

[54] **SOLENOID CONTROL SYSTEM**

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317/124, 318/127
[51] Int. Cl. **B65h 3/24**
[58] Field of Search **271/44, 44 A, 41,**
271/42, 54, 84; 317/124; 318/127, 686, 470;
250/229

[56] **References Cited**

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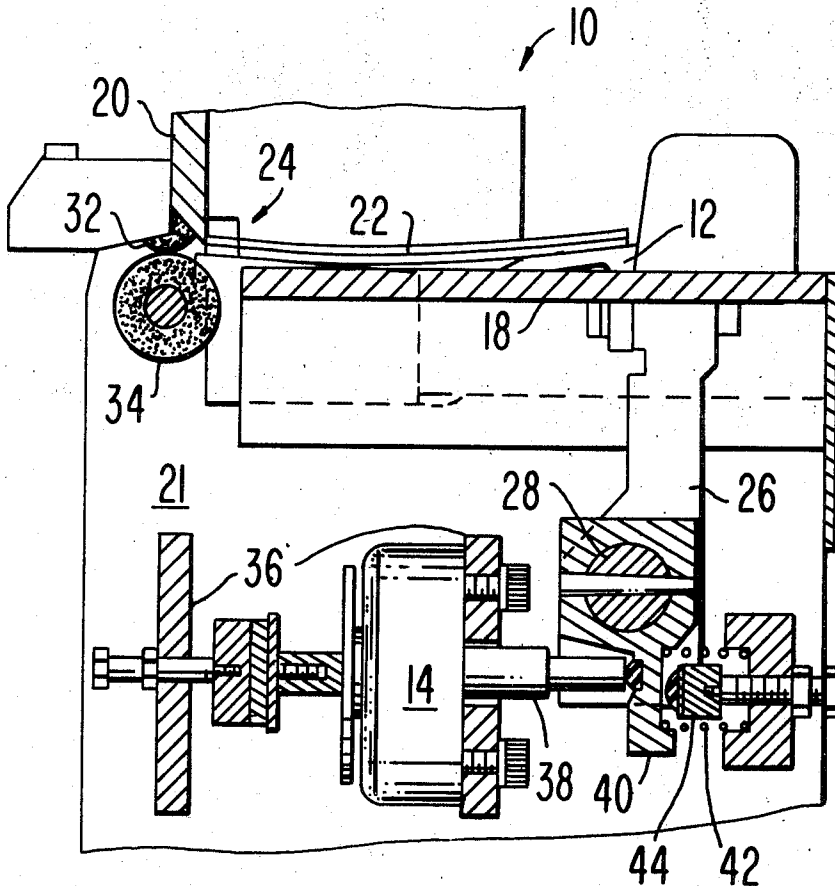
Attorney—Paul W. Fish et al.

[57]

ABSTRACT

A solenoid control system is provided in which the plunger travel of a card feeder solenoid subjected to varying loads is monitored, solenoid actuating current being discontinued when the plunger reaches a predetermined point such that the duration of solenoid actuation, rather than being fixed, is a function of the varying loads to which the solenoid is subjected.

