The system is capable of operating purely synchronously, purely asynchronously or as a hybrid of the same. If purely synchronous operation is desired, the longest document by its length will determine the constant and maximum throughput rate for all other documents. For purely asynchronous operation, each document by its own length determines its own throughput rate. For hybrid operation, a standard document length can be arbitrarily selected whose own throughput rate will be the maximum and also the constant throughput rate for all other relatively shorter documents, and all documents relatively longer than the standard length will determine their own throughput rate by their length which will be less than the standard document's throughput rate.

The system further includes speed retarding means that acts in a digital manner for close control of document speed in the guideway and effects a very efficient separation of overlapping documents due to the high acceleration-deceleration forces that are quickly built up and impressed against documents passing through. Additionally, the system includes various rollers disposed serially along the guideway having speed differentials which together with any subsequent documents length will determine the degree of interdocumental spacing between successive documents. More specifically, the document speed control instrumentality is comprised of a document feed roller disposed adjacent to the inlet of the guideway and a pressure actuator for applying pulsating forces on the documents as they are engaged and impelled by the drive roller into the guideway, such pressure pulses additionally acting to retard the speed of the drive roller to an acceptable document throughput rate.

57 Claims, 9 Drawing Figures
FIG. 6.
INTERACTIONS BETWEEN VELOCITY AND FEED ROTORS.

PREVIOUS TRAILING EDGE SENSED POINT

MINIMUM INTERVAL IN WHICH FEED MAY BE RE-TURNED ON, ONCE NEW TRAILING EDGE IS SENSED.

95 MS.    43 MS.

FEED ON REQUIRED FOR A 6" DOCUMENT.

INTERVAL IN WHICH FEED WILL RE-TURN ON IMMEDIATELY AFTER BEING OFF BY NEW TRAILING EDGE BEING SENSED.

138 MS.

FEED ON REQUIRED BY A MAXIMUM LENGTH 8 3/4" DOCUMENT.

FEED ON REQUIRED BY A MINIMUM LENGTH 4 7/8" DOCUMENT.

5 MS 32.5 MS 100.5 MS.

UNCONDITIONAL FEED ON INTERNAL

CONDITIONAL FEED ON INTERVAL SUBJECT TO TURN OFF BY NEW TRAILING EDGE BEING SENSED.

UNCONDITIONAL FEED OFF INTERVAL.

TIME
FIG. 8.

INTERDOCUMENT SPACING.

SUBSEQUENT DOCUMENT LENGTH (SOL)

INTERDOCUMENT SPACING (IDS)

4 7/8"

252

6"

256

6.5

254

PRECEDING DOCUMENT

13"

8 3/4"

DOCUMENT FLOW

FEED ROLLERS (FR)

60 IPS

26

150 IPS

25

DRIVE ROLLERS (DR)

FIG. 9.

THROUGHPUT RATE-DOCUMENT LENGTH DEPENDENCIES.

DOCUMENTS PER MINUTE (DPM)

600 DPM

400 DPM

246 SYNCHRONOUS OPERATION

248 ASYNCHRONOUS OPERATION

600 DPM MODE 242

240 SYNCHRONOUS OPERATION 250

400 DPM MODE 244

258

260

4 7/8"

6"

8 3/4"
SYSTEM FOR CONTROLLING THE FEED OF DOCUMENTS INTO AND ALONG A DOCUMENT TRANSPORT PATH

CROSS REFERENCE TO RELATED PATENTS

A patent entitled "Document Separator Control System" bearing U.S. Pat. No. 3,635,465 and granted Jan. 18, 1972 to Jack Beery and a patent entitled "Controlled Torque Document Feed System" bearing U.S. Pat. No. 3,737,158 and granted June 5, 1973 to Jack Beery and Donald C. Russell describe and claim document feed, velocity and separator control systems upon which the present invention is an improvement and which are assigned to the same assignee as the present patent application. Also, attention may be called to the patents of Solyst U.S. Pat. No. 3,027,161 and Zyen U.S. Pat. No. 3,159,397 which are assigned to the assignee of the present patent application.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to the field of sheet item or document feeding and more particularly to control provisions for varying the times of operation of the feed of the documents to the input end of a document transport path, for varying the times of operation and the velocity of the document feed means for impelling the documents into the transport path, and for separating overlapping documents as they are fed into the document transport path.

2. Prior Art

Previous mechanisms having to do with document feed control at the entrance end of a document transport path did not adequately compensate for queueing documents of unequal lengths thereby leaving the system vulnerable to "bunching" of documents thereby causing misreading and missorting of documents and undesired system down time.

With respect to the control of the throughput of the documents, previous workers in this art have suggested the employment of controlled pressures for braking of retarding the documents to assure serial spacing of the documents along the transport path. The resultant lag time in feeding back the velocity deviations of the document drive member to the velocity control means for controlling the pressure actuator was due to the analog nature of the velocity control circuitry.

