United States Patent

[11] 3,558,127

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[54] **SHEET HANDLING APPARATUS**
6 Claims, 5 Drawing Figs.

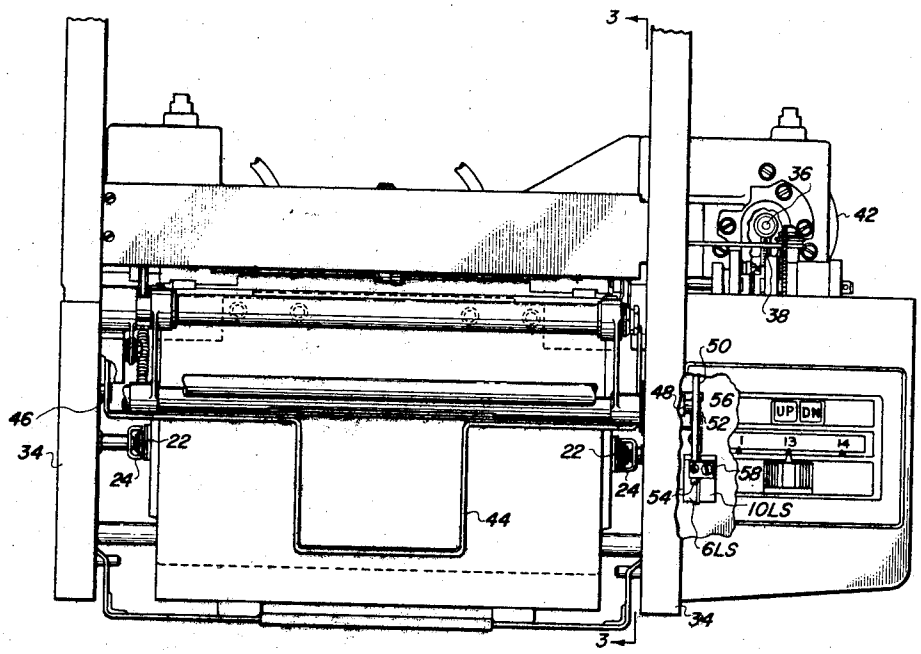
[52] **U.S. Cl.** **271/62,** 318/146
[51] **Int. Cl.** **B65h 1/00**
[50] **Field of Search** ..... 271/62; 187/29; 318/(Inquired)

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ABSTRACT: Sheet-handling apparatus for retaining a stack of sheet material at a predetermined level so that the topmost sheet may be forwarded therefrom by cooperable sheet-forwarding means. The apparatus includes a sensor bar pivotal into contact with the topmost sheet in the stack. The pivotal motion of the sensor bar controls two switches so that the upward motion of the stack will cause the opening of the first of the switches to reduce the speed of further upward movement of the stack. Continued pivotal movement of the sensor bar, caused by the slow movement of the stack, then opens the second switch to stop the stack at a predetermined height.