4 Claims, 9 Drawing Figures



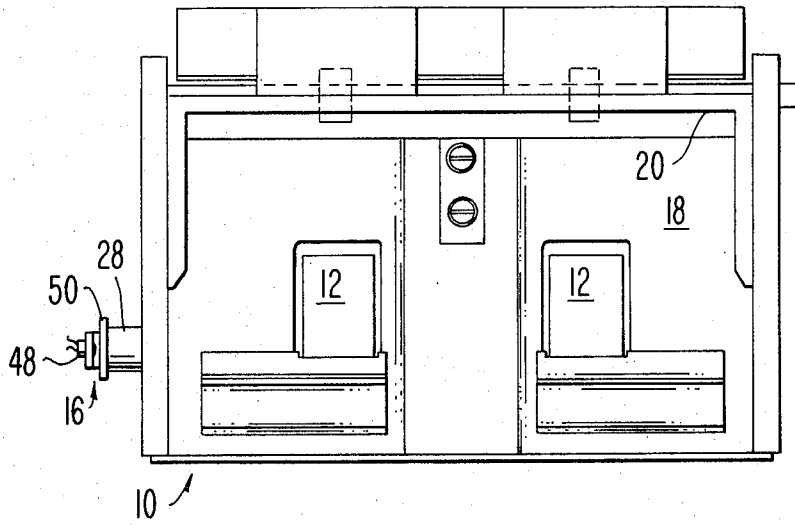


FIG. 1

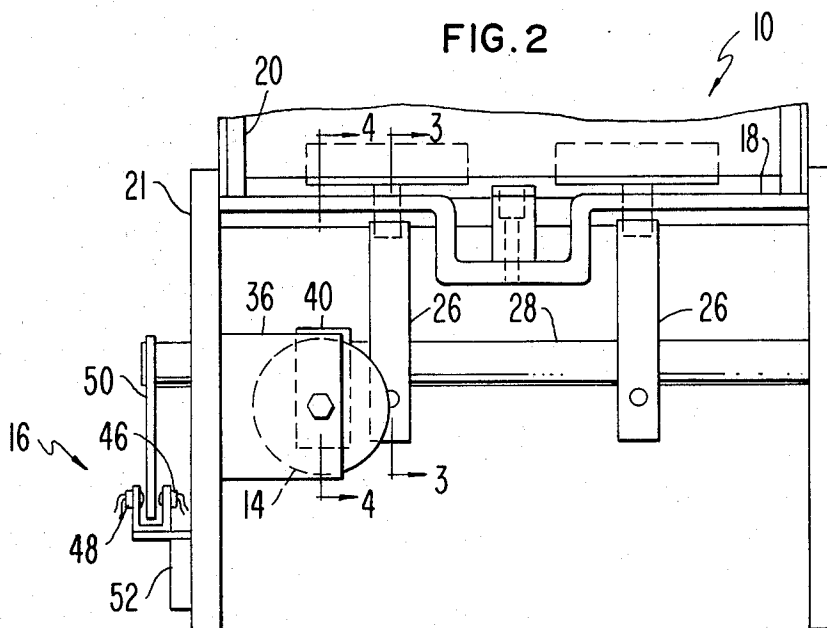


FIG. 2

FIG. 3.

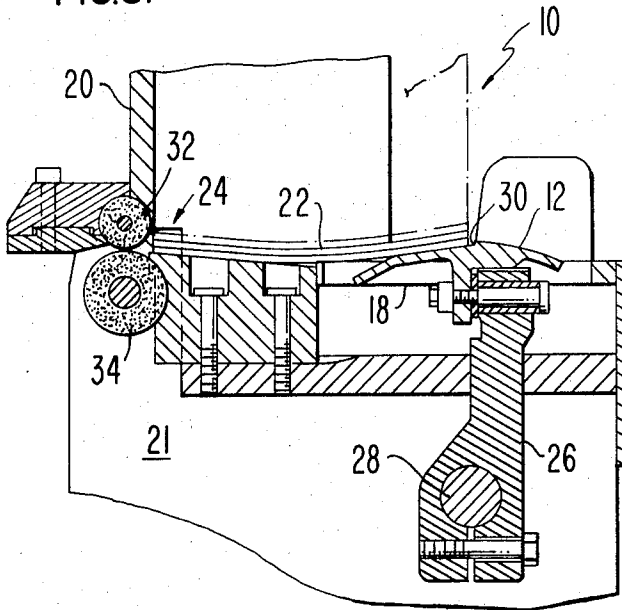


FIG. 4.