SUMMARY OF THE INVENTION

It is an important object of the invention to employ digital timing logic for varying the speed of the document drive elements in order to achieve a desired throughput rate and interdocumental spacing thereby improving the overall system throughput rate while avoiding problems of document bunching and overlapping.

It is another important object of the invention to provide a document transport system employing digital logic control circuitry for achieving quick responses to velocity deviations of the document drive or feed members due to the digital nature of the circuitry thereby realizing the full potential of such a system.

It is another important object of the invention to provide an improved document transport system employing digital rather than analog techniques for controlling the advance of document as well as performing effective separation of overlapping documents.

Another important object of the invention to employ digital timing logic for controlling document "feed on" intervals in order to vary the system's throughput rate asynchronously dependent on document length or to keep the throughput rate synchronously constant for certain desired lengths of documents thereby improving throughput for relatively longer documents while providing a constant maximum throughput for relatively shorter documents.

Another important object of the invention is to provide interdocumental spacing to a degree determined by the speed differentials of document driving members positioned along the transport path in order to define the boundaries of the spaces between succeeding documents.

A further important object of the invention is to employ high frequency pulsating forces rather than relatively steady forces on a highly accelerating document drive member thereby imposing a series of rapidly applied braking thrusts on the document drive member to reduce it down to a desired average speed for governing the throughput rate.

In carrying out the objects of the invention, a document transport system is provided which is capable of transporting a serial stream of documents of various lengths from a hopper into and along a transport path at different throughput rates and with various interdocumental spacings and further capable of self-operably changing to either synchronous or asynchronous operating modes depending on the lengths of the documents. Incorporated in the system is a control circuit which modifies the timing and the operation of the document feed or drive means in relation to the length of each document and initiates such determination in response to the sensing of the trailing edge of the preceding document at a point downstream from the feed means. In performing this operation with a mixture of documents of various lengths, the control circuit assigns a particular time frame for each advancing document, with the result that for the synchronous operating mode all documents having a length at or below a prescribed standard the time frames are equal regardless of the length of the documents and for the asynchronous operating mode all documents of a length greater than such standard the time frames will vary depending upon the lengths of the document. Accordingly, the time frames are representative of synchronous periods for relatively short documents and of asynchronous periods for relatively long documents, being directly proportional to their simulated or actual advancement lengths respectively.

The document feed or drive means co-acts with the predetermined time frames representative of the actual or simulated document lengths thereby establishing the throughput rate for each document, using the relationship where the throughput rate is equivalent to the ratio
of the document speed to its length. This document feed means, which preferably is a cyclically movable member, and one or more additional downstream higher speed document imparting members, imparts a net speed differential upon each document that is high enough so that the previously obtained throughput rate for that document does not vary even though the space between that document and the preceding document is extended to a degree dependent upon the length of the former document.

An important feature of the document transport system is the provision for controlling the speed of the document feed means. Designed to operate in excess of the desired speed for impelling the documents into the transport path, the document driving member is subject to the control of a circuit cooperating with a pressure actuator to retard or brake down the driving member to the desired speed by applying high frequency pressure pulses upon the driving member and any document interposed therebetween. Circuit means continuously determines the velocity of the document driving member and the extent of any deviation from a predetermined desired velocity and varies the pulsing signals delivered to the pressure actuator in accordance therewith for controlling the impetus with which the driving member impels the documents. The actual velocity and the ideal velocity are continuously compared by digital logic circuitry, and as long as the actual velocity exceeds the desired velocity, a string of rapid pulses for retarding the action of the document driving member will be generated.

Means is provided which will interrupt the string of braking pulses when the string exceeds a prescribed time interval by outputting a blocking pulse to cancel them thereafter so as to compensate for the lag time encountered for the pulsing to take effect due to the multiple mechanism time constants in the system.

An added benefit of the digitizing, pulsing pressure nature of the document velocity control is the high acceleration and deceleration forces built up by the pressure actuator in cooperation with the document driving member on overlapping documents to reduce any incidence of two or more such documents proceeding past the pressure actuator point in the transport path. Those overlapping documents which are statically attracted to one another or are stuck together for some other physical reason are more readily separated from one another when subjected to rapid, digitally applied braking thrust pressures for decelerating the documents while subjecting the foremost document to relatively high accelerating forces imparted by the document drive member.

BRIEF DESCRIPTION OF THE DRAWINGS

Various other objects, advantages and meritorious features of the invention will become more fully apparent from the following specification, appended claims and accompanying drawings.

The features of a specific embodiment of the invention are illustrated in the drawings, in which:

FIG. 1 is a plan view of an assembly of operative units forming a document handling system embodying the invention;

FIG. 2 is a schematic block diagram of the document feed control subsystem together with the mechanism of the system with which it is operatively coupled according to the invention;

FIG. 3 is a typical multi-stage up-binary counter utilized in the illustrated embodiment of the invention;

FIG. 4 is a timing diagram for the binary counter of FIG. 3 used in the feed control subsystem;

FIG. 5 is a schematic block diagram of the velocity control subsystem together with the mechanism it is operatively coupled to according to the invention;

FIG. 6 is a time chart representing the timing sequences between the document feed and velocity rotors;

FIG. 7 is a timing diagram illustrating the pulsing sequence on a given document and the delayed effect thereon in connection with the circuitry of FIG. 5;

FIG. 8 illustrates the interdocument spacing effect between documents of different lengths in connection with the circuitry of FIG. 5; and

FIG. 9 illustrates the dependencies between the throughput rates and document lengths.

