Sept. 17, 1968 F. H. SHEPARD, JR 3,401,782

PAPER-SHIFTING MECHANISM

Filed Oct. 11, 1965 2 Sheets-Sheet 1

Fig. 1.

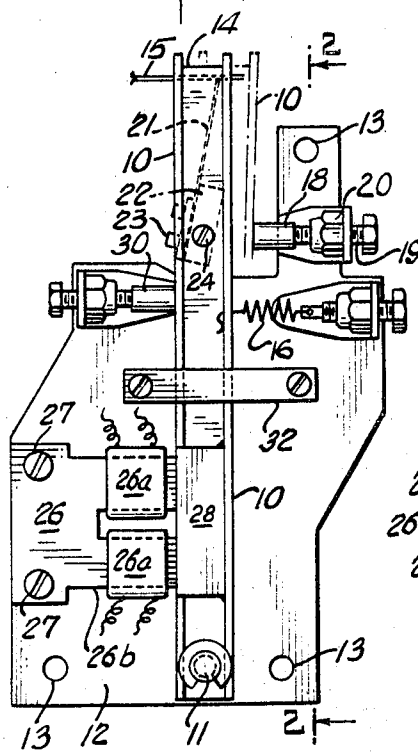


Fig. 2.

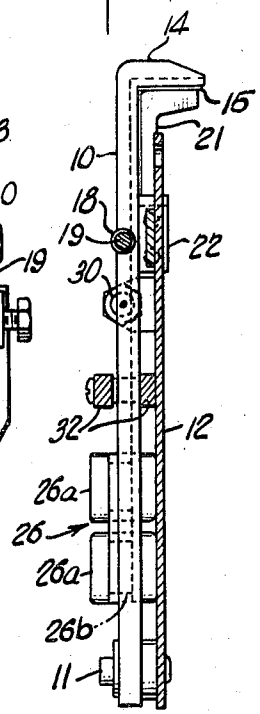


Fig. 3.

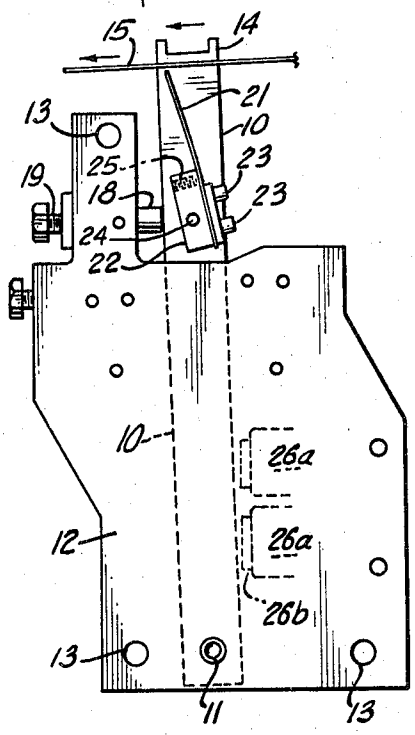


Fig. 5.

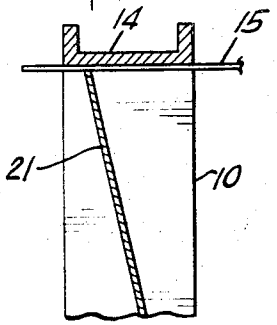


Fig. 6.

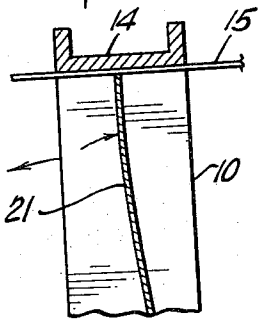
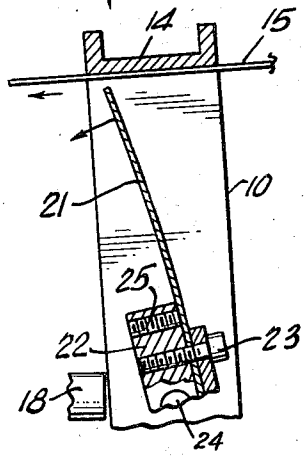


Fig. 7.