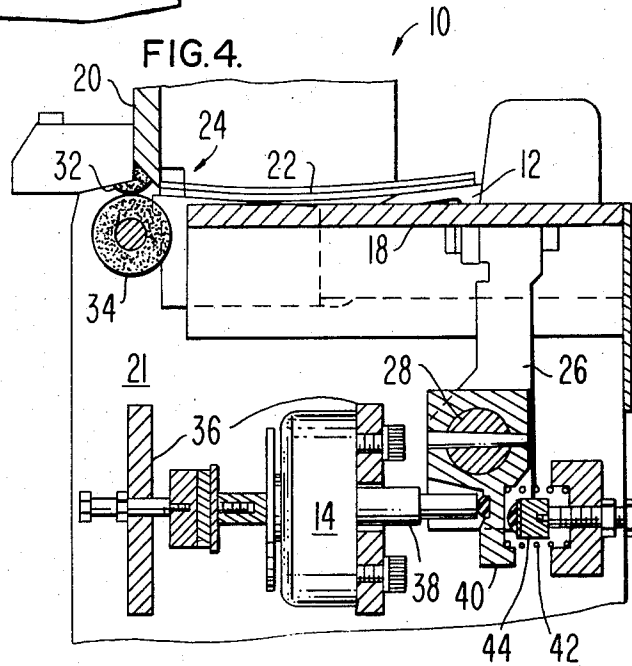


FIG. 5.

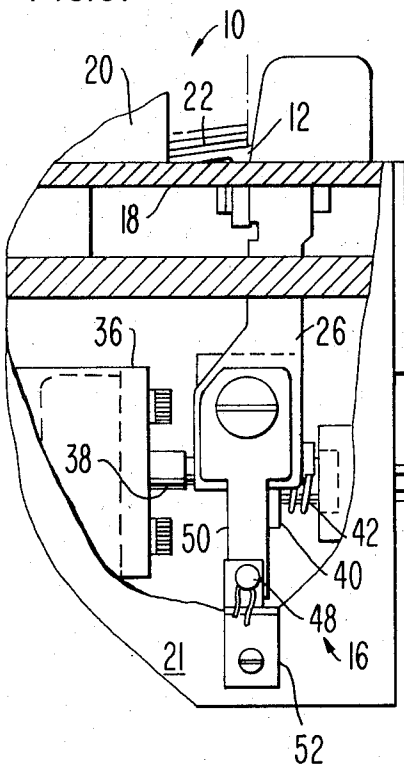


FIG. 6.

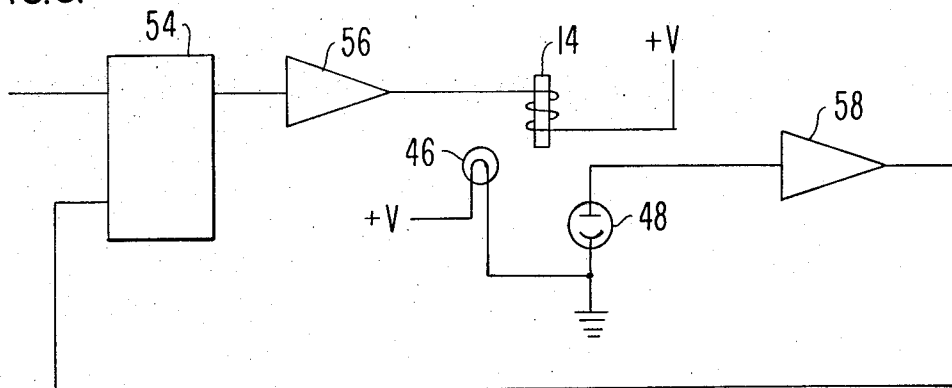


FIG. 7.

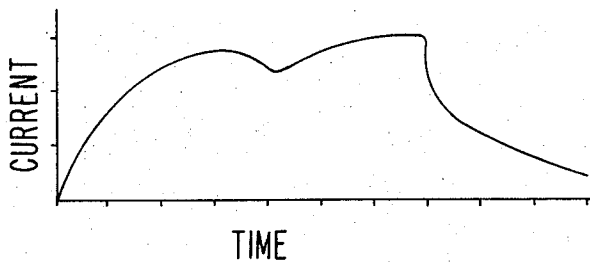


FIG. 8.