DESCRIPTION OF A PREFERRED EMBODIMENT OF THE INVENTION

For illustrating a preferred embodiment of the invention, the general assembly of mechanical parts making up the systems disclosed in the referenced U.S. Pat. No. 3,635,465 and the referenced U.S. Pat. No. 3,737,158 have been selected for this purpose. Accordingly, the document handling assembly illustrated in FIG. 1 includes: a stack of documents 10 contained within a document storage hopper 12 adjacent to the input end 14 of a document transport path which is shortly assumed by a pair of parallel side walls forming a guide way 16. The illustrated document handling assembly further includes a document dispensing assembly generally indicated at 18 for dispensing documents out of the hopper and into the input end 14 of the transport path, a document drive unit 20 adjacent to the entrance 14 of the transport path, a pressure actuator unit 22 positioned opposite to the document drive unit and cooperate therewith, a document sensing means 24 further downstream in the guideway 16 which is responsive to the passage of each document, and even further downstream a series of high speed roller pairs 25 for driving the documents along the balance of the transport path.

More specifically, a stack of documents 10 are initially stored, preferably on edge, in the hopper 12 prior to being fed into the entering end 14 of the document transport path. The documents are dispensed from the hopper by the document dispensing unit 18 and thence to the inlet 14 of the document drive unit 20 and pressure applying unit 22. The document drive or feed unit 20 includes a drive member 26 in the form of a roller having its peripheral surface thereof treated or otherwise provided with a layer 28 having a high coefficient of friction. Cooperating with the drive unit, the pressure unit 22 functions both to apply braking pressures on the drive roller 26 to slow it down and to separate and overlapping documents one from the other, such as will be performed on the document superimposing upon the leading or foremost document 32 which will be directly engaged by the drive roller 26.

Positioned downstream from the drive roller 26 is the document sensing assembly 24 which in the illustrated system comprises a source of radiant energy or lamp 34 on one side of the guide way and directly opposite on the other side of the guide way a photoelectric cell 36 is positioned to receive the light beam from lamp 34.
when this beam is not intercepted by a passing document. Other forms of sensing means may be employed, such as a sonic source on one side of the guideway cooperating with a sonic detector opposite thereto. In whatever form the document sensing provision may take, the detector serves as a transducer to convert the received energy into electrical signals which are utilized by the systems as hereinafter described.

The hopper document dispensing assembly 18 herein comprises a wheel 38, sometimes referred to as a document picker or nudger, which actually may consist of a pair of side by side wheels as described in the aforesaid referenced U.S. Pat. No. 3,635,465 and which are fixedly mounted for joint rotation on a shaft 40 loosely carried on one end of a rocking lever 42. The picker or nudger wheel 38 is driven by an endless belt 43 operationally coupled to a drive shaft 44, which also serves as the pivotal mounting for rocking the lever 42 in opposite directions so as to bring the drive wheel 38 into engagement with the first available document at the exit end of the hopper. For this purpose the end plate 46 of the hopper is provided with an opening permitting the feed wheel to rise therethrough and into engagement with the end document in the hopper.

Connected to the opposite end of the lever 42 is a switch mechanism 48 and a constant pressure spring 49. The spring 49 functions to bias the nudger wheel 38 through the opening in the plate 46 of the hopper and against the dispensing end of the stack of the documents 10 in the hopper. The amount of displacement of nudger wheel into the hopper is sensed by the switch mechanism 48 which when actuated electrically causes a motor (not shown) to rotate a lead screw 50 in the hopper and move a backup plate 52 toward the exit end of the hopper to compress the stack of documents 10.

As the documents are pressed in this fashion, they will in turn force the nudger wheel 38 and associated end of the lever away from the hopper, thereby opening the switch 48 and discontinuing compression movement of the backup plate 52.

It should be noted that in the schematic view of FIG. 5 to be described hereinafter, a simplified alternative arrangement is shown for the feeding of documents from the hopper where a motor 145 has its drive shaft attached directly to the nudger roller 38.

In addition to the roller 26, the document drive or feed assembly 20 includes, as shown at the bottom of FIGS. 2 and 5, a drive shaft 58 upon which the roller is secured for joint rotation and which in this illustrated embodiment of the invention extends through a high response motor 60, such as a moving coil d.c. printed circuit motor with constant current windings of the type recited in the aforesaid references. Such a motor should quickly accelerate to a speed considerably beyond that needed for driving the documents, but its speed will be held down or snubbed by braking pressures applied by the pressure actuator unit 22 as will be explained in more detail hereinafter. The drive shaft 58 terminates with a tachometer generally shown at 62 in FIG. 5 including a disk 64 which has equally spaced apart radial slits 65 and which is jointly rotatable with the shaft, and further including means for sensing the slots which may be a light source 66 and a solar cell 68 or other detector as mentioned in connection with sensor 24. The alternating light and dark conditions of the solar cell as caused by the passage of the slits thereby will generate electrical signal pulses, the frequency of which will be proportional to the rotational velocity of the shaft 58 and roller 26.

