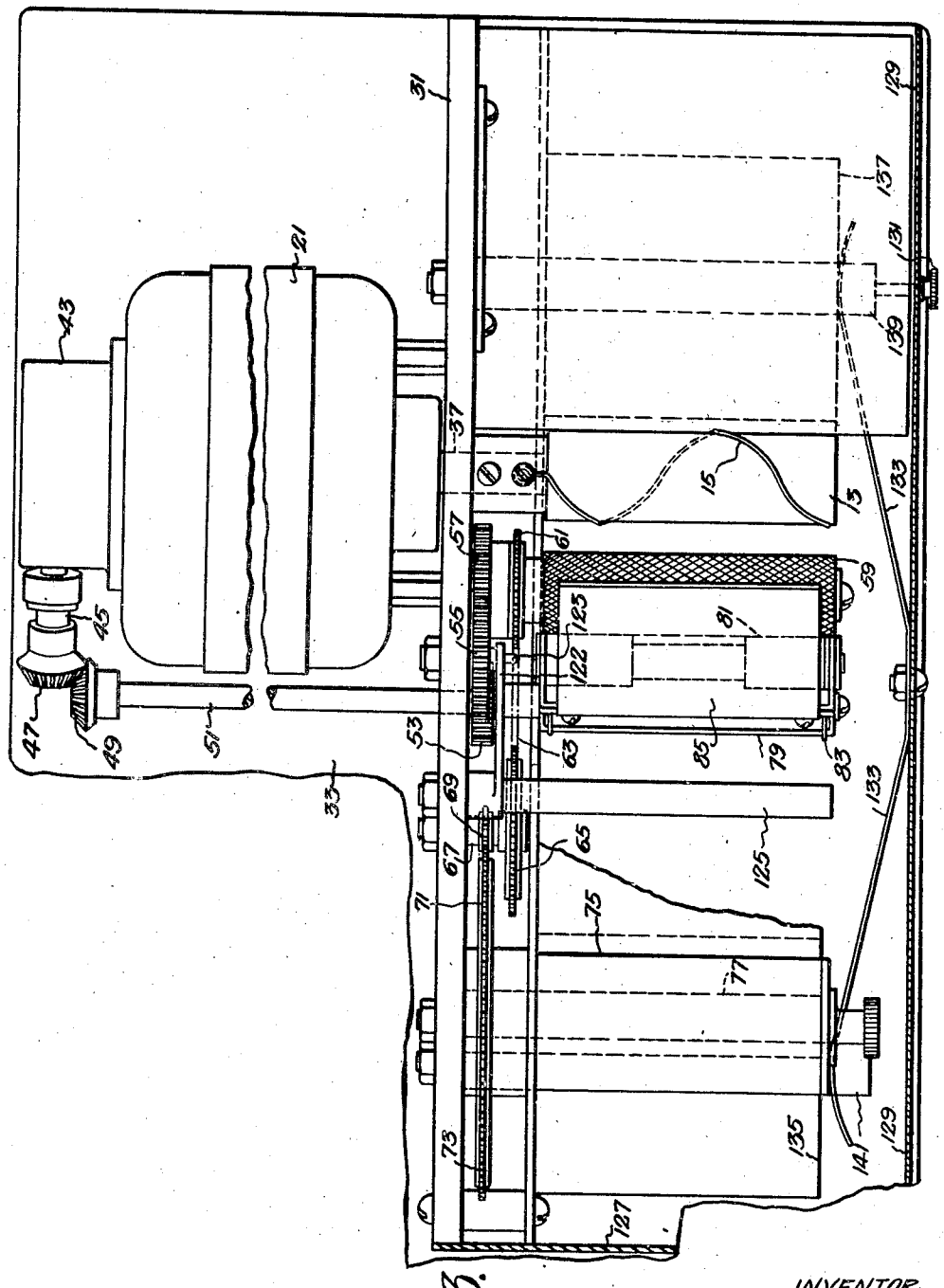


Fig. 3.