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PAPER-SHIFTING MECHANISM

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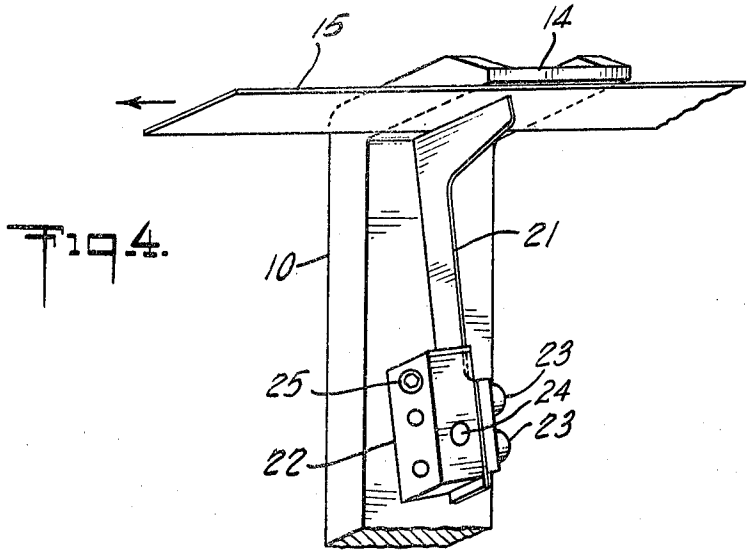


Fig. 4.

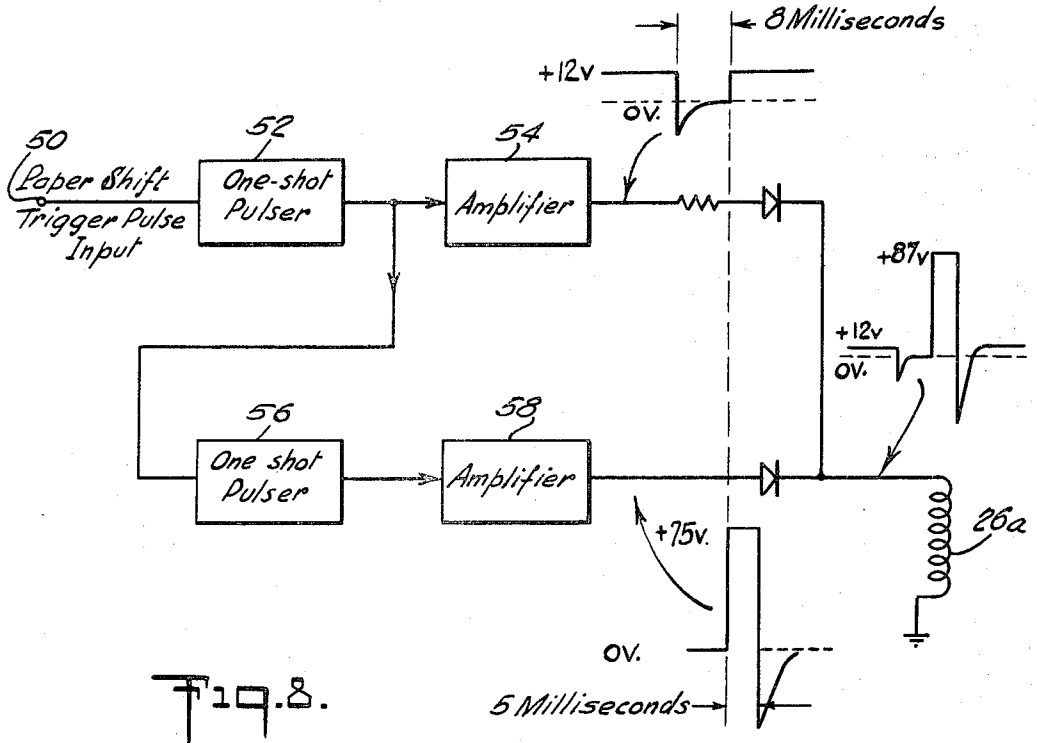


Fig. 8.