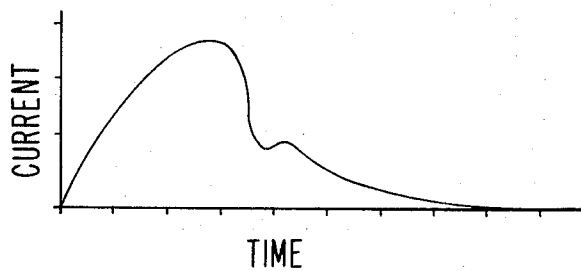
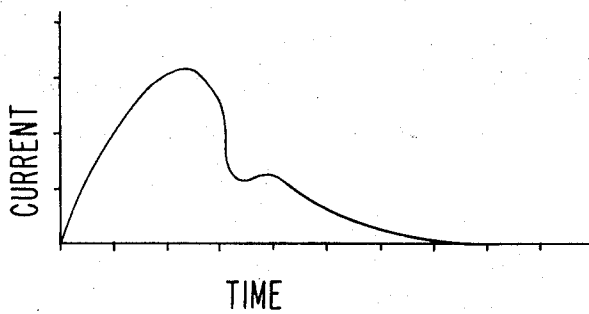


FIG. 9.



SOLENOID CONTROL SYSTEM

CROSS REFERENCE TO RELATED APPLICATION

The present invention is related to the Card Feeding Apparatus disclosed and claimed by F. A. Houghton, L. Wasielewski and J. L. Kinner in a U.S. Pat. application, Ser. No. 246,433, filed Apr. 21, 1972 and assigned to the assignee of the present application.

BACKGROUND OF THE INVENTION

This invention relates generally to solenoid-actuated record card feeding devices and more particularly to solenoid control systems therefor.

Prior art discloses may record card feeding devices, some of which are actuated by an electrical solenoid. A typical example, one closely related to the present invention, may be found in record card readers where individual cards are fed from the bottom of a stack thereof by a card feeding implement having an edge abutable with the trailing edge of a card being fed, the implement being forced against the card by an electrical solenoid actuated for a fixed period. To ensure a relatively rapid feed rate, the implement, once it has driven a card a desired distance, is halted in its travel by a stop member prior to being retracted to its original position by a return spring. The stack overlying the card being fed presses down upon it, imposing a load upon the solenoid since the frictional force between cards is directly proportional to the normal forces acting thereupon. Since this normal force varies with the weight of the card stack, it is evident that a large stack imposes a greater load upon the solenoid than does a small stack. This load is manifest in the feeder by the time it takes the solenoid to advance a card a desired distance, that is, it takes a greater amount of time for the solenoid to advance the lowermost card of a large stack to a given position than to advance the lowermost card of a small stack to that same position. Since prior card feeders actuated their respective solenoids for fixed amounts of time, that period of actuation must obviously be chosen which will allow a card to be advanced from under the largest stack anticipated. Consequently, at times when the stack is relatively small, the solenoid will be inefficiently held actuated for a longer period than is actually required to advance a card to a desired position, resulting in the feeding implement being driven against its associated stop member with considerable force, causing excessive noise, wear and implement recoil. The greater the card feeding frequency, the distance of card advance under the influence of the feeding implement, the mass of the implement and the disparity of respective weights imposed on a lowermost card by maximum and minimum sized stacks, the more pronounced will be these disadvantages of solenoid-actuated card feeding devices having fixed actuation periods.

SUMMARY OF THE INVENTION

The invention resides in the provision of a bistable solenoid control which is responsive to a photoelectric monitor operably coupled to the plunger of a solenoid under control of the system such that solenoid actuating current is discontinued when the plunger reaches a predetermined point, the duration of solenoid actuation being a function of the load-determined, plunger travel time.

