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Hunter et al.

[11] **3,814,415**

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[54] **DEVICE FOR AIDING THE STACKING OF DOCUMENTS**

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[52] **U.S. Cl.** **271/181,** 271/176, 271/214

[51] **Int. Cl.** **B65h 29/14**

[58] **Field of Search** 271/87, 86, 71, 88, 68; 214/7

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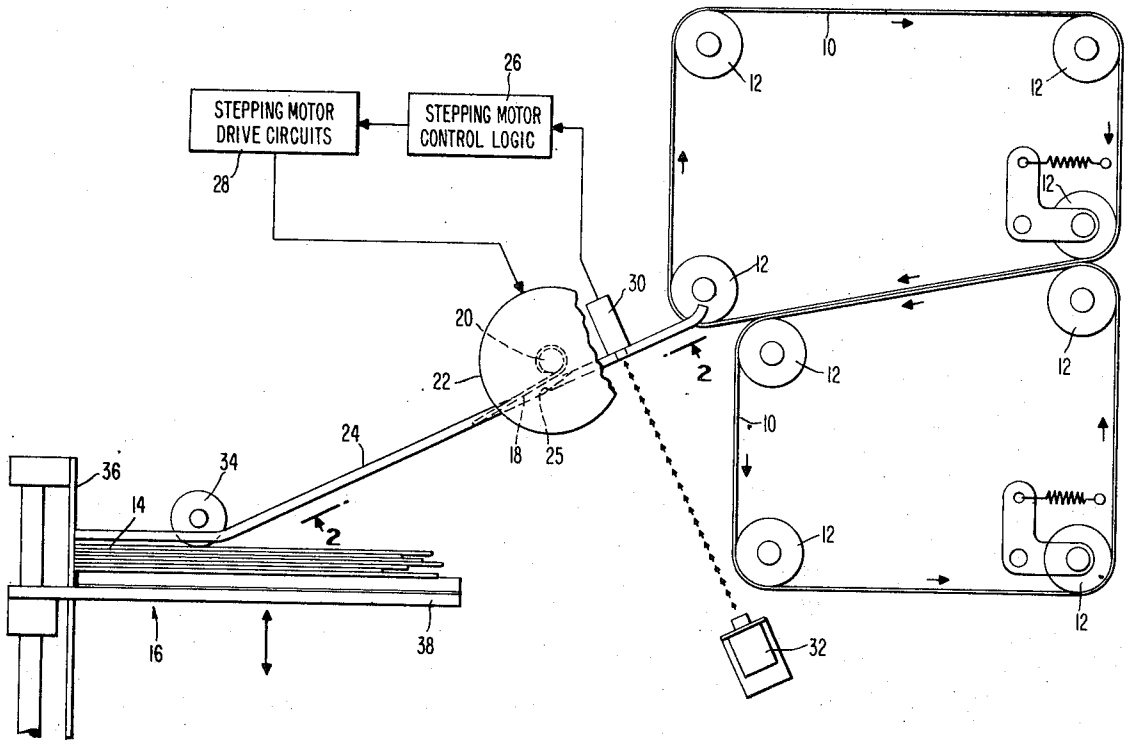
[57] **ABSTRACT**

The present disclosure describes a technique for prevening collisions and jams of closely spaced documents, such as mail pieces which vary in size and weight, as they enter a stacking mechanism at high speed in a single file. Means are provided which are timed to impart a rotary motion about a vertical pivot point to each document as it approaches the stationary stack. Such motion insures that the leading edge of a succeeding document does not collide with the trailing edge of the preceeding document. Moreover, in a positive sense the leading edge of each document is caused to contact the previously stacked stationary document close to its leading edge, thereby eliminating the jamming of documents which might otherwise occur, particularly with documents having substantially different lengths.