The pressure actuator assembly 22 of the presently illustrated embodiment of the invention, certain mechanical features of which are disclosed in the aforesaid U.S. Pat. No. 3,635,465, comprises an endless scrubber belt 70 driven by a drive pulley 72 along a closed path defined by a pair of pulleys wheels 74 and 76 which are mounted for rotation on the supporting plate 78 for the document handling assembly illustrated in FIG. 1. A linear actuator, which is shown in the form of a solenoid 80, has a sheath protected extension 82 of its armature connected to a pair of triangularly shaped plates 84 (only one of which is shown) carrying rollers 86 and 88 at two corners thereof in the manner shown in FIGS. 1 and 5. The relationship of the coil of the solenoid to its armature is such that upon energization of the coil it will thrust the armature toward the document transport path and by means of the rollers 86 and 88 press the adjacent section of the scrubber belt 70 against the frictional surface of the feed roller 26 with increased pressure and any document interposed therebetween. On the other hand, upon de-energization of the solenoid coil the armature will be retracted by the compression in the belt thereby reducing the pressure exerted by the belt upon the drive wheel 26 and upon a document therebetween. The pair of pulleys wheels 74 and 76 and the pair of rollers 82 and 84 are so mounted as to cause the adjacent section of the scrubber belt to closely hug the periphery of the drive wheel 26.

As described in the aforesaid patent the endless separator belt 70 is preferably a flexible urethane foam belt and has that portion of its extent which is positioned in engaging opposition to the drive wheel 26 moving slowly in the direction counter to the periphery of the wheel. In the illustrated embodiment of the invention herein, the separator belt 70 moves slowly in the same direction as the wheel 26. In either case, one purpose of such movement is to spread the wear of the belt by continuously bringing fresh surfaces of the belt into engagement with the drive roller 26 and the documents fed therebetween. In the normal operation of the document transport system, the drive wheel 26 is operated at a rotational speed of approximately 35 r.p.m. which will apply a peripheral speed to the roller such that the roller speed will have an overall average of approximately 60 inches per second. On the other hand, the drive pulley 72 for the endless scrubber belt 70 will be driven at a rotational speed of 1 r.p.m. which in turn will move the belt at a surface speed not exceeding a preset value, such as approximately 0.16 inches per second. Any drive force applied in the belt 70 by the document drive roller 26 to move the belt at a faster rate will be restrained by the drive pulley 72 and its source of motive power. It is evident that the linear speed of the belt 70 is substantially slower than the document drive roller 26 and that regardless of its direction of movement the slow moving belt will retard any overlapping documents not directly engaged by the drive roller and separate it from the documents which is directly engaged by the drive roller and subjected thereby to relatively high speed driving forces.
The foregoing description is primarily intended for the establishment of a suitable mechanical environment for the document feeder control system of the present invention and is approximately the same as that described and illustrated in the aforementioned U.S. Pat. No. 3,635,465 and patent application Ser. No. 181,525, now U.S. Pat. No. 3,737,158. The present invention includes further apparatus and electrical circuitry used in conjunction with a suitable environment such as has been described.

Referring to FIGS. 2 to 8 inclusive by the characters of reference, there is illustrated an overall system in accordance with the invention for controlling the movement of documents into and along a guideway leading from a hopper or collection station to a discharge station, overall control over such document movement involving feed control, throughput control and control over the separation of the documents. Included in the control system are subsystems utilizing electrical logic circuits and components for accomplishing the desired ends.

In the schematics of FIGS. 2 and 5, all the flip flops shown are J-K type flip flops. The flip flops are negative triggering and where the trigger or T input is used, the flip flop is controlled by a pulse on the trigger line. All of the logic gates are positive AND or OR gates. Thus for an output signal from an AND gate to be true, all of the input signals must be true and likewise, for the output signal from an OR gate to be true, at least one input signal must be true. In the preferred embodiment, the voltage level for a "True" or "1" is the 0.4 volt level and for a "False" or "0" is the 0.15 volt level. Although "AND" and "OR" logic is employed in the illustrated embodiment of the invention it should be understood that "NAND" and "NOR" logic is equally applicable especially for use with MOS technology.