Accordingly, it is an object of the present invention to provide a solenoid control system which is electromechanically efficient in its using solenoid actuating current only as long as is required by a solenoid which is subject to varying loads.

It is another object of the invention to provide a system where the duration of solenoid actuation is a function of the load imposed upon the solenoid.

It is yet another object of the invention to provide a system which equalizes and minimizes noise occurring when the solenoid plunger strikes an associated stop member under varied solenoid load conditions.

Yet another object of the invention is to provide a system which minimizes part wear and failure and the maintenance expense associated therewith.

Still another object of the invention is to provide a system which equalizes and minimizes solenoid plunger recoil occurring after the plunger strikes an associated stop member under varied solenoid load conditions.

An important aspect of the invention is the use of a bistable solenoid control in combination with a photoelectric monitor to establish a functional relationship wherein the varying load imposed on a solenoid is delineated as the independent variable and the duration of solenoid actuation as the dependent variable thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects, aspects and advantages of the invention will be more clearly understood from the following description when read in conjunction with the accompanying drawings, in which:

FIG. 1 is a plan view of a record card feeding device embodying features of the invention;

FIG. 2 is a rear view of the device shown in FIG. 1;

FIG. 3 is a sectional view taken in the direction of the arrows 3—3 in FIG. 2;

FIG. 4 is a sectional view taken in the direction of the arrows 4—4 in FIG. 2;

FIG. 5 is a partially fragmented end view of the device shown in FIG. 1;

FIG. 6 is a schematic representation of the solenoid control system;

FIG. 7 is a graphic representation of a typical relationship existing between applied solenoid actuating current and time for a conventional, solenoid-actuated card feeder wherein the solenoid is actuated for a fixed period;

FIG. 8 is a graphic representation of the same relationship as shown in FIG. 7 for a solenoid-actuated card feeder employing the present solenoid control system and operating under a representative load; and

FIG. 9 is similar to FIG. 8 but shows the relationship under a lighter load condition.

DETAILED DESCRIPTION OF THE INVENTION

A typical solenoid-actuated, record card feeding device incorporating the solenoid control system is shown in FIGS. 1 through 5. It has a hopper generally indicated at 10, a pair of feed knives 12—12, a card feeder solenoid 14 and a photoelectric monitor generally indicated at 16. The feed knives are pivotally mounted beneath and extend effectively upward into the hopper, the knives being rockably actuated by the solenoid, the monitor also being responsive thereto.

The hopper 10 has a substantially horizontal, lower support or base member 18 and upright support mem-

bers 20 affixed normally to the base member, which, in turn, rests on a support member or frame 21. The configuration of the upright support members 20 conforms to the dimensions of record cards to be supported thereby such that the hopper 10 is capable of maintaining a uniformly aligned card stack 22. The lower edge of the leading upright support member 20 is disposed above the card support member 18 at a distance slightly greater than the thickness of a single record card to form a throat 24 to prevent the simultaneous feeding of more than one card. Located immediately posterior to the throat 24 is a pair of continuously rotatable drive rollers 32—32, each roller being resiliently opposed by one of a pair of pressure rollers 34—34. These rollers are disposed such as to drivingly grip a card fed through the throat and propel it in a desired direction for processing.

The feed knives 12—12 are respectively affixed to the upper ends of a pair of feed knife supporting levers 26—26, which are secured at their lower ends to a pivotable shaft 28 journaled in the frame 21 below the hopper base member 18. The feed knives extend effectively upward through the base member 18 to support the trailing edge of the lowermost card stacked in the hopper 10. Impelling projections 30—30 extend upward from the bodies of the feed knives 12—12 and are normally positioned slightly behind the trailing edge of the lowermost card. The feed knives are coaxially disposed in parallel, the distance separating them being somewhat less than the length of record cards to be fed thereby.