6 Claims, 3 Drawing Figures



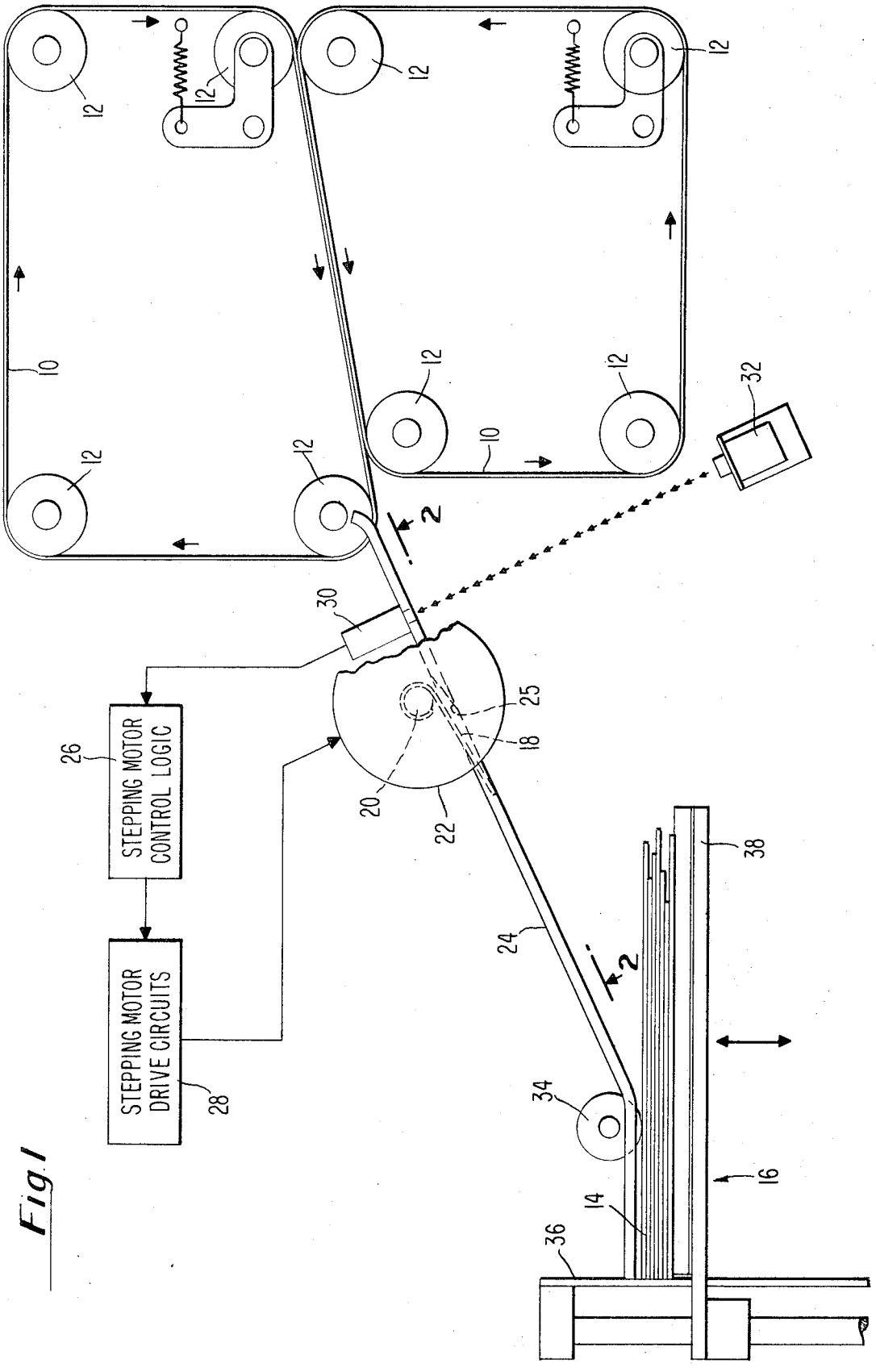

12
10
32
30
2
25
18
20
22
26
STEPPING MOTOR CONTROL LOGIC
28
STEPPING MOTOR DRIVE CIRCUITS
24
38
34
16
14
36

Fig. 1

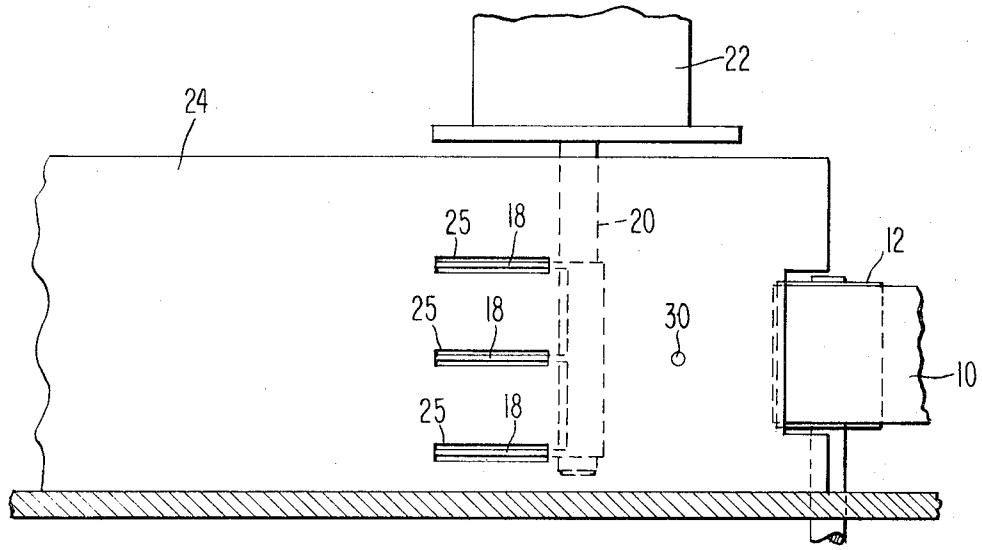

22
24
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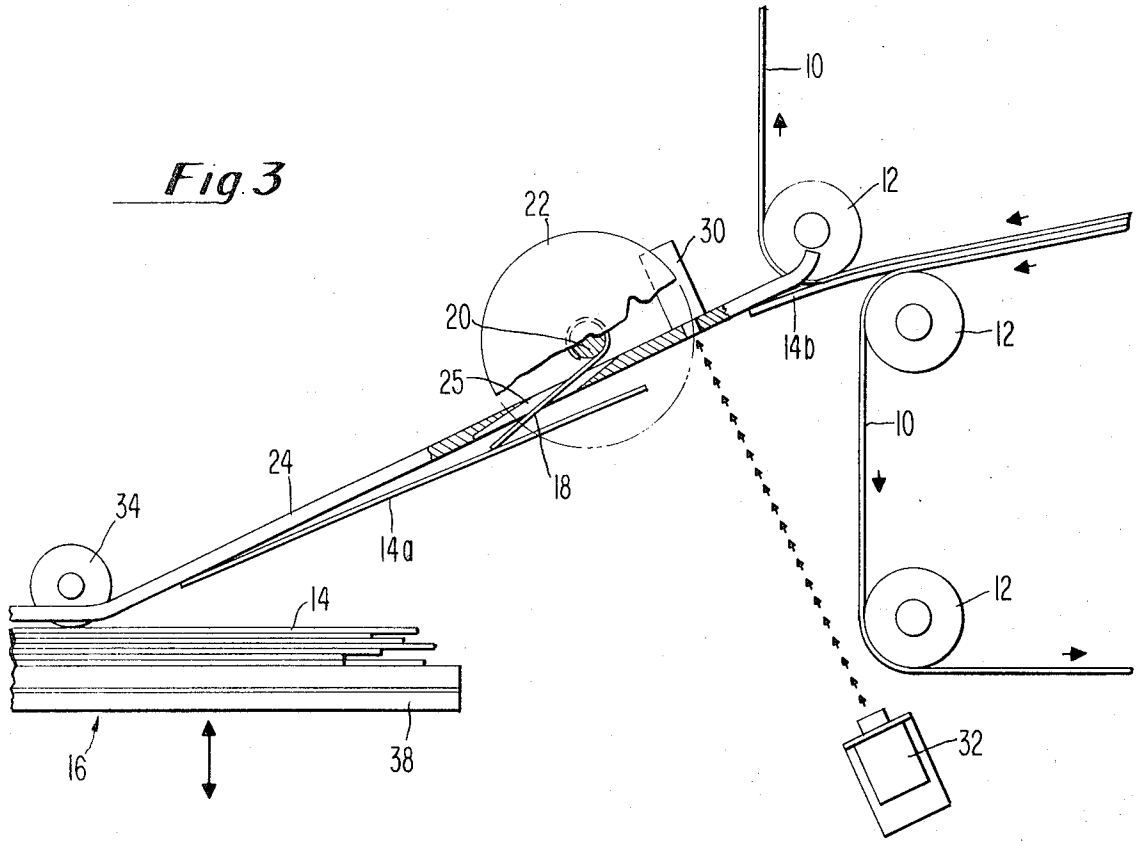
Fig. 2

Fig. 3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DEVICE FOR AIDING THE STACKING OF DOCUMENTS

CROSS REFERENCE TO RELATED APPLICATION

The present invention utilizes, in a preferred embodiment, a stepping motor to extend and subsequently retract a "kicker" mechanism at predetermined times to impart the desired sideward motion to the document being stacked. To the extent that application Ser. No. 222,215, now U.S. Pat. No. 3,755,727, "Control System for Stepping motors," by Italo H. Schifalacqua relates to a means for controlling stepping motors of the type used in said invention, it is cross-referenced herein. The reference application and the present one are assigned to a common assignee.