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SHEET 1 OF 4

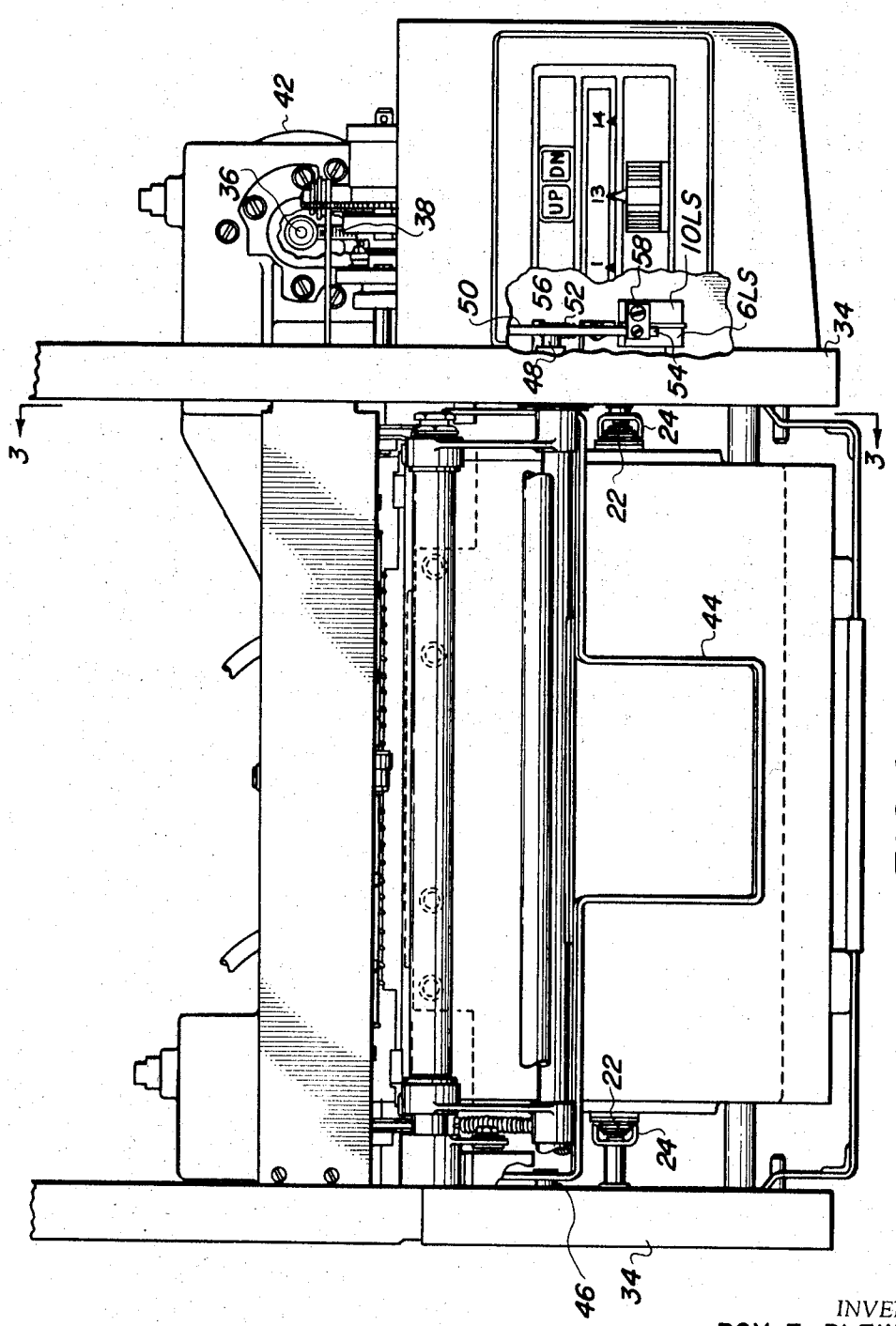