The card feeder solenoid 14 is mounted on a bracket 36 affixed to the frame 21 below the hopper base member 18, its plunger 38 extending transversely to and below the shaft 28 to abut, at its distant end, a torque arm 40 affixed to and depending from the shaft. The torque arm 40 is resiliently held in its most clockwise position, as best shown in FIG. 4, by a helical spring 42 and is limited in its counterclockwise movement about the shaft 28 by a stop 44 affixed to the frame 21. Since the feed knife supporting levers 26—26 are also affixed to the shaft 28, any counterclockwise excursion of the torque arm 40 caused by the solenoid 14 will be communicated to the feed knives 12—12 respectively disposed at the upper ends of the levers 26—26.

The photoelectric monitor 16 has a light projector 46, a light detector 48 and a light shutter 50, as best shown in FIGS. 2 and 5. The light projector and detector are mounted in effective apposition on respective parallel but spaced apart, upward extending arms of a bracket 52 secured to the outer surface of the frame 21. The light shutter 50 is affixed to the end of the shaft 28 extending through the frame 21 and normally extends downwardly to a position between the light projector 46 and the light detector 48, thus preventing light emitted by the former from reaching the latter. The configuration of the shutter 50 is such that it will be swung clear of the monitor light path whenever the shaft 28 is rotated by the solenoid 14.

In conjunction with the mechanical structures previously described and shown in FIGS. 1 through 5, a number of electronic elements are included which make up the balance of the solenoid control portion of the system as shown in FIG. 6. The control portion has a control member 54, a solenoid driver 56 and an optical signal amplifier 58. The control member 54 is a bistable device such as a flip-flop. In a typical feeder con-

trol operation, its "set" input would be operably coupled to card feed control logic, which would provide an electrical signal to "set" the flip-flop when a card feed is desired. The "set" output of the flip-flop is operably coupled to the card feeder solenoid 14 through the solenoid driver 56. The light detector 48 of the photoelectric monitor 16 is operably coupled to the "reset" input of the flip-flop 54 through the amplifier 58.

OPERATION OF THE INVENTION

In preparation for a typical card feeding operation, the hopper 10 of the solenoid-actuated card feeding device shown in FIGS. 1 through 5 would be loaded with a stack 22 of record cards. The cards would be vertically aligned by the upright support members 20 and supported by the hopper base member 18. The trailing edge of the lowermost card would rest on the feed knives 12—12 just ahead of the impelling projections 30—30 thereon.

Upon receiving a card feed command signal from external control logic, the flip-flop 54 (FIG. 6) will be transferred to its "set" state, actuating the solenoid 14 through the solenoid driver 56. When the solenoid 14 is actuated, its plunger 38, as best shown in FIG. 4, will force the torque arm 40 to pivot in a counterclockwise direction, rotating the shaft 28 to which the arm is affixed in the same direction. As the shaft 28 is rotated, the feed knife supporting levers 26—26 affixed thereto, as best shown by FIG. 3, will also pivot in a counterclockwise direction, swinging the feed knives 12—12 disposed respectively at the upper ends in the same direction. The impelling projections 30—30 will abuttingly engage the trailing edge of the lowermost card in the stack 22 and advance the card until the torque arm 40 (FIG. 4) strikes the stop 44. At this time, the leading edge of the lowermost card will have been forced through the throat 24 and between the drive rollers 32—32 and their respective, resiliently opposing pressure rollers 34—34, the card thereafter being advanced under their continuous influence until it has completely exited the hopper 10. When the actuating current supplied to the solenoid 14 is discontinued, the helical spring 42 acting against the torque arm 40 will rotate the shaft 28 in a clockwise direction, thus restoring the feed knives 12—12 to their initial positions slightly behind the trailing edge of the next lowermost card in the stack 22.