A subsystem of this overall control system is the feed control circuit provision shown in FIG. 2, whereby documents 10 are advanced from the hopper or collection station 12 leading to the inlet 14 of a document transport path and thereafter sequentially along the guideway 16 which may terminate in a stacker or a plurality of storage pockets (not shown). This feed control subsystem includes the document feeder roller 26 receiving documents from the nudger wheel 38 and advance the same into the inlet 14 of the transport path extending between the feed wheel 26 and the adjacent section of the scrubber belt 70 and thence into the entrance of the guideway 16, the sensing means 24 for sensing the passage of a document past a predetermined point downstream in the guideway 16, and an improved feed control circuit embraced within the boundary of long dash lines 100 in FIG. 2 for controlling the document feed roller 26 using signals on line 17 from the document sensing means 24.

In the illustrated embodiment of the invention, the feed control circuit embraced within the dash lines 100 of FIG. 2 is composed of first counting means 102, including a six stage flip-flop first binary counter 104 having one set of timed "on" output terminals 106 and a second set of complementary timed "off" output terminals 106', each set of terminals providing progressively longer "on" time periods, as 2.5 ms., 5.0 ms., 20 ms., 40 ms. and 80 ms. duration, going from low to high stages, respectively. The terminal set 106 provides normal signals representing the aforementioned time periods, and the other terminal set 106' provides the complement signals of the first set. This is to say, when a signal appears on a terminal in set 106, the corresponding terminal in the other set 106' does not provide a signal. Although six terminals are shown for each set 106 and 106' of the binary counter, all or any combination of these terminals may be used at any one time with the balance of the circuit. For example, possible combinations are the 5 ms., 10 ms., and 80 ms. terminals or the 10 ms., 20 ms., 40 ms. and 80 ms. terminals, respectively of set 106 are used for the operation of the presently described embodiment of the invention, and two terminals representing the 40 ms. and 80 ms. of set 106' are similarly employed for this purpose, the remaining unused terminals of both sets being reserved for use by other parts of the equipment with which the invention may be associated.

A typical six stage binary up-counter suitable for counter 104 is illustrated in FIG. 3. The chart of the six flip-flops A1 to A6 and their respective input and output interconnections are shown in this Figure together with the normal and complementary terminals 106 and 106', respectively, which are identified in FIG. 2 by their respective time periods in milliseconds. The binary counter 104 receives clock pulses from a clock pulse generator herein shown in the form of 2.50 ms. crystal controlled square wave oscillator 108 which serves to clock the binary counter. In the operation of the binary counter 104 in the illustrated embodiment of the invention, the counter is conditionally cut off at the selected synchronous time period which in this example is the combination of the second, third and sixth stages of the counting shift register 104 as represented by the normal outputs 5 ms., 10 ms., and 80 ms. equaling 95 ms., at which time the counter will hold until a signal originated by the document sensing means 24 is received for recycling the counter. The cut off of the counting of the binary counter 104 may be accomplished by tapping the 5 ms., 10 ms. and 80 ms. outputs and AND gating them by gate 110 in the manner shown in FIG. 3 and employing the resultant signal on line 112 to reverse bias the first stage of the binary counter which will stop the counting of the counter. This condition will remain until a document trailing edge signal is sensed so as to reset the binary counter for a new counting cycle.

Referring to FIG. 4, the three normal outputs 5 ms., 10 ms., and 80 ms. of the binary counter 104 limit the counting to 95 ms. as previously mentioned, which cut off point in the counting cycle is indicated by vertical line 114. The concurrent receipt of the two complementary outputs 40 ms. and 80 ms. of the binary counter provide a time period during which the binary counter cannot be reset as will be later described herein, the limit of the period being indicated by vertical line 116 in FIG. 4.

The binary counter 104, upon counting up to a predetermined point consisting of the three separate time "on" periods of 80 ms., 10 ms. and 5 ms. or "on" signals of subset 106, which collectively represent a duration of 95 ms., will generate a standard or synchronous period of time represented by an output signal signifying the 95 ms. duration at their respective output terminals. This output signal will be conveyed by leads within a conduit or cable 130 to other components of the circuit as described hereinafter. Such a time period signal represents in the illustrated embodiment of the invention the transit time for the trailing edge of an av-
verage size document, using a system speed or throughput rate of 600 documents per minute (dpm), to travel from the inlet 14 of the transport path to the document sensing means 24 in the guideway 16. An alternative method of regarding the 95 ms. time signal is to think of it as a synchronous period in which all documents less than 6 inches in length will be simulated to appear to be 6 inches in length even though actually not, by varying the feed "off" interval in a manner inversely proportional to the document's actual length.

When the binary counter 104 outputs the complements of the 40 ms. and 80 ms. signals at any given point in time, a non-occurrence of a standard time period will be indicated thereby. The binary counter 104 will then output on complementary terminals 40/40 and 80/80 a non-standard time period signal representative of the duration of 37.5 ms. for indicating the unconditional "feed on" interval for the document feed member 26. Leads connected to the two complementary terminals are enclosed within a conduit or cable 132 for conduction to other components of the control circuit as later described herein. A signal representative of the fifth state "on" signal is outputted on the "40" terminal on line 133 for conduction to other components of the control circuit as later described herein. A second signal representative of the sixth stage "on" signal is outputted on the "80" terminal on line 135 for conduction to other components also of the control circuit as later described herein.