BACKGROUND OF THE INVENTION

The conversion of a single-file stream of documents, with gaps between them, into a uniform stack of documents is relatively easy to accomplish if the gaps are sufficiently large. However, as the gap length diminishes, the problem of rear-end collisions between documents arises.

Documents enter the stacking mechanism with an initial velocity and then decelerate to rest by various means, against a reference edge guide. As the leading document slows down, the succeeding document still travelling at the same value of initial velocity, begins to overtake the leading document, and reduces the original gap which existed therebetween. No problem arises until the gap disappears completely — at which time a collision and possible jam are likely.

Numerous prior art methods have been employed to cause the trailing edge of the leading document to move sideward, toward the stationary stack, to allow the trailing document to overtake it in an orderly shingled fashion and slow to rest against the reference edge guide. The most common scheme is to position the stack in such a manner that gravity provides the necessary sideward motion of the document. Another common scheme deliberately deflects the leading half of the document being stacked as it contacts the stationary stack. This action causes the trailing edge of the document to move in the required sideward direction. A mechanized solution to the problem employs a rotating worm screw or friction belt placed in the base plate beneath the documents as they enter supported on their thin edges. The worm screw or belt provides a motion toward the stack essentially at a right angle to that of the document entering the stacking mechanism.

While the foregoing methods aid in preventing rear-end collisions of the documents, they are not positive in their action and present a serious side effect of moving the document toward the stack prematurely. In many cases, jams occur as a result of a succeeding document running into the trailing end of a short-length, previously stacked, document. It is thus apparent that the succeeding document should contact the stationary document near the reference edge guide to prevent colliding with the trailing end of a short stationary document.

The present invention substantially eliminates the aforementioned problem by providing positive means, timed to impart to each document, regardless of length, a sideward motion to insure uniform jam-proof stacking.

SUMMARY OF THE INVENTION

In accordance with the present invention, the problem of collisions and jams of documents being stacked at high speed is solved through the use of a kicker mechanism which in a preferred embodiment is powered by a high-speed stepping motor to impart the necessary sideward motion to each of the documents. The kicker mechanism which may comprise a plurality of fingers, normally rests below the surface of the stacking plate. A sensor system located upstream from the plate, senses the passage of the trailing edge of a document and energizes the stepping motor to extend the kicker fingers at a time which causes them to contact the document close to its trailing edge. This gives the necessary sideward velocity to the document. Immediately after the last-mentioned action, the kicker fingers are retracted to prevent them from contacting the leading edge of the following document.

Other features and advantages of the present invention will become apparent in the detailed description appearing hereinafter.

FIG. **1** is a plan view, diagrammatic representation of the present invention.

FIG. **2** is an elevation view presented along lines **2—2** of FIG. **1** depicting the stacking plate and the kicker fingers disposed therein, as well as the photocell sensor.

FIG. **3** is a partial view illustrating the effect of the invention on the positions of the documents as they proceed to the stack.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The basic elements used in the kicker device of the present invention are depicted in FIG. **1.** The diagram has been purposely simplified so as not to obscure the contribution to the art made by the invention. Details of conventional items such as the document transport system have not been included since these items are well known to persons skilled in the art.

FIG. **1** depicts transport means such as the belts **10** and rollers **12** for conveying documents **14,** which may be mail pieces, into the stacker **16.**