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PAPER-SHIFTING MECHANISM

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ABSTRACT OF THE DISCLOSURE

Paper-shifting mechanism in which a lightweight pivoted arm which forms one pole of an electromagnet has a right-angle extension or shoulder at its outer end beneath which is positioned a thin flat leaf spring. The upper end of the leaf spring and the underside of the extension comprise a pair of grippers by which a strip or sheet of paper, for example, is advanced in one direction. In operation the force of inertia when the arm is suddenly moved forward causes the spring to pinch against the extension and, conversely, when the arm is suddenly retracted by the electromagnet, inertia causes the spring to move away from the extension. A further feature is in the provision for allowing the arm, when it moves forward, to bounce against a stop and as it bounces back to "cock" it against the electromagnet. This prevents spurious bouncing and provides for very high speed operation, for example, about 100 strokes per second.

The present invention relates to a mechanism having particular application for advancing or shifting from one line to the next the paper in a high speed printer.

At the present time, paper is advanced in a high speed printer by means of pinch rollers. In such an arrangement, the paper is grasped between an idler roller positioned on one side of the paper and a driver capstan positioned on the other side. After the paper has been moved the required distance, the driving engagement is broken by moving the idler roller out of contact from the paper.

Generally, presently available paper shift mechanisms have maximum speeds which are lower than desirable and which limit the speed of the printer. Besides being limited in speed, these mechanisms are relatively complex, which makes them costly and subject to repeated breakdowns. Furthermore, in conventional arrangements because of slippage of the paper between the idler and the capstan, these components are subject to wear.

Another disadvantage of a pinch roller type of mechanism is the problem of varying the amount of paper advance. Generally, either the time over which the idler and capstan are in contact with the paper must be varied or idlers and capstans of different diameters must be employed. Both of these approaches add complexity to the mechanism, while the latter approach can be undesirably time consuming.

Accordingly, it is an object of the present invention to provide a new and improved paper shift mechanism.

It is another object of the present invention to provide such a mechanism capable of operating at speeds considerably higher than the speeds of previously available mechanisms.

It is a further object of the present invention to provide a paper shift mechanism which is reliable, yet simple and inexpensive.

These and other objects will in part be understood from and in part pointed out in the following description.

In accordance with the invention, in one specific embodiment thereof, there is provided a very simple paper shifting mechanism which includes an upright arm. This arm is pivoted at its lower end and its upper end is a right-angle extension which has a flat, horizontal underside adapted to slide upon the top of a piece or strip of paper along one edge. This arm is movable backward, in very rapid sequence, against a stop by means of an electromagnetic coil. When the coil is de-energized, the arm is swung forward, again rapidly, by a strong tension spring against another stop.

Fixed to the arm about an inch below its upper, horizontal extension is a limber leaf spring compressionally stiff because of its straightness. This extends upward but at a slight forward, wedging angle relative to the vertical axis of the arm, with the top of the spring forming a polished or rounded edge parallel to and closely opposite the underside of the right angle arm extension. This edge and the arm extension, as will be explained, automatically pinch or grip the paper when the arm suddenly swings forward and hence cause the paper to be advanced by the amount the arm swings forward.

Now when the arm is suddenly drawn back by the electromagnet, the top edge of the leaf spring, under its own inertia, and because of friction with the paper, lags the motion of the arm and hence moves relatively forward and down away from the underside of the arm extension and the paper. This permits the mechanism to cock for a subsequent advance stroke without rubbing against the paper.

When the arm is released, it is rapidly drawn forward by its tension spring. The upper end of the leaf spring, lagging the motion of the arm because of inertia and because of friction against the paper, moves relatively back and up against the arm extension thereby tightly gripping or wedging against the paper and causing it to be pulled forward by the arm for the amount of its stroke. This sequence of cocking and release can be repeated at very high speed to shift paper one line at a time at a very rapid rate.