It will be noted that the 95 ms. time period configuration just described is for the 600 dpm mode. If 400 dpm mode is desired, all that is necessary is to switch the jack from the 5 ms. terminal to be 20 ms. terminal and connect a fourth jack to the 40 ms. terminal as represented by dotted lines 131 in order to obtain a longer time period of 150 ms. which provides a totally synchronous operation as will be explained later herein. By the above accommodation, synchronous operation may be had at almost any point between 37.5 ms. and 150 ms.

Enclosed within the dotted outline 148 is a bistable device in the form of a first reset flip-flop 150 used cooperatively with a second reset flip-flop to be described hereinafter for resetting the binary counter 104. The flip-flop 150 is pulsed by the high frequency clock pulse generator 138 previously described. Gating means in the form of a gate 152 will output a biasing signal on line 154 directly to the input of the flip-flop 150 and indirectly through an inverter 156 which will reverse bias the K input of flip-flop 150 when the output time signals comprising 80 ms., 10 ms. and 5 ms. from the binary counter 104, and collectively representing the standard time period signal of 95 ms., are concurrently received by the three inputs of AND gate 152 thus enabling the first reset flip-flop 150 to be triggered to its "on" state for producing a conditional resetting signal on its output line 158. When no signal is received by gate 152, the flip-flop 150 will be triggered to its "off" state thus terminating the outputting of the conditional reset signal on line 158.

Enclosed within the dotted outline 160 is a second bistable device in the form of flip-flop 162 which cooperates with the first reset flip-flop 150 for resetting the binary counter 104. The flip-flop 162 is clocked by the previously described time generator 138. Whenever gating means in the form of "AND" gate 165 receives signals on lines 135 and 146 simultaneously, it will output a signal on line 166 to the "OR" gate 167, similarly, whenever gating means as "AND" gate 163 receives signals on lines 133 and 146 simultaneously, it will output a signal on line 161 to the "OR" gate 167. When the "OR" gate has been put in a true state by inputting signals 161 or 166, it will output a signal on line 169 to bias the J input of flip-flop 162 thereby enabling it to be triggered to its "1" state thus producing a second conditional resetting signal for cooperating resetting on line 168. Gating means in the form of AND gate 174 is connected to the flip-flop outputs 158 and 168 and upon the concurrent receipt of the two conditional reset signals it will produce an unconditional reset signal which will be reverse biased by inverter 171 to output to the document feed motor 60 to bring the motor to a fast stop for a short time interval, such as 5 ms. After the 5 ms. unconditional stop interval, the DMV 67 is in a conditional stop mode so that upon receipt of a new driving signal on line 147, it will output normal polarity power current on lines 69 to drive motor 60. The unconditional minimum 5 ms. motor stopping interval for motor 60 will allow the preceding document to space out to at least a controllable minimum distance from the subsequent document which is held up by the stoppage of the motor. The motor stoppages provide an average speed for the document feed roller which is substantially lower than that of the high speed downstream rollers 25. As will be more fully explained hereinafter, this speed differential provides the basis for the relative interdocumental spacing.

As will be more fully explained hereinafter in connection with the operation of the system as a whole, the elapsed or transit time for relatively long documents will exceed the standard time period of 95 ms. using the 600 dpm mode. The net result in such a case is that the flip-flop 136 will remain "on" after the binary counter has reached 95 ms. and continue to be "on" until the sensor 24 has sensed the trailing edge of the document which will then cause the operation of the binary counter to recycle.
put on line 176 to the plurality of reset inputs of binary counter 104 as shown in FIG. 3 thus resetting the bi-
ary counter to zero. Gating means in the form of AND
gate 170 will output a biasing signal on line 172 to the K input of flip-flop 162 when the complementary out-
put terminals 40 ms. and 80 ms. of subset 106 of bi-
ary counter 104, representing the non-standard time period signal, are received simultaneously by gate 170,
thereby enabling the flip-flop 162 to be triggered to its "off" state thus terminating the outputting of the sec-
ond conditional reset signal on line 168. The net result of the interaction between the first and second counter
reset devices 148 and 160 is to control the resetting of
the binary counter 104 such that only after the counter
has reached its standard time period of 95 ms. and also
a trailing edge of a document has been sensed will the
counter be reset to zero to thus reinitiate the feeding
sequence.

A second subsystem of the overall control system is
the document throughput control provision shown in
FIG. 5 for controlling the introduction of documents
into and along the transport path 16. This provision in-
cludes the cyclically movable member or drive wheel
26 for moving documents along the transport path, the
velocity-sensing means 62 for providing a continuous
determination of the speed of the drive wheel 26, the
circuit means illustrated in FIG. 5 for producing a pul-
sating signal in response to signals from the velocity-
determining means 62, and the pressure actuator assem-
bly 22 which utilizes the pulsating signals to apply
pulsating forces upon the highly accelerating drive wheel 26 and any document interposed therebetween
to brake the drive wheel down to the desired speed.
Such pulsating forces will not only limit the rotating
speed of the drive wheel 26, but also as a result of the
pulsating force of the pressure actuator it will limit or
hold down the velocity of the documents in the trans-
port path passing between the scrubber belt 70 of the
pressure actuator and the document drive roller 26. By
controlling the velocity of the drive wheel 26 in this
manner, the throughput rate will be proportionately
controlled also where such throughput rate is a function
of the velocity of the drive wheel and the length of the
documents engaged thereby and introduced into the
guidance path. An additional advantage is the assistance
in separating any overlapping documents from the
foremost document directly engaged by the drive
wheel 26.