The kicker fingers **18** which may be formed of stiff wire are attached to a common member — the assembly resembling a comb with three widely spaced teeth. This kicker mechanism is in turn directly coupled to the shaft **20** of a stepping motor **22.** Activation of the stepping motor causes the kicker fingers to be extended approximately ⅛ to ¼ inch above the surface of the stacking plate **24** and subsequently, to be retracted so that they lie as seen in FIG. **1** below the surface of the plate in slots **25.** The control of the stepping motor is effected by the stepping motor control logic and drive circuits, depicted respectively by the functional blocks **26** and **28.** In the embodiment of FIG. **1,** the stepping motor logic block **26** is adapted to receive an external electrical signal to cause the stepping motor **22,** through its drive circuits **28,** to extend the kicker fingers. The electrical signal is derived from the photocell sensing device **30** which functions in combination with light source **32** to detect the trailing edge of the document being stacked. Subsequently, prior to the arrival of the leading edge of the succeeding document, the

stepping motor logic **26** itself automatically returns its output level to a steady state condition by means of a conventional monostable circuit incorporated therein. The control logic output to the drive circuits is then such that the stepping motor shaft is returned to its original position. This action retracts the kicker fingers **18.**

In operation, and with continued reference to FIG. **1,** and specific reference to FIGS. **2** and **3** where indicated, it is assumed that the documents **14** (mail pieces) are being conveyed by the transport belts **10** into the stacker **16.** The transport belts **10** are positioned with respect to the front surface of the stacking plate **24** such that the documents are released at an angle of approximately 10° to 15° with respect to the plate surface. This insures that after the leading edge of the document contacts the stacking plate, virtually the entire flat surface of the document will bend to lie contiguously against the plate surface. If the egress from the belts had been designed to be parallel with the forward portion of the stacking plate, the contact between the document and the plate surface would have been tenuous. The stacking plate forward surface is oriented approximately 25° to 30° with respect to the edges of the documents already stacked. Further, the three-fingered kicker is at rest below the surface of the stacking plate **24.** A photo cell sensor system comprising the sensor **30** and light source **32,** are located upstream from the flanges **18.** The sensor system detects the passage of the trailing edge of the document adjacent the plate — the transition from dark to light causing the sensor to apply a signal pulse to logic block **26.** Through the action of the drive circuits **28,** the stepping motor windings are energized. This causes a rotation of the motor shaft through one of its discrete steps, which may be approximately 15°, causing the kicker fingers coupled thereto to be extended, as seen more clearly in FIG. **2.** Thus, as depicted in FIG. **3,** the kicker fingers give a sideward velocity to the document **14***a.* The system is timed such that the kicker contacts the document close to its trailing edge. This action imparts a rotary motion to the document, about a vertical pivot line. The trailing edge of document **14***a* moves toward the stationary stack, as desired, while the leading edge of the same document tries to move away from the stack but is guided by the stacking plate **24.** The latter action assures that the leading edge of the document contacts the previously stacked stationary document close to the reference edge guide **36** which is desirable to prevent jamming. An edger-roller **34** causes the documents to decelerate to rest against the reference edge guide **36.** A stack-follower **38** is adapted to move in one direction or the other as a function of the volume of documents being stacked. FIG. **3** also shows the succeeding document **14***b* in contact with the stacking plate **24** and proceeding toward the kicker mechanism.

A monostable circuit within the logic block **26** is designed to have an active period such that the logic block output level quickly returns to its steady state condition. This last level imparted to the drive circuits **28** effects the energization of those stepping motor windings which cause the motor shaft to return to its original position. Thus the kicker fingers **18** are immediately retracted after imparting the sideward motion to the initial document and come to rest below the surface of the stacking plate in slots **25** before the leading edge of the second document can reach them. This insures that the kicker will operate upon the second document in the same manner as that described for the initial one. It should be noted that in the present system, the transition from light to dark also causes the sensor to apply a pulse to logic block **26** corresponding to the leading edge of each document. The logic is designed such that its output is unchanged with the application of the last-mentioned pulse, that is, it remains at its steady state level.

Having executed the kicker extension and retraction cycle initiated by the sensor trailing edge detection and completed by the monostable activity of the logic block, the system awaits the next sensor pulse derived from the trailing edge of the succeeding document to execute the next kicker cycle.

In connection with the operation of the kicker mechanism, it may be observed that a simple solenoid in which the moveable core is attached to the kicker fingers might be used in place of the stepping motor to perform the "in-out" action. However the solenoid is incapable of the high response speed and concomitant higher throughout required in many stacking applications. A stepping motor operated with a suitable translator, i.e., control logic and drive circuits, has been found to be ideally suited for the stacking application. Such translator functions are well known to electrical designers who specify them to fit particular operating requirements.