FIG. 1

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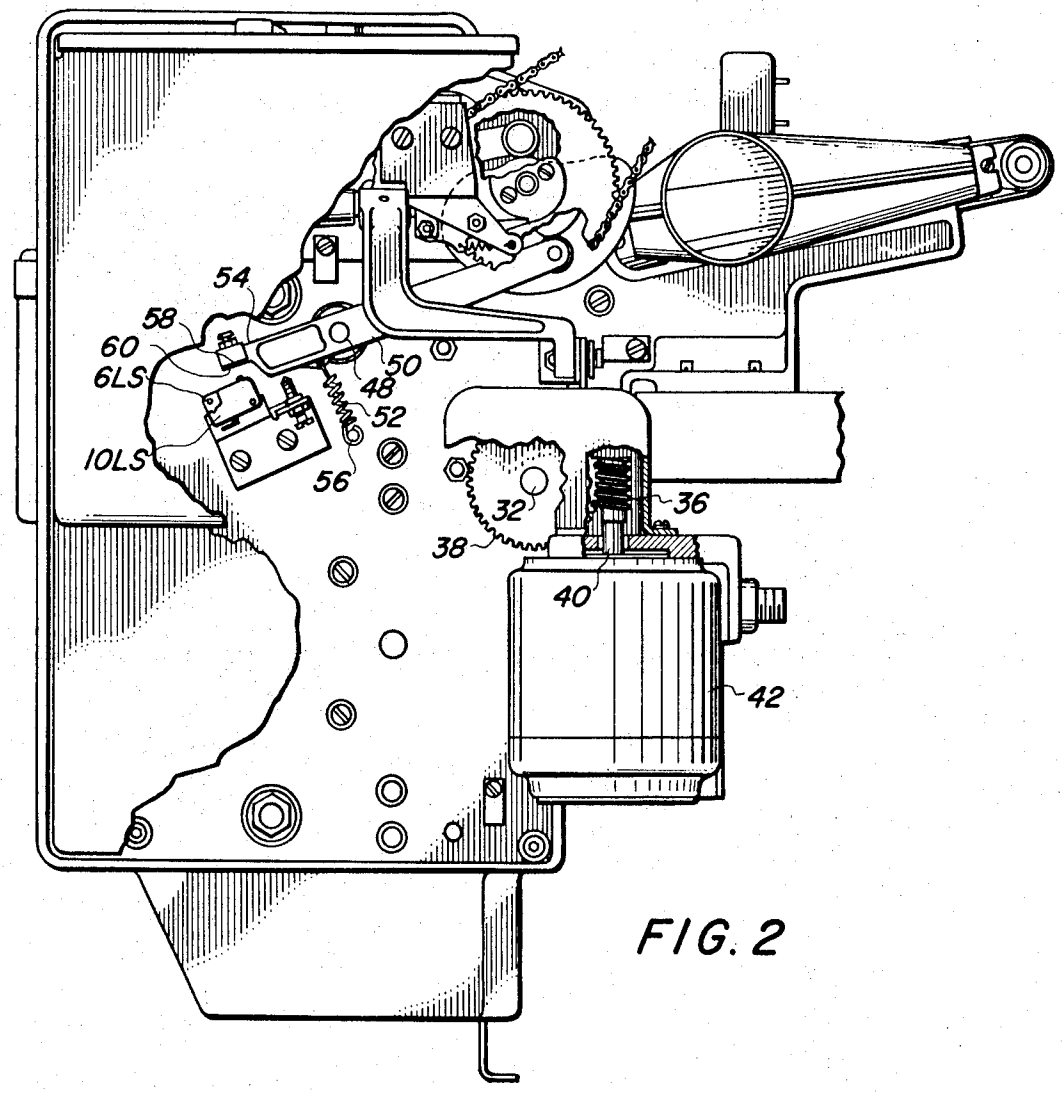