A preferred embodiment of the document through-
put control subsystem includes separate means which
are provided for establishing the real and the ideal ve-
locities of the drive wheel together with additional
means for comparing the respective two velocities.
Only when the real velocity is greater than the ideal ve-
locity will action be taken to limit the drive wheel ve-
locity down to the ideal velocity. Specifically, when
the document drive roller 26 has moved a predetermined
distance, a brief finite time will be provided in which
the actual or real time as measured will be compared
to a standard or ideal time to move the predetermined
distance. When the actual time is less than the standard
time, as sampled within the time frame, then the roller
26 must have its speed retarded. To this end there is
provided a timing means or counting provision in
the form of a binary counter 190 similar to the previously
described binary counter 104 but having three flip-flop
stages each having "on" and complementing "off" out-
puts. Accordingly, starting with the lowest counting
stage, the first "on" and "off" outputs are designated
Z1 and Z1/ respectively where Z1 will indicate the per-
missible time when the drive flip-flop 212 must be
switched "off," second stage "on" and "off" outputs
are designated Z2 and Z2/ outputs respectively where
Z2 will indicate the permissible time when the drive
flip-flop 212 may be switched "on," and the third stage
"on" and "off" outputs are designated as Z3 and Z3/
outputs respectively where Z3 will indicate the permis-
sible time when the ideal time counting means 194 may
be reset. The binary counter 190 is cycled by signals
on line 191 from a relatively high frequency clock pulse
time generator 192 (as compared to time generator
196) having a period of 5 us. (microseconds) which
may be a crystal controlled square wave oscillator.
The binary counter 190 will not count beyond Z2 plus Z3
but rather will stay at Z2 plus Z3 until reset because of
a self-biasing feedback arrangement similar to binary
counter 104. The actual completion of a predeter-
mined movement by the driving roller 26, such as the
distance separating adjacent slits 65, is sensed by the
velocity-determining assembly 62 which will send a sig-
nal on line 228 as each slit 65 is sensed to the binary
counter 190 resetting it to zero. The binary counter
190, in effect, will establish a status time frame within
which a comparison can be made for indicating when
the drive flip-flop may be switched "on" or "off" and
additionally by its reset points, give indication of the
actual velocity of the document drive roller 26, the pur-
pose of which will be explained more fully hereinafter.

A second timing means or counting provision is in-
cluded in the circuit of FIG. 5 taking the form of binary
counter 194 having six flip-flop stages each having
"on" and complementing "off" outputs. The sixth or
final stage "on" output of the counter 194 produced on
line 195, hereinafter referred to as Y6 output, repre-
sents in the illustrated embodiment of the invention a
predetermined standard time of 2.176 ms. for a predet-
ominated movement of the document drive member 26.
As mentioned earlier, this predetermined movement of
the drive member 26 is the distance separating any ad-
jacent pair of the radial slits on the disk 64. The binary
counter 194 is clocked by signals on line 199 from a
relatively low frequency clock pulse time generator (as
compared to time generator 192) such as a crystal con-
trolled square wave oscillator 196, having a period of
64 us. (microseconds). The binary counter 194 will not
count beyond the Y6 stage output but will stay at stage
Y6 until time of reset, by virtue of a self-biasing ar-
angement similar to binary counter 104. Depending
on the desired throughput rate, other combinations of
stages for the binary counter 194 could have been used.
Gating means in the form of AND gate 198 is con-
ected to the complementing Z1/ and Z2/ outputs and
the Z3 output of the binary counter 190 and will output
a signal on line 200 when all of these three output sig-
als are concurrently received by the AND gate for
resetting the binary counter 194 to zero. The binary
counter 194, in effect, represents the desired standard
velocity for achieving the selected document through-
put rate.

A bistable device in the form of flip-flop 202 for sam-
ping for a Y6 output on line 195 has a sampling output
state and a non-sampling output state designed herein-
after as S and S' respectively. The flip-flop 202 is
clocked by signals on line 191 from the clock pulse time generator 192. The flip-flop 202 can be triggered to its S output state by a Y6 signal on line 195 to the J input thereof. The flip-flop 202 can be triggered to its S' output state by the absence of a Y6 signal because the K input thereof is always grounded.

Gating means in the form of AND gate 204 will output a signal on line 206 when Z3, Z2, and S signals are received concurrently thereby. Another gating means in the form of AND gate 208 will output a signal on line 210 when Z1, Z2, and Z3 signals are received concurrently thereby.