A better understanding of the invention together with a fuller appreciation of its many advantages will best be gained from the following description given in connection with the accompanying drawings wherein:

FIGURE 1 is a front elevation view of a paper shift mechanism constructed in accordance with the present invention showing the mechanism in its cocked condition;

FIGURE 2 is a side elevation view of the mechanism of FIGURE 1;

FIGURE 3 shows the mechanism of FIGURES 1 and 2 after the paper has been advanced and released;

FIGURE 4 is an enlarged perspective view of a portion of the mechanism shown in FIGURES 1, 2 and 3;

FIGURES 5, 6 and 7 illustrate the sequence of a strip of paper being gripped, advanced and released by the mechanism of FIGURES 1, 2 and 3; and

FIGURE 8 shows the schematic of a circuit for energizing the mechanism.

As seen in FIGURES 1 through 3, inclusive, the paper shifting mechanism (shown substantially to scale) includes a generally vertical operating arm **10** which swings about a pivot point at its lower end defined by the axis of a stud **11**. Stud **11** passes through the operating arm **10** and is fastened in a frame or base **12**. The base **12**, in turn, is secured to a high speed printer (not shown) by means of bolts **13**.

The operating arm **10** has a right angle extension **14** at its upper end. The extension **14** is rigidly affixed to the operating arm **10** and the two are preferably formed together as a unit. The underside of extension **14** serves as a first paper gripping member. A piece of paper **15** passes under the extension **14** as shown.

Also included in the mechanism shown in FIGURES 1 through 4 is means for moving the operating arm **10** in a first direction which corresponds to the direction of paper advance. In particular, a coil spring **16** secured to

operating arm **10** and anchored to the base **12** urges the operating arm to move clockwise about stud **11** from the full line position shown in FIGURE 1 to the position shown in dotted line. The position of the operating arm **10** shown in FIGURE 1 will be referred to as the "cocked" position, while the position shown in FIGURE 3 (a view from the opposite side) will be referred to as the "released" position. The operating arm **10** in the released position bears against a percussion cap **18** fitted on a stop screw **19**. This screw **19** passes through a self-locking nut **20** secured to the base **12**. The position of the threaded member **19** is adjustable by movement into or out of the nut **20**. The amount of paper advance is determined by the position of screw **19**. Once the desired position of the threaded member **19** is achieved, it is left locked in place.

The paper shifting mechanism further includes a second paper engaging member in the form of a leaf spring **21**. The upper end of the latter, in rest position, is spaced from the extension **14** to permit the paper **15** to pass freely between the bottom surface of extension **14** and the top edge of the leaf spring. The top edge of the leaf spring **21** serves, during dynamic movement of arm **10**, to pinch the paper against the underside of extension **14**. The lower end of the leaf spring **21** is secured by means of a pair of screws **23** to a member **22** extending outward at a right angle from the operating arm **10**. Member **22** is rigidly fixed to arm **10** by a screw **24**. The leaf spring **21** is so mounted that the top edge of the leaf spring is positioned in the path of motion of the extension **14** as it and the operating arm **10** are urged to move from the cocked position shown in FIGURE 1 toward the released position shown in FIGURE 3.

This mechanism additionally includes means for driving the operating arm **10** from the released position to the cocked position. To this end there is mounted near the lower pivoted end of arm **10** a solenoid **26** secured to the base **12** by means of bolts **27**. Carried on the lower part of arm **10** and opposite solenoid **26**, is an armature **28** of magnetic material which may be integral with arm **10**. As the solenoid coils **26*a*** are energized, the operating arm **10** is drawn about pivot stud **11** toward the solenoid core **26*b*** against the action of the coil spring **16** and assumes the cocked position shown in FIGURE 1 in which armature **28** is held against core **26*b*** by magnetic attraction. The operating arm **10** is held in the cocked position by solenoid **26** until it is desired to move the paper, after which coil **26*a*** is de-energized and the operating arm flies rapidly from the cocked position to the released position under the urging of tension spring **16**.