FIG. 2

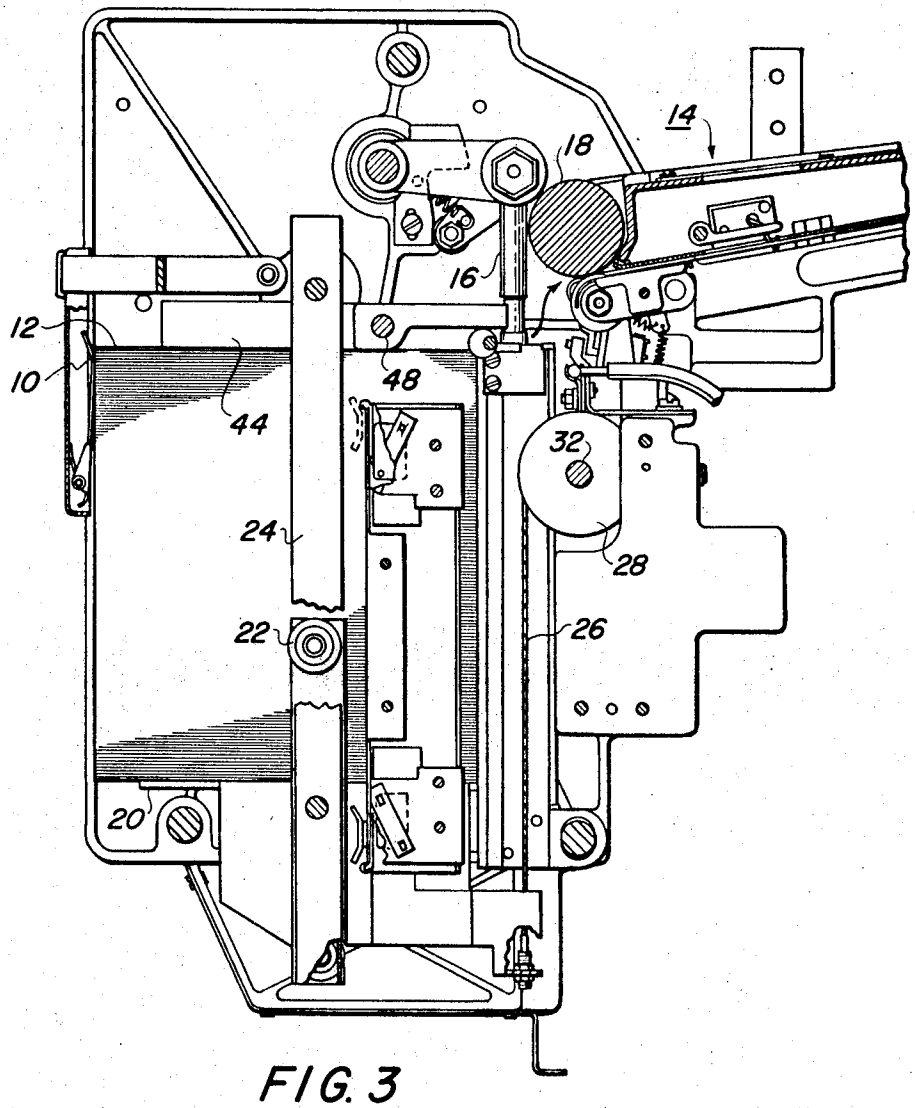


FIG. 3

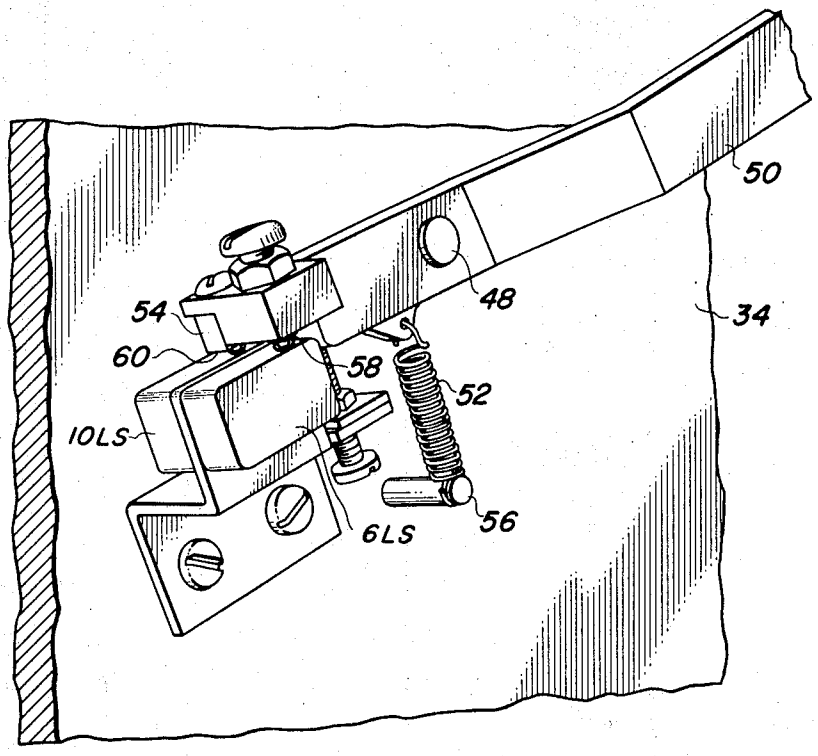

50
48
34
54
60
58
52
10LS
6LS
56

FIG. 4

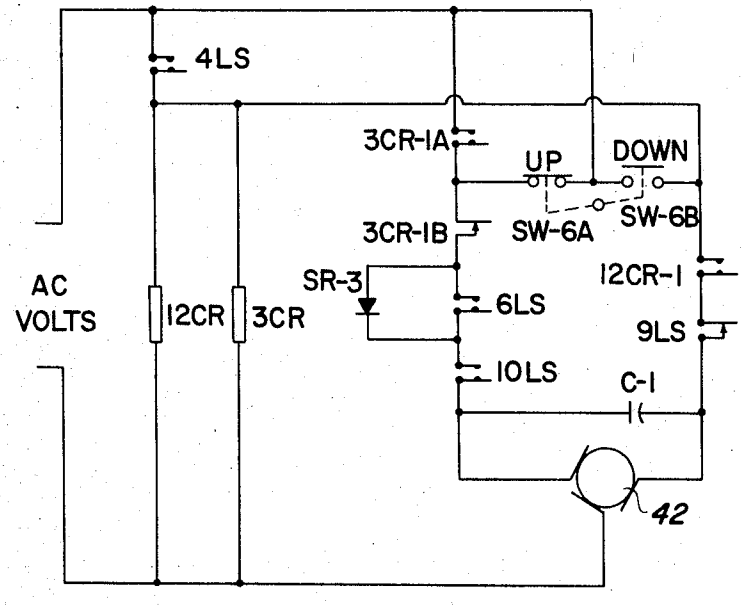

4LS
3CR-1A
UP
DOWN
SW-6A
SW-6B
3CR-1B
AC
VOLTS
12CR
3CR
SR-3
6LS
12CR-1
9LS
10LS
C-1
42

FIG. 5

SHEET HANDLING APPARATUS

This invention relates in general to sheet-handling apparatus for retaining the topmost sheet in a stack of sheet material at a predetermined height whereby it may be sequentially forwarded.

More specifically, this invention relates to apparatus for raising sheet material toward a predetermined height at a fast speed, reducing the speed as it approaches the predetermined height and then stopping it at the predetermined height so that it may be sequentially forwarded. In conjunction, therewith, the apparatus is also adapted to periodically raise the stack of sheet material as its height is reduced through the forwarding of the uppermost sheets therefrom.

In continuous and automatic xerographic-reproducing machines of the type described in U.S. Pat. No. 3,301,126 issued Jan. 31, 1967 in the name of Robert F. Osborne et al. as well as in other machine applications wherein sheet material is forwarded from a stack, it has been found necessary to provide means for retaining the topmost sheet of a stack of sheet material at a predetermined height. The retention of the sheet material at a predetermined height is necessary so that the topmost sheet thereof may be at a specific level with respect to the mechanisms forwarding it from the stack. More sophisticated sheet forwarding mechanisms employed in high-speed sheet feeders require an accurate positioning of the topmost sheet of the stack so that nonfeeds and double sheet feeds are eliminated.

One solution for the maintaining of the height of the stack at a predetermined level is described in the aforementioned Osborne et al. patent. According to that disclosure, a pivotal sensor bar is located above the preselected horizontal orientation of the stack of sheet material so that it may be pivoted slightly when the stack is in the proper orientation. Also, pivotal in conjunction with the sensor bar is a switch actuator arm coactable with switching means which opens a circuit to a stack-elevating motor as the stack pivots the sensor bar through its physical contact therewith. As sheet material is depleted from the stack, the sensor bar pivots downwardly to retain contact with the next topmost sheet of the stack. When the stack has been sufficiently depleted, an increased downward pivotal motion of the sensor bar causes the actuator arm to contact the switch and remake the circuit to the elevating motor. The reactivated motor drives until the upward movement of the stack again pivots the sensor bar and actuator arm sufficiently so that the switch contacting arm again opens the switch. This, consequently, breaks the circuit to the elevating motor to stop the stack at the predetermined height.