As cards are added to and fed from the stack 22, the load imposed upon the solenoid 14 when the lowermost card is being fed naturally varies. As the load varies, the time required for the feed knives 12—12 to advance the card being fed to the drive rollers 32—32 varies proportionally. If solenoid actuating current were applied for a fixed period adequate to provide for card feeding with a maximum-height card stack, it would be applied for an excess amount of time with a minimum-height stack. In the latter case, the torque arm 40 would be driven against the stop 44 with an ultimately debilitating force, causing excessive noise, wear and feeder knife recoil. Solenoid actuating current is, however, applied only for that period required by an existing load, thereby reducing these deleterious effects to a minimum. This is accomplished by using the photoelectric monitor 16 to detect the time at which the feed knives 12—12 have advanced a card to a desired position.

As previously described, the light shutter 50 (FIG. 5) depends from the shaft 28 such that it normally blocks the path of light between the light projector 46 and the light detector 48. Since the shutter 50 is affixed to the shaft 28, it will pivot about the axis of the latter when the solenoid 14 is actuated, as will the feed knives 12—12. Its angular disposition is therefore directly indicative of that of the feed knives, the relationship being established such that the shutter is swung out of the monitor light path just as the feed knives have reached the point when solenoid actuating current is to be most advantageously discontinued. With the shutter 50 swung out of the monitor light path, emissions from the light projector 46 will reach the light detector 48. In response thereto, the detector will generate an output signal which will be applied to the "reset" input of the flip-flop 54 through the optical signal amplifier 58. Upon application of this signal, the flip-flop 54 will be restored to its "reset" state, thus removing actuating current from the solenoid 14. The counterclockwise swing of the torque arm 40 (FIG. 4) will be halted upon its impact with the stop 44; and the solenoid plunger 38, the torque arm 40, the feed knives 12—12 and the light shutter 50 will be returned to their initial positions under the influence of the helical spring 42.

As a practical example of the advantageous operating characteristics of the solenoid control system, graphic representations of the relationship existing between applied solenoid actuating current and time are shown by FIGS. 7, 8 and 9. FIG. 7 shows the relationship for a conventional, solenoid-actuated card feeder wherein the solenoid is actuated for a fixed period. In contrast, FIGS. 8 and 9 show the same relationship for a solenoid-actuated card feeder employing the solenoid control system, the latter figure of the same feeder operating under a lighter load condition. As may be readily observed, the duration of solenoid actuating current application decreases in proportion to decreases in the load imposed upon the solenoid by the weight of the card stack.

While the solenoid control system has been shown and described in considerable detail, it should be understood that many changes and variations may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. In a solenoid-actuated record card feeding device wherein individual cards are advanced from a stack thereof and wherein the load opposing subsequent actuations of the device varies directly with the weight of the stack as cards are added and fed, a solenoid control system comprising:

monitor means responsive to the position of the plunger of an electrically actuatable card feeder solenoid associated therewith for providing an electrical output indicative of the plunger position; and

control means operably responsive to the electrical output of said monitor means for prolonging the actuation of the card feeder solenoid only until its plunger has been advanced a predetermined distance, the duration of solenoid actuation thereby being a function of solenoid plunger travel time, which is a function of varying card stack weight;

said monitor means comprising:

light projecting means for providing a source of light;

light detecting means disposed in effective opposition to said light projecting means for detecting light emissions therefrom, said light detecting means having an electrical output operably responsive to the light emissions; and

light shutter means for controlling the passage of light from said light projecting means to said light detecting means in response to the position of the card feeder solenoid plunger;

said light projecting means comprising a light emitting element having a substantially unidirectional optical output;

said light detecting means comprising a photoelectric device having a characteristic electrical output responsive to the presence and absence of light emitted by said light projecting means;

said light shutter means comprising an optically opaque lever normally disposed between said light projecting means and said light detecting means, blocking the passage of light therebetween, said shutter means being movable away from its normal position upon actuation of the card feeder solenoid, thereby permitting the passage of light from said light projecting means to said light detecting means; and

said control means comprising a bistable logic element responsive to an external card feed signal for initiating actuation of the card feeder solenoid and being responsive to the electrical output of said light detecting means for discontinuing solenoid actuation.