The control system for stepping motors described in the referenced copending application is admirably suited for operation of the stepping motor at high speeds. It is a feature of the last-mentioned control system that the oscillations occuring at the end of each discrete step of motor operations are eliminated. This means that in applications where the travel limits of a step are restrained by physical stops, the system avoids the impact and the resultant noise which would normally occur at such limits, and insures a longer life for the associated components. In accomplishing these objectives, the system permits acceleration for an initial increment of travel in any given step, deceleration in the final increment of travel, and holding torque in the limit positions.

As taught in the referenced application, a multiphase stepping motor **22** may be operated in the following manner which is suitable for the present application. It is assumed that the stepping motor shaft **20** is to repose in one of two positions whose angular displacement of approximately 15° from each other corresponds to a single step of the motor. The kicker mechanism is designed such that the motion of the motor shaft is physically confined to the aforementioned angular displacement. The stepping motor's housing is manually rotated until the motor shaft is positioned approximately midway between the two shaft limit positions.

Through the selective energization of the phase windings of the stepping motor **22** by the drive circuits **28** in the following manner and sequence as determined by the output of the control logic **26,** the kicker fingers **18** may be extended or retracted as desired. Thus, the fingers may be extended from their retracted position by energizing predetermined phases of the motor with a high level current pulse of suitable duration. The motor shaft then moves toward a midpoint position with diminishing torque — the torque being substantially zero

at the midpoint. Beyond the midpoint position, the shaft is slowed down by increasing torque in the reverse direction. As the shaft velocity approaches zero, the last-mentioned high level pulse is terminated and the appropriate phases of the motor are pulsed with a low level signal to bring and to hold it there. In similar fashion, appropriate phases of the motor may be energized to cause the kicker fingers to move from their extended to their retracted position.

In conclusion, the inventive concepts and implementations described herein have proved highly satisfactory in actual operative systems in which the stacking of as many as 40 documents per second with gaps between them as small as one inch, has been accomplished. The kicker mechanism under such conditions performs a complete extension and retraction "cycle" in 20 milliseconds. However it should be understood that changes and modifications thereof may be needed to suit particular requirements. Such changes and modifications, insofar as they are not departures from the true scope of the invention, are intended to be covered by the claims appended hereto.

What is claimed is:

1. A device for aiding the placing of documents into a stack comprising:

transport means operatively connected to convey said documents edgewise single-file into proximity to said stack,

a stacking plate positioned with respect to said transport means such that said documents exiting from said transport means contiguously traverse the face portion of said plate,

a kicker mechanism comprising a plurality of kicker fingers situated in said face portion of said stacking plate and being capable of assuming either of two positions comprising respectively an extended position above and a retracted position below the surface of the face portion of said plate,

control means including a stepping motor having its shaft coupled to said kicker mechanism and operatively connected for causing said kicker fingers to assume said extended position at predetermined times with respect to a document traversing said stacking plate so as to impart to the trailing portion of said document a rotary motion about a vertical pivot line, said control means being further adapted to cause said kicker to retract in sufficient time to prevent it from contacting the leading edge of a succeeding document,

control logic means and drive circuit means, said drive circuit means being interposed between said control logic means and said stepping motor for selectively energizing the windings of said stepping motor, said motor being driven in opposite directions as a function of the respective output levels of said control logic means, said control logic means being normally in a steady state condition and having a first output level which causes said kicker fingers to assume a retracted position, means for applying an external signal to said control logic means for generating a second output level effective in initiating the extension of said kicker fingers, said control logic means being adapted to return to its steady state condition at a predetermined time following the application of said external signal thereto, thereby returning said kicker fingers to their retracted position.

2. A device as defined in claim **1** further including means for detecting the trailing edge of the document traversing the face portion of said stacking plate, and for generating as a result of the detection said external signal applied to said control logic means.

3. A device as defined in claim **2** wherein said means for detecting the trailing edge of the document traversing said stacking plate is a photocell and lamp assembly located up-stream from said kicker fingers.

4. A device as defined in claim **1** wherein said transport means comprises a plurality of rollers and at least a single transport belt disposed thereon.

5. A device as defined in claim **1** wherein said transport means is positioned with respect to the forward portion of the surface of said stacking plate such that the initial path of travel of a document exiting from said transport means is toward said surface of said plate and is non-parallel thereto.

6. A device as defined in claim **5** wherein the documents exiting from said transport means initially contact the surface of said stacking plate at an angle of approximately 15°, said forward portion of said stacking plate being oriented at an angle of approximately 25° with respect to the edges of the documents in said stack.

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