The springiness of leaf spring **21** is chosen so that the top edge of the leaf spring, under its own inertia lags an initial sudden movement of the operating arm **10** and extension **14**. The desired springiness, and the initial setting of spring **21**, is achieved by the selection of suitable material, thickness and width for the leaf spring **21**, and by the setting of a screw **25**. Spring **21** is shaped and dimensioned substantially as shown in FIGURES 1–3.

FIGURE 6 illustrates the flexure of the leaf spring **21** as compared to its unflexed condition shown in FIGURE 5. The flexure of leaf spring **21** is due to the lower end of the leaf spring moving with the operating arm **10**. The arrow leading from the operating arm **10** in FIGURE 6 indicates that the operating arm is moving at this point in the cycle of operation of the mechanism. With the top edge of the leaf spring **21** remaining in the path of movement of the extension **14**, the leaf spring bears against the paper **15** wedging it against the bottom surface of extension **14**. The result is that the paper **15** is gripped and it and arm **10** move together counterclockwise toward the released position of FIGURE 7 to advance the paper one step. It should be noted that the angle of the spring against the pinch surface is such that the paper is jammed in one direction and will not slip when the arm pulls forward.

When the operating arm **10** reaches the released position, it hits cap **18** thereby abruptly halting. The leaf spring **21**, due to its inertia, continues to move in the same direction as indicated by the arrow leading from the leaf spring in FIGURE 7 so that the paper is released. To prevent the leaf spring from undergoing unwanted oscillations its resonance frequency is preferably set well above the operating frequency of the operating arm **10**. In order to avoid undesired vibrations upon impact with the percussion cap **18**, the percussion cap is made of nylon and is positioned at the center of percussion of the operating arm **10**.

Immediately after the leaf spring has been released, the operating arm **10** is drawn back to the cocked position by the energization of the solenoid **26**. In this position the arm bears against a second stop **30** which is adjusted so that there is zero air gap between solenoid core **26*b*** and armature **28** of arm **10**. Arm **10** is guided laterally by a pair of parallel nylon bars **32** fixed to frame **12** and lying parallel to the plane of FIGURE 1.

By re-energizing solenoid **26** immediately after arm **10** hits stop **18**, the normal bounce back of the arm adds to the pull of the solenoid and helps recock the arm. The solenoid is held on with reduced current after the arm is cocked and is again momentarily de-energized to advance the paper once more. This mode of operation eliminates unwanted bouncing of arm **10** against stop **18** and prevents the paper from being spuriously advanced.

The circuit for energizing solenoid **26** is shown in FIGURE 8. This circuit applies a low hold voltage (and low current) to the solenoid to hold it cocked. The circuit momentarily drops the "hold" voltage to release the solenoid, and a short time later, in accordance with the time it takes arm **10** to swing against stop **18** (about 5 milliseconds in this embodiment) a large voltage (and high current) is applied to solenoid **26** to re-cock the arm, after which the voltage is dropped to its "hold" value (shown here as +12 v.)

The circuit of FIGURE 8 has an input **50** which receives a trigger pulse when paper is to be shifted one line. The input signal actuates a first pulser **52** whose output is applied to a first amplifier **54** and a second pulser **56**. Pulser **52** produces an approximately 8 millisecond pulse. At the end of this pulse, pulser **56** in turn produces an approximately 5 millisecond pulse which is applied to a second amplifier **58**. The output voltages of amplifiers **54** and **58** are connected to coils **26*a*** of the solenoids as shown. The voltage waveforms at the points indicated are as shown. The net result is that solenoid **26** is de-energized for about 8 milliseconds, then fully energized for the next 5 milliseconds, and then energized with reduced "hold" voltage until the next trigger input. The actual elements in the pulsers and amplifiers can be any of those well-known in the art.