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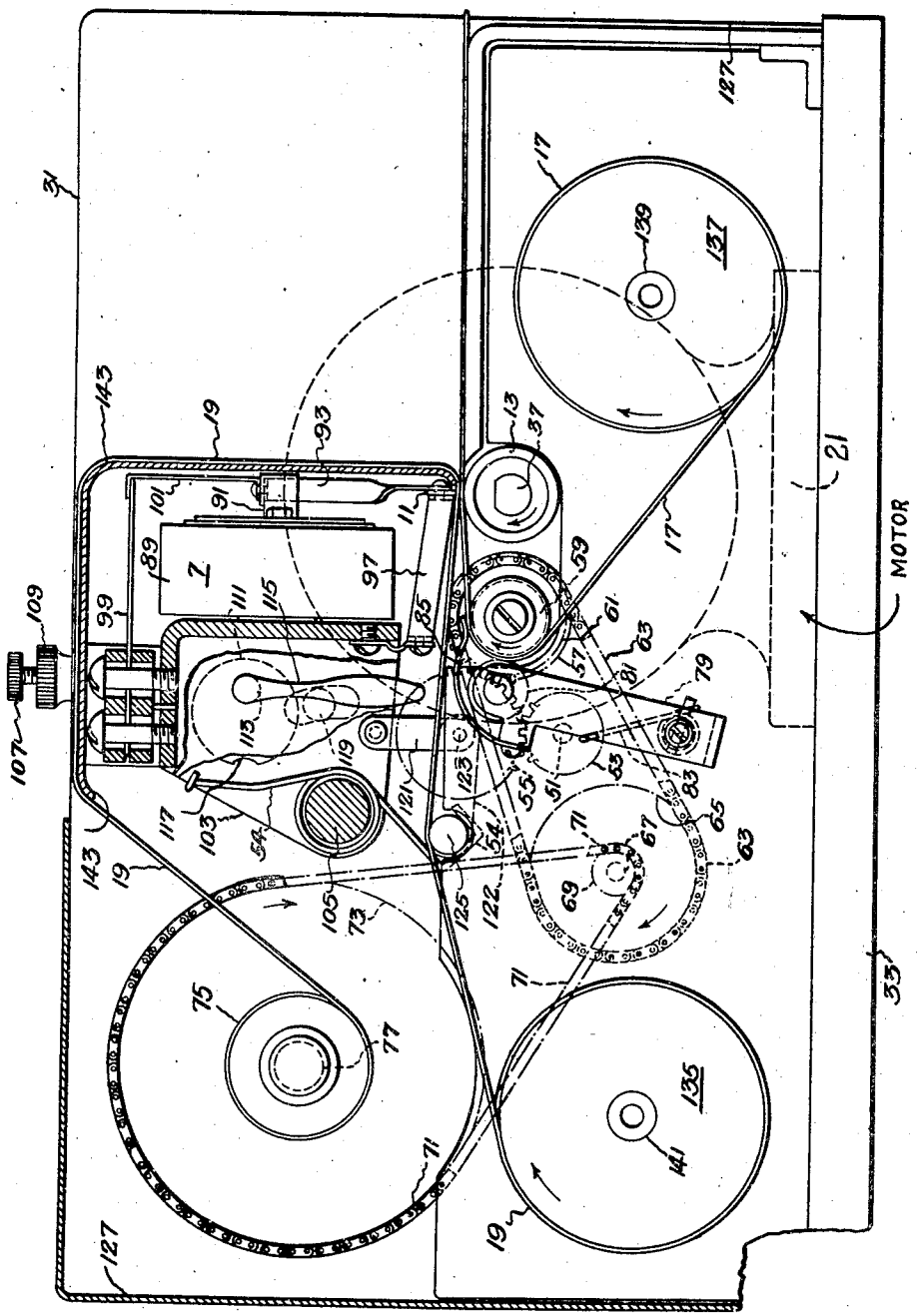


Fig. 4.

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PAPER FEED DEVICE

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Continuation of application Serial No. 52,353, November 30, 1935. This application June 28, 1938, Serial No. 216,208

2 Claims. (Cl. 234—70)

My invention relates to paper feed devices. More particularly, my invention relates to a paper-feed mechanism which is capable of very accurately maintaining the alignment of a paper strip and a printing member, such as is used in watch-timing devices and the like, and of feeding a paper strip through a printing mechanism without a take-up roll or moving device operating on the strip after the printing operation has been performed, thus making the record immediately available for observation or removal.