2. A solenoid-actuated record card feeding device, wherein individual cards are advanced from a stack thereof and wherein the load opposing subsequent actuations of the device varies directly with the weight of the stack as cards are added and fed, comprising:

a support member;

an electrically actuatable solenoid disposed on said support member and having a plunger movably dependent thereon;

at least one card feeding implement movably disposed on said support member and operably coupled to the plunger of said solenoid for advancing an individual card from a stack thereof in response to each actuation of the solenoid;

a monitor disposed on said support member and having an electrical output responsive to the position of said card feeding implement; and

a control member operably responsive to the electrical output of said monitor for prolonging the actuation of said solenoid only until said card feeding implement has been advanced a predetermined distance, the duration of solenoid actuation thereby being a function of card feeding implement travel time, which is a function of varying card stack weight.

said monitor comprising:

a light projector disposed on said support member for providing a source of light;

a light detector disposed on said support member in effective opposition to said light projector for detecting light emissions therefrom, said light detector having an electrical output operably responsive to the light emissions; and

a light shutter for controlling the passage of light from said light projector to said light detector in re-

sponse to the position of said card feeding implement;
said light projector comprising a light emitting element having a substantially unidirectional output.
said light detector

comprising a photoelectric device having a characteristic electrical output responsive to the presence and absence of light emitted by said light projector;

said light shutter being normally disposed between said light projector and said light detector, blocking the passage of light therebetween, said shutter being movable away from its normal position upon actuation of the card feeder solenoid, thereby permitting the passage of light from said light projector to said light detector; and

said control member comprising a bistable logic element responsive to an external card feed signal for initiating actuation of the card feeder solenoid and being further responsive to the electrical output of said light detector for discontinuing solenoid actuation.

3. A solenoid-actuated record card feeding device as defined by claim 2 wherein said card feeding implement comprises a feed knife affixed to the upper end of an associated feed knife support lever, the lever being pivotable about its lower end by said card feeder solenoid, the body of said feed knife having an impelling projection extending upward therefrom, the projection being abutable with the trailing edge of the lowermost card of a stack thereof for advancing that individual card upon actuation of said solenoid.

4. A solenoid-actuated record card feeding device, wherewith individual cards are advanced from the bot-

tom of a card stack and wherein the load opposing subsequent actuations of the device varies directly with the weight of the stack as cards are added and fed, comprising:

a supporting structure;

an electrically actuatable solenoid disposed on said supporting structure and having a plunger movable in one direction in response to the energization thereof and returnable in the opposite direction in response to the deenergization thereof;

at least one card feeding implement movably disposed on said supporting structure and operably coupled to the plunger of said solenoid for advancing an individual card from a stack thereof in response to each energization of said solenoid;

detector means disposed on said supporting structure and having an electrical output responsive to the position assumed by said card feeding implement at the conclusion of its card advancement; and

electrical circuit means for controlling the energization and deenergization of the solenoid, said circuit means including an electrically operated bistable logic element having "set" and "reset" inputs and being responsive to an external card feed signal on the "set" input of the logic element for initiating the energization of the solenoid and being further responsive to the electrical output of said detector means on the "reset" input of the logic element for discontinuing the energization of the solenoid, the duration of solenoid energization thereby being a function of card feeding implement travel time which is a function of the varying card weight.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,779,544 Dated December 18, 1973

Inventor(s) Leonard Wasielewski and James L. Kinner

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Col. 1, line 14, change "may" to read --many--.
Col. 5, line 37, change "many" to read --may--.
Col. 8, line 33, change "card weight" to read --card stack weight--.

Signed and sealed this 23rd day of April 1974.

(SEAL)

Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

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