Such a system has been found quite satisfactory to accomplish the desired result. But in order to assure the accuracy of operation required, it has been found necessary to employ a stepping motor which is characterized by its ability to quickly stop upon the removal of current to the up winding of the motor. Such a motor includes a rotor or armature composed of permanent magnets and a stator wherein the alternating current applied thereto effects a rotative indexing of the armature within the stator. This type of motor has an inherent locking capability. In addition to these features, such a motor is conventionally very expensive. Commercial utilization of the system described in the aforementioned Osborne et al. patent has required the use of a Slo-Syn synchronous motor electrically connectable for reversible rotation, for example, a number SS–150–1077 electric motor manufactured by the Superior Electric Co., Bristol, Connecticut. Conventional and less expensive induction motors have not been found suitable for this application due to the fact that they are characterized by their tendency to overrun when power is interrupted. That is, after the stator energizing current is stopped, the armature will continue to rotate until its inertia is balanced with the various inherent rotational losses. It is possible to employ a conventional induction motor to the system of the aforementioned Osborne et al. patent, but to do so and still retain its accurate indexing capabilities, would require the motor to be operated at unacceptably slow speeds so that the initial inertia is quite small.

The instant invention includes a motor and control apparatus adapted to be an improvement over that disclosed in the aforementioned patent. According to the instant invention, the expensive indexing motor is replaced by a relatively inexpensive induction motor. The controls thereto have also been modified to permit the elevating of the stack of sheet material at an extremely fast rate until the rising stack of sheet material approaches its predetermined level. At this point, a sensor bar coactable with a top of the stack of sheet material is pivoted by the stack slightly to modify the control circuitry to the induction motor. At this time, the alternating current which was rotating the motor at a high speed is removed and the motor is driven by half-wave rectified current whereby its speed of rotation is greatly decreased. This causes the elevator to rise at an slow speed so that its further action on the sensor bar further pivots it causing the removal of all current from the up winding. Since the speed of the motor prior to this time was extremely slow, the inertial effects on the motor are negligible and it will stop at an accurate location of the stack of sheet material with respect to sheet forwarding means.