This application is a continuation of my U. S. application Serial No. 52,353, filed November 30, 1935, and entitled "Chronometer deviation recorders," which application has been abandoned.

I am aware that there are a great many different methods of feeding paper from a roll through a machine. However, there are certain types of machines which have particular problems and which therefore necessitate the consideration of requirements which are somewhat unusual. For example, in a watch-timing chronometer of the type disclosed in my above-identified copending application, the time deviation of a watch is recorded on a moving paper strip. The error of the watch is shown by the trace of a line which is printed on the strip, the angle made by the line and the edge of the paper being a measure of the watch error. To be practical, such a device must indicate in a few minutes errors amounting to only a few seconds a day. Obviously, great accuracy is necessary. One essential to the fulfillment of such accuracy is the maintenance of perfect alignment between the recording paper and the printing mechanism.

It is also highly desirable to have a paper feed which does not interfere with the paper after it has passed through the printer mechanism. The reason for this is that it is frequently desirable to remove the printed portion of the paper from the machine as soon as it has been printed. For example, in facsimile recorders and the like, it is desirable to tear off the paper as soon as a page has been completely printed. A paper feed which pulls the paper through the printer makes this impossible.

Further considerations are that the paper must be fed at a uniform speed, that the system must provide for the easy and quick insertion of new paper rolls and, in cases where a strip of carbon paper is also fed through the rollers, that it be possible to adjust the speed of the carbon paper independently of the paper speed.

One of the objects of the present invention is to provide an improved paper-feed device for use with apparatus for timing watches and similar devices where great accuracy of alignment is required.

Another object is to provide a paper-feed mechanism which operates at a uniform rate.

A further object of my invention is to provide a paper-feed mechanism which permits the removal of that portion of the paper which has been printed, or otherwise affected, immediately after it has been so altered.

A further object is to provide means in a chronometer deviation indicator, or the like, whereby carbon paper and record printing paper may be readily attached to the machine.

My invention will be better understood from the following description when considered in connection with the accompanying drawings. Its scope is indicated by the appended claims. Similar reference numerals refer to similar parts throughout the several drawings.

Referring to the drawings,

Figure 1 is a schematic illustration of the component parts which are used in a system for recording the time deviation of watches and the like,

Figure 2 illustrates two typical printed records made by a watch-testing device, indicating the nature of the record made by the machine,

Figure 3 is a plan view of a paper-feed mechanism according to this invention as applied to a watch-timing chronometer, and

Figure 4 is the elevational view of the device shown in Fig. 3.

In Fig. 1 a watch, clock, or other time piece is placed on a crystal microphone 3 so that the metallic part of the time piece touches a metal pin (not shown) which is located in the center of the microphone. The crystal microphone 3 is connected to a suitable microphone amplifier 5 which reproduces in amplified form currents generated in the crystal microphone 3 by the beats or ticks of the time piece.

The currents from the microphone amplifier 5 are not of suitable wave form for actuating the printer motor 7. I prefer to change the wave form to a series of sharp impulses corresponding to the time piece ticks. A printer amplifier 9 employing suitable thermionic tubes and circuits is connected to the microphone amplifier 5 whereby the microphone currents are changed to current impulses which are further amplified.

The current impulses from the printer amplifier 9 operate the printer motor 7. This motor is an electromagnetic device which operates a

printer bar 11. The printer bar 11 is positioned immediately above a drum 13 which revolves at a constant predetermined speed. On the surface of the drum is a single raised helical turn 15. Between the helical drum 13 and the printer bar 11 are passed a sheet of printing paper 17 and a sheet of carbon paper 19. Each downward stroke of the printer bar 11, which is actuated by each tick of the time piece 1, causes the carbon paper 19 to impress on the record printing paper 17 a mark corresponding to the instantaneous position of the helix 15.

If the time piece ticks occur at the proper predetermined rate, which is related to the speed of the drum as will hereinafter be described, the printer bar will always strike at the same points on the helix. If, however, the watch is running slowly, the printed record of the printer bar striking the helix will show drift. A series of simple calculations will show how slowly the watch is running in terms of seconds per day. In a similar manner, if the watch is running too fast, the printed record will disclose a drift which may likewise be measured in terms of seconds gain per day.