While there has been described what is at present considered to be the preferred embodiment of this invention it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention and it is, therefore, aimed to cover all such changes and modifications as fall within the true spirit and scope of the invention.

I claim:

1. A drive arrangement of the character described comprising: a pinch feed mechanism including an arm which is pivoted at one end, the other end of which is movable back and forth at high speed over a limited arc of travel, said arm at its other end having a pair of gripping members, one of said members being movable relative to the other by inertia to pinch a strip of paper and the like when said arm is moved forward and to unpinch when said arm is moved back, said arm having a magnetic armature adjacent its pivoted end, a stationary electromagnet positioned opposite said armature to pull said arm back and hold it in a cocked position, a drive spring to move said arm forward away from said electromagnet at high speed, stop means to limit the forward

travel of said arm to a desired amount, and circuit means to energize said electromagnet to hold said arm in cocked position, and to release it to move forward and to re-cock it at high speed, said circuit means energizing said electromagnet with a momentary release pulse and quickly thereafter with a re-cocking pulse, said release pulse lowering the holding force of said electromagnet to less than the force of said drive spring, said re-cocking pulse being timed to energize said electromagnet to pull said arm backward to cocked position as soon as it hits said stop means and bounces back therefrom.

2. A high speed pinch feed arrangement comprising a lightweight arm supported near its bottom for pivoting back and forth, said arm comprising an armature of an electromagnet, the upper end of said arm having a right angle extension, a thin elongated flat leaf spring rigidly attached at its lower end to said arm a short distance beneath said extension and being generally aligned with the vertical axis of said arm, the upper end of said leaf spring and said extension forming a pair of grippers for advancing a strip of paper and the like, an electromagnet positioned opposite said arm and serving to pull it quickly back and hold it in cocked position against said electromagnet, spring means to pull said arm at high speed forward away from said electromagnet, stop means to suddenly stop the forward motion of said arm, said leaf spring by its inertia and in conjunction with said extension gripping the paper as the arm is rapidly driven forward and ungripping the paper as the arm is driven back, and circuit means to energize said electromagnet to hold said arm against the electromagnet in cocked position and to release the arm to move forward and then to re-cock it at high speed, said circuit means for each cycle of operation energizing said electromagnet with a momentary release pulse and quickly thereafter with a re-cocking pulse, said re-cocking pulse being applied as soon as said arm hits said stop means and bounces back therefrom, whereby high speed operation is obtained and spurious bouncing of said arm avoided.

3. A high speed pinch feed mechanism comprising a long thin arm supported near its bottom end for pivoting back and forth, said arm near its pivoted end having a magnetic portion which serves as the armature of an electromagnet, the other end of said arm having a right angle extension, a thin light elongated leaf spring having a generally flat surface and being rigidly attached at its lower end to said arm a short distance beneath said extension, said leaf spring having its flat surface generally at right angles to the back and forth movement of said arm, the length axis of said leaf spring being generally aligned but at a slight upward and forward angle to the length axis of said arm, the upper end of said leaf spring and the underside of said extension forming a pair of grippers for advancing a strip of paper and the like, said leaf spring by its inertia being bendable slightly at its upper end back toward said extension to pinch said paper against said extension as said arm is rapidly driven forward and bendable forward to unpinch the paper as the arm is rapidly driven backward, a stationary electromagnet positioned opposite the magnetic portion of said arm and serving to pull the arm quickly back and hold it in cocked position against said electromagnet, spring means to swing said arm rapidly forward away from said electromagnet, and stop means to limit the forward travel of said arm, said spring means urging said arm toward said stop means.

4. The mechanism in claim 3 wherein said stop means comprises a plastic bumper positioned approximately opposite the center of percussion of said arm.

5. The mechanism in claim 3 wherein said leaf spring is mounted on a block fastened to said arm, said block carrying a set screw engaging the flat surface of said leaf spring and by which the upper end of said leaf spring can be adjusted relative to said extension of said arm.

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