When a few sheets have been forwarded from the stack, the sensor bar will be caused to move downwardly to a lower portion whereby the circuitry will permit the half-wave rectified current to again drive the motor at a slow paper-elevating speed until the sensor bar and topmost sheet in the stack is again at its proper sheet forwarding level. At this time, the current will again be removed from the motor and the stack will once again be at its proper height.

It is therefore an object of the instant invention to elevate a stack of sheet material until the topmost sheet thereof is at a proper predetermined level for being forwarded.

It is another object of the instant invention to raise sheet material by a motor at a rapid rate until it approaches a predetermined level reduce its speed of elevation and then stop the raising of the stack at the exact height.

It is another object of the instant invention to control a motion imparting motor through electrical current of a first characteristic and then by electrical current of a second characteristic to drive the motor at various speeds and then to remove current therefrom to stop the motor at a predetermined orientation.

It is a further object of the instant invention to sense the height of the topmost sheet in a stack of sheet material being driven upwardly at a fast rate of rise, to reduce the rate of rise of the sheet material as it comes closer to a predetermined height and then to stop its rise entirely at the predetermined location.

These and other objects of the instant invention, together with additional features and advantages thereof, will become apparent from the following description of one embodiment of the invention when read in conjunction with the accompanying drawings wherein:

FIG. 1 is a plan view of sheet forwarding mechanisms, sheet-handling assembly and controls therefor constructed in accordance with the instant invention;

FIG. 2 is a side elevational view of the assembly shown in FIG. 1;

FIG. 3 is a sectional view taken along lines 3–3 of FIG. 1;

FIG. 4 is a perspective view of the switching means and actuator arm shown in FIGS. 2 and 3; and

FIG. 5 is an electrical schematic of the control means for the assembly shown in FIGS. 1—4.

Shown in the FIGS. is a workpiece in the form of a stack of sheet material **10**, the topmost sheet **12** of which is adapted to be forwarded by sheet forwarding mechanisms **14** including pneumatic section tubes **16** which move to advance the sheet material to supplemental roller means **18**. The stack of sheet material is supported on a tray **20** having rollers **22** movable in vertical channels **24** to raise and lower the stack with respect to the pneumatic section tubes. The tray has, in association therewith, a cable **26** mounted over a rotatable spindle or pul-

ley **28**. The spool is mounted for rotation on shaft **32** which extends through one of the side frames **34** of the sheet supporting assembly. The side of the shaft **32** opposite from the spool **30** includes a gear **38** cooperable with worm gear **36** mounted on the armature or rotor **40** of the motor designated as **42**. One type of motor suitable for this function is Type NC 1—34 RL, 8 pole reversible permanent split capacitor motor manufactured by the Bodine Electric Company. Rotation of the motor **42** in a first or counterclockwise direction will rotate the gear **34** and consequently the spool **28** to lower the stack of sheet material. Rotation of the worm rotor **40** and worm gear **36** in the opposite direction will counterrotate its gear **34** and spool **28** to raise the stack of sheet material on the tray **20**.

Located above the horizontal sheet forwarding position of the stack of sheet material is a U-shaped sensor bar **44**. The sensor bar is mounted for rotation in short shafts **46** and **48** which are coaxially mounted in the side frames **34** of the assembly. The short shaft **48** located on the side of the apparatus adjacent the motor **42** extends through the side frame **34** and has secured on its opposite end a switch actuator arm **50** which is concurrently pivotal with the sensor bar **44**. The switch actuator arm **50** has a coil spring **52** secured near the first end **54** of the actuator arm. The opposite end of the spring is mounted on a stud **56** in the machine frame and acts to continually urge the switch actuator arm to a lower most position. This, in turn, would tend to pivot the sensor bar **44** downwardly toward the stack of sheet material on the tray.