In order that the drum may be revolved at constant speed, I have found that an alternating current of constant frequency must be employed to operate the motor 21 which rotates the drum. A tuning fork, operating at constant temperature and arranged in a suitable electrical circuit, can be made to generate alternating current of a frequency of 480 cycles per second, by way of example, which will not vary more than plus or minus 2 seconds per day. The standard of frequency may be checked against radio time signals or by astronomical methods.

The currents developed by the standard frequency unit 23 are used to control the operation of a thermionic inverter device 25. This inverter converts direct current into alternating current whose frequency is equal to one-eighth of the frequency standard. If the frequency standard could supply sufficient power at the lower frequency, the inverter would not be needed. In any event, the constant frequency alternating current generated by the inverter operates the chronograph motor 21 at constant speed. Directly connected to the chronograph motor is the drum 13 carrying the helical element 15. I have also found it desirable to use this same motor by means of speed-reducing gears to drive the carbon paper 19 and record printing paper 17 over the drum. The power for the several amplifiers may be supplied by the storage batteries or alternating current which may be rectified and filtered in the usual manner. The cathode heaters of the several thermionic tubes may be energized by alternating current or any convenient source of power.

Since my invention is primarily directed to the means by which I utilize the motor 21 to drive the paper, I shall not describe in detail the several amplifiers, rectifiers, frequency standard and inverter. These elements are well known to those skilled in the art, are commercially available, and require no detailed description. By way of example, I have found the following elements entirely suitable: RCA tuning fork frequency standard type GM 53A3, RCA inverter type GM 52D1, RCA microphone amplifier type GM 103A1, and RCA printer amplifier GM 77A1.

I shall now describe the paper-feed mechanism and the movable elements of the chronograph shown in Figs. 3 and 4. A paper-guide plate 31 is fastened to a suitable base 33. Behind the paper-guide plate 31 and suitably fastened thereto is a synchronous induction motor 21. The shaft 37 of this motor projects through the upright supporting member and carries a rotating drum 13 on which is fastened in a suitable groove a raised single turn helix 15. An extension of this shaft 37 projecting through the rear portion of the motor operates speed-reducing gears which are located within the housing 43 but are not shown. A shaft 45, connected to the speed-reducing gears, projects from the speed-reducing gear housing. A bevel gear 47 on the end of this shaft engages a second bevel gear 49 which operates a slow-speed shaft 51 which supplies the power for driving the carbon paper and record printer paper over the rotating drum.

A drive gear 53 is fastened to the end of the slow-speed shaft. This drive gear 53 engages an idler gear 55 which is held in engagement by a detent spring 54. The idler gear 55 engages a driven gear 57 which is fixed to a knurled paper feed roll 59 and to a suitable sprocket 61. This sprocket 61 is connected by a chain 63 to a second sprocket 65 which rotates on a stud 67. Concentrically fastened to the second sprocket 65 is a small sprocket 69. This sprocket 69 by means of a chain 71 drives a large sprocket 73 which is fastened to a carbon takeup roll 75. The carbon takeup roll 75 and its associate sprocket 73 rotate on a suitable stud 77 which is fastened to the upright supporting member 31.

A pivoted arm 79 carries an idler roll 81 which engages the knurled paper feed roll 59. A detent spring 83 engaging the arm 79 forces the idler 81 and a paper guide 85, both idler and guide being carried by the arm, into constant frictional engagement with the paper feed roll.

In Fig. 4 the printer motor has been indicated at 7. To avoid confusion it has not been shown in Fig. 3. The printer motor consists essentially of an electromagnetic field piece 89 which operates on a movable armature 91. Attached to the armature 91 is a connecting link 93 which fastens to the printer bar 11. The printer bar 11 is held in position by a flexible spring member 97 which is mounted to the rear of the electromagnetic elements. As the armature 91 moves, the connecting link 93 causes the printer bar 11 to move up and down with respect to the drum carrying the helical member. To provide sufficient restoring force to the armature, a restoring spring 99 and connecting link 101 are connected from the top of the printer motor to the armature.

Since the carbon paper 19 and the printing paper 17 must be threaded between the printer bar and the drum, I have found it desirable to arrange a suitable means for disengaging the printer motor and the paper drive mechanism. This is accomplished as follows: A suitable cam 111 is mounted on a pivot 113 and fastened to a handle 115. The cam surface preferably includes a depression 117 which temporarily locks the printer motor in the disengaged position. As the handle is turned counterclockwise, the cam 111, which is mounted on the printer motor assembly, presses against a pin or cam follower 119 which is secured to the upright supporting member 31. The action of the cam 111 on this pin 119 raises the printer motor assembly until the depressed surface 117 of the cam engages the pin. A suitable link 121 is mounted on the printer motor assembly. This link 121 carries a shaft 123 on which the idler gear 55 rotates. As

the printer motor assembly is raised by the cam action, the link 121 likewise carries with it the idler gear.

It will be seen that the idler gear 55 is also supported by an arm 122 which is pivoted on a stud 125 fastened to the upright supporting member. The detent spring 54, previously described, engages this arm and the printer motor assembly so that in the raised position the detent spring acts to force the printer motor assembly downward and frictionally engage the depression in the cam surface against the cam follower pin thereby locking the printer motor in the raised position. In the downward position of the printer motor assembly, the same detent spring 54 holds the idler gear 55 in engagement with the drive gear 53 and driven gear 57 and further acts to hold the printer motor assembly in its lower position.

The movable elements of the chronograph may be enclosed in a suitable housing 127. A door 129 is hinged to this housing. A cap screw 131 locks the door in place. A pair of spring arms 133 are fastened to the door. These spring arms thrust against a roll 135 of carbon paper 19 and a roll 137 of printer paper 17 holding them in the proper position against the paper guide plate 31 which is mounted on the supporting member 33 and perpendicular thereto.

To place the rolls 135—137 in the machine the door 129 attached to the housing is opened. A roll 137 of printer paper 17 is positioned on a stud 139 located on the right and slightly below the rotating drum 13. The paper 17 is fed from the bottom of the roll over the knurled paper-feed screw 59. The pivot arm 79 is disengaged during the operation of threading the paper to thereby disengage the idler roll 81 which is carried by the arm 79.

A roll 135 of carbon paper 19 is positioned on a stud 141 located to the left of and slightly below the rotating drum. The carbon paper take-off is from the top of the carbon paper roll. It is carried over a guide stud 125, under the printer bar 11, and around the entire printer motor mechanism which is surrounded by a shell 143 which acts as a suitable guide for the carbon paper. The carbon paper is continued from the top of the printer motor mechanism around the lower part of the carbon take-up roll 75. It is well to wrap one or two turns around this roll to secure initial frictional engagement thereto. Both the paper roll and the carbon paper roll are thrust against the paper guide plate 31 by the spring arms 133.

Care must be taken to thread the record paper through the paper feed roll so that it will run true and not on a bias. After the paper has been correctly positioned, the pivoted arm 79, carrying the idler and the paper guide, is released so that the recording paper is pressed firmly against the paper feed roll. It is well to carry the printing paper three or four inches past the drum carrying the helical member.

After the two papers have been threaded through the machine, it will be apparent that the carbon paper is on top of the printing paper. The printer motor 7 is then released from its upper position. This lowers the printer motor 7 and engages the idler gear 55 with the drive gear 53 and the driven gear 57. In this position the printer motor mechanism is adjusted so that in its downward position the printer bar will strike the helix through the layers of carbon and record printing paper. Each downward stroke of the printer bar striking the helix through the two papers will cause a mark to be made on the printing paper. The adjustment 107 of the printer motor mechanism and the power applied thereto should be just sufficient to make a legible mark.