Also located adjacent this first end **54** of the switch actuator arm **50** are a pair of limit switches **LS6** and **LS10** coactable with the switch actuator arm. A flat portion **60** on the end of the switch actuator arm contacts the finger of **LS10** while a set screw **58** adjustable through the sensor bar arm, contacts the actuator arm of **6LS** These switches are oriented with respect to the switch actuator arm so that when the actuator arm is pivoted to the extreme counterclockwise position as shown in FIG. **3**, these normally open switches are held closed. Pivoting of the actuator arm in a clockwise direction, as caused by movement of sheet material against the sensor bar, causes the set screw **58** to first move away from the finger of **6LS** to cause this switch to open. Further clockwise rotation of the sensor bar arm will then cause the sensor bar to move away from the contact finger of **10LS** and also open this normally opened limit switch.

The end of the switch actuator arm, remote from the switches may have cam means associated therewith. As described in the aforementioned Osborne et al. patent, this action raises the sensor bar away from the sheet material as each sheet is forwarded to reduce drag thereon. This does not effect the switching sequence since the switches are normally open during sheet feeding.

References now had to the electrical circuit shown in FIG. **5**. When the stack of sheet material is at a lower most position after the down switch **SW–6B** has been depressed, the physical location of the tray will hold the down limit switch **9LS** open so that no current is being provided to either the up winding or the down winding of the motor **42**. In this orientation **9LS**, the tray-down limit switch is also open.

To drive the tray upwardly it is necessary to depress the up button **SW–6A** to permit the flow of current through contact **3 CR–1B**, **6LS** and **10LS** which are in their closed orientation due to the counterclockwise orientation of the sensor bar and switch actuator arm through the holding action of the spring. This will cause alternating current to be supplied to the up winding of the motor and cause it to drive the stack of sheet material toward a sheet forwarding orientation through worm gear **36**, gear **38** and spool **30**.

As the stack of sheet material makes initial contact with the sensor bar **44**, the sensor bar will be driven upwardly until the sensor bar and switch actuator arm have moved sufficiently to permit the opening of **6LS**. With **6LS** opened, the current is conducted through rectifier **SR–3** which will permit half-wave rectified current to pass through closed **10LS** to the up winding of the motor. The motor now being driven by half-wave rectified current will cause the motor to rotate and the tray to rise at at extremely reduced rate of speed. This movement then continues until the stack of sheet materials and the sensor bar have reached their proper height at which time the switch actuator arm will be moved out of contact with **10LS**. At this time **10LS** will be in its normally opened state to remove all power from the up winding of the motor. This self locking characteristics of the worm and gear prohibit, as in the aforementioned Osborne et al. patent, downward drifting of the sheet material on the tray.

In actual operation, the tray may be driven upwardly by the motor rotating at **720** revolutions per minute under the alternating current input. The switching to half-wave rectified current will cause an electrical breaking action on the armature to reduce its inertia and then continue to drive the motor at **15** revolutions per minute, substantially less than 10 percent of the initial speed. With this slow speed of motor movement, removal of current from the motor will permit its stoppage at a height whereat paper can be dependably fed therefrom. By an exact height it is meant an exact height plus or minus about 0.020 inch, about the thickness of 6—8 sheets of paper.

Due to the characteristics of this control circuitry for the elevator motor **42**, as sheet material is depleted from the stack through its being forwarded therefrom, the effective height of the stack is constantly being reduced. When several sheets have been removed from the stack, the sensor bar will be pivoted downwardly toward the stack causing the sensor bar to close switch **10LS**. When this occurs, the half-wave rectified current will be introduced to the up winding of the motor to again raise the stack slightly at a slow speed until proper height of the stack is again attained. This action continues so long as a sufficient quantity of sheet material remains on the tray for being forwarded.

If it is desired to lower the stack of sheet material for any purpose, as for example, the changing of the size of sheet material on the stack, it is only necessary to depress the down button **SW–6B**. When this occurs, power can longer be supplied to the up winding of the motor, since the current path is opened. In this condition, current is supplied to energize **12CR** and **3CR** to close **12CR–1** and supply alternating current through **12CR–1** and **9LS** to the down winding of the motor. Thus the motor will rotate at a high rate of speed to quickly lower the sheet material. When the tray reaches its lowermost position, limit switch **9LS** will be opened to remove power from the down winding of the motor to stop the movement of the tray.