Having described the method by which the paper is threaded through the machine, it will be apparent that, when the motor is running at a constant speed, the printing paper will be fed to the helix drum at a constant linear rate. That is, the paper is pulled from the roll 137 by the knurled paper feed roll 59, and fed between the printing helix 15 and the printer bar 11. The direction of rotation of the feed roll 59 and the printing cylinder 13 has been made the same, as shown by the arrows pointing in a clockwise direction in Fig. 4. Consequently, the high speed of rotation of the printing cylinder tends to pull the paper along, overcoming any tendency of the intermittently operating printing bar to retard the paper while the feed roll acts as a regulator to restrain the paper and to maintain a uniform speed. It is to be noted that the paper is fed through the printer without a take-up roll to pull it through and yet without any buckling. The carbon paper will be drawn through the machine and around the printer motor mechanism at a rate which is variable. The carbon paper moves from one-quarter to one-half of the printing paper speed. The carbon paper speed is determined by the ratios of the driving gears and the ratios of the relative diameters of the carbon paper roll and carbon paper take-up roll; the latter ratio is continuously variable as the carbon paper is taken up. The papers are used only once.

The time comparison operates on the following theory: The helical drum is rotated at a constant speed of 1800 revolutions per minute, by way of example. This means that the helix, which consists of a single turn of 2" length, will travel across the paper at a constant rate of 2" for every revolution of the motor drum. At the same time the paper is fed over the drum at a constant rate of 2" per minute.

If the watch or time piece under observation is operating at 4, 5 or 6 beats per second without deviation from the standard, the printer bar will be operated by current impulses derived from each beat, and will strike the rotating helix at the same point for every beat. This will leave a printed record consisting of parallel lines which are uniformly spaced from the edge of the paper. If the time piece beats or ticks deviate from the true time or standard frequency, the ticks as recorded will print a series of lines which slope one way or the other across the paper. The slope of a line through the centers or terminations of these lines will indicate the rate at which the time piece is gaining or losing with respect to the standard time or frequency.

By way of example, if the printed record indicates a drift of $\frac{1}{8}$" in a 6" length of paper, this corresponds to an error of 1 second per day. Since the paper speed is 2" per minute, it should be quite apparent that one and one-half minutes of recording requires 3" of paper which is sufficient to disclose a drift of $\frac{1}{16}$" which corresponds to an error of 1 second a day. Likewise, $\frac{1}{8}$" drift in 12" of recording paper would be $\frac{1}{2}$ second per day or $\frac{1}{8}$" in 3" of recording paper would be equivalent to 2 seconds per day. The error in seconds per day may be expressed in accordance with the formula for a single turn helix drum

speed of 1800 revolutions per minute, and a paper speed of 2" per minute:

$$\text{Error in seconds per day} = \frac{48 \times \text{drift in inches}}{\text{length of record in inches}}$$

The direction of the slope of the record indicates whether the time piece is operated fast or slow with respect to the standard. If the line slopes down toward the right, the time piece is running too fast. If the line slopes up to the right, the time piece is running too slow. It is apparent that it is essential that the paper be maintained in a uniform position with respect to the printing mechanism. Side slip of the paper is equivalent to an apparent error in the time piece. In Fig. 2 are reproduced characteristic records which show, respectively, the deviation of a slow and fast time piece.

While I have described my invention in connection with a watch timing chronometer, my invention is not limited thereto but is only limited as required by the prior art and the appended claims.

I claim as my invention:

1. In a recorder mechanism having a rotating helical member and a printer bar for engaging and marking a recording strip, feed means including the combination of means for supporting a roll of recording strip, a constant speed strip feed roll and idler for feeding said strip from said roll between said helical member and printer bar in the same direction as paid member tends to feed it, and means for rotating said feed roll at a peripheral speed less than that of said helical member so that said helical member exerts a frictional pulling force on said recording strip overcoming any tendency of said printer bar to retard said strip, whereby said strip is fed through said recorder at a constant speed determined by the speed of said feed roll.

2. In a recorder mechanism having a rotating printing member and pressure means for intermittently frictionally engaging said printing member, paper feed means including the combination of a paper feed roll for feeding a recording paper between said printing member and said pressure means in the same direction as said printing member tends to feed it so that said paper is frictionally and slidably engaged by said recorder and urged in a direction away from said feed roll, the speed of the surface of said feed roll being less than the speed of the surface of said printing member, whereby any tendency of the intermittent frictional engagement of the paper by the pressure means to retard the movement of said paper through said recorder is overcome, and said paper passes through said printer at a constant speed determined by the speed of said paper feed roll.

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