Also located in association with a tray is a low paper limit switch **4LS**. When the quantity of sheet material has been greatly reduced from the tray, the tray will become raised to a higher than desirable orientation. When this occurs, normally opened limit switch **4LS** will be closed to switch relays **12CR** and **3CR**. With **3CR** being switched, **3CR–1B** will be opened and **3CR–1A** will be closed to prohibit the flow of current to the up winding of the motor. With **12CR** being reversed, **12CR–1** will be closed to permit the flow of alternating current to the down winding of the motor despite the fact that the down button **SW–6B** has not been depressed.

As can be understood from the above description, the apparatus and controls of the instant invention result in the use of a less expensive motor to control the height of a stack of sheet material to be forwarded. The control system also has the advantage of permitting the stack of sheet material to be raised and lowered at extremely high rates of speed to minimize down time of the assembly when changing sheet material employed. The fast rate of rise of the elevator causes no problems with its proper positioning due to the switching of the motor to a lower speed as the stack of sheet material approaches its proper orientation.

While the present invention, as to its objects and advantages, has been described and carried out in a specific embodiment thereof, it is not desired to be limited thereby; but it is intended to cover the invention broadly within the scope of the appended claims.

I claim:

1. Apparatus for elevating a stack of sheet material to a predetermined height including:

sensing means mounted for movement in response to sheet material moved toward the predetermined height;

motor means adapted to move the stack of sheet material to the predetermined height;

motor control circuit means having first and second paths for delivering alternating current and half-wave rectified current, respectively, to said motor means to operate said motor means at a fast or slow speed;

first switching means coupled with said sensing means for disabling said first path and enabling said second path as said stack of sheet material is moved toward the predetermined height at the fast speed;

second switching means coupled with said sensing means for disabling said first and second path to interrupt current to said motor means and stop the stack of sheet material in response to the sheet material arriving at the predetermined height.

2. The apparatus as set forth in claim 1 wherein said sensing means is moved and said second switching means reactivated by the removal of sheet material from the stack to drive said motor and said stack of sheet material at the slow speed to again raise the stack of sheet material to the predetermined height.

3. The apparatus as set forth in claim 2 wherein the first and second switching means are connected in series and said circuit means includes a rectifier in parallel with said first switching means so that alternating current is passed through said first and second switching means, bypassing said rectifier, when said motor is being driven at the fast speed and so that half-wave rectified current is passed through said rectifier and second switching means when said motor is being driven at the slow speed.

4. Apparatus for moving a workpiece and then stopping it at a predetermined location including:

motor means operable to move the workpiece;

circuit means to deliver full wave current to said motor means to drive said motor and the workpiece at a fast speed as it moves toward the predetermined location;

sensor means to detect when the workpiece approaches the predetermined location and, in response thereto, to modify said circuit means to deliver half-wave current to said motor means to drive said workpiece at a slow speed;

and means responsive to the arrival of the workpiece at said predetermined location to interrupt current to said motor means to stop the workpiece at a predetermined location;

said circuit means including a first switching means and a rectifier in parallel and a second switching means in series therewith and wherein the fast speed is attained through alternating current passing through said first and second switching means while the slow speed is attained through half-wave current passing through said rectifier and said second switching means.

5. Apparatus for moving a workpiece and then stopping it at a predetermined location including:

motor means operable to move the workpiece;

circuit means to deliver full-wave current to said motor means to drive said motor and the workpiece at a fast speed as it moves toward the predetermined location;

sensor means to detect when the workpiece approaches the predetermined location and, in response thereto, to modify said circuit means to deliver half-wave current to said motor means to drive said workpiece at a slow speed;

and means responsive to the arrival of the workpiece at said predetermined location to interrupt current to said motor means to stop the workpiece at the predetermined location.

6. Apparatus for moving a workpiece and then stopping it at a predetermined location including;

motor means operable to move the workpiece;

circuit means to deliver full-wave current to said motor means to drive said motor and the workpiece at a fast speed as it moves toward the predetermined location;

sensor means to detect when the workpiece approaches the predetermined location and, in response thereto, to modify said circuit means to deliver half-wave current to said motor means to drive said workpiece at a slow speed;

and means responsive to the arrival of the workpiece at said predetermined location to interrupt current to said motor means to stop the workpiece at the predetermined location;

said circuit means including two switching means and a rectifier and wherein the slow speed is attained through half-wave current passing through said rectifier and one of said switching means while the fast speed is attained through full-wave current passing through the other of said switching means.