A bistable device characterized by flip-flop 212 is associated with the solenoid 80 of the document separator and pressure actuator assembly 22 through a driving amplifier 211 so as to cause the pressure actuator to limit the velocity of the document driving member 26. Flip-flop 212 has a driving output state and a non-driving output state designated as D and D' respectively. The flip-flop 212 is clocked by pulse signals on line 191 from the clock pulse time generator 192 and can be triggered to its D output state by a signal on line 206 from AND gate 204 to the J input thereof. Flip-flop 212 can be triggered to its D' output state by a signal received by the K input on line 230 which is outputted on line 210 from AND gate 208 and is ORed through "OR" gate 231 as later described herein. Referring to FIG. 7 and FIG. 5, it can be seen that the logic pulsing as represented at 238 of drive flip-flop 212 is delayed by five microseconds from reacting to the slip sensing shown in 235 due to the need for the logic circuit to determine whether or not speed correction is needed according to the status at that time of binary counter 190.

A block pulse clock generator 214, which may take the form of a relay monostable multivibrator (DMV) or a crystal controlled elapsed time counter, is triggered by a D signal on line 216 and will count for 10 ms. then output a signal on line 218 for a 10 ms. interval. The output signal on line 218 from the delay monostable multivibrator 214 branches to provide a first signal on line 220 and a second signal on line 222. An inverter gate 224 inverts the second signal so that it becomes an inverted output on line 226. Output signals on lines 206 and 220 have a common terminal so as to produce a signal on line 218 entering the J input of flip-flop 212, thereby switching or triggering the flip-flop 212 on the next clock pulse received by it. Output lines 210 and 226 both input into the "OR" gate 231 so as to produce a signal on line 230 entering the K input of flip-flop 212 when either 210 or 226 signals are present.

Making reference to FIG. 7 as well as FIG. 5, when the DMV 214 is activated by a D signal on line 216 indicating that the actual or real speed of the feed wheel 26 is greater than the desired standard speed, it will delay any action for a first 10 ms. time interval thereby allowing flip-flop 212 to power pulse the associated solenoid 80 with an overall pulse up to 10 ms. as shown by the pulse interval 232 in FIG. 7, for the purpose of correcting the speed of the document feed wheel 26 and thereby the throughput of the document being acted upon. Next, during a second 10 ms. time interval 234 (FIG. 7), the DMV 214 will output a signal to cancel any bias applied to the J input and concurrently normally bias the K input of flip-flop 212 to thus turn off flip-flop 212 thereby disallowing any power pulsing to the associated solenoid 80 during this second interval. These first and second time periods of conditional pulsing for speed correction and unconditional non-pulsing for non-speed correction respectively provide document velocity correction to the degree needed, but do not allow over-correction of velocity to take place which would otherwise be the result if time lags introduced by mechanism time constants of the system were not compensated for.

It is an additional feature of each power pulse interval, that the logic pulsing occurring within this interval will be sharply delineated as between individual pulses so that when flip-flop 212 (FIG. 5) is clocked or triggered "on" for an effective interval, the logic pulsing sent to the associated solenoid 80 will reflect a relatively steep falling off and steep return of the power signal between each effective logic pulse. The manner in which the flip-flop 212 outputs these effective logic pulses is as follows: Using the given 5μs. clock 192, the drive flip-flop 212 could be alternately switched "on" and "off" at a 5μs. rate if the velocity sensing means 66-68 should be designed to detect the slits 65 on the photo disk 64 also at this rate. In the herein presented mode of operation, this will not happen due to the relatively low speed of the motor 60. Actual "on" - "off" switching rates of the pressure actuator 22 effective for separating overlapping documents will usually occur in the low millisecond time period range even though ineffective switching rates may be realized for periods of shorter duration. The actual switching rate at any given time is dependent on the document friction surfaces in contact with the drive wheel 26 and the separator member 70 which will determine how effective the pressure actuator 22 will be in RETARDING drive wheel 26 speed and thus what the switching rate of pressure actuator 22 must be. The above-mentioned advantages of having nearly vertical slopes defining the drive pulses thus enabling them to be effective, for purposes of separating overlapping documents, can only be realized when the pulse duration against the given document surface is or appears to be 2.176 ms. or longer. A series of closely spaced logic pulses can give the net impression of one effective pressure actuator pulse even though individually none of them would so qualify due to the insufficient "pulse off" time 236 between pulses. Thus, in an overspeed condition, any given one logic pulse will not be any longer in duration than 2.176 ms. 237 as this represents a drive wheel speed just under the ideal drive wheel speed of 60 ips whereby the ideal drive wheel speed does not require any braking thrusts by the pressure actuator 22. Under actual conditions as shown in FIG. 7 a series of non-effective logic pulses of varying durations may precede one effective logic pulse which when considered together will effectively pulse 238 the pressure actuator 22 to retard the drive wheel's velocity and the throughput rate of documents passing therebetween down to a desired level. As earlier mentioned herein, it will be noted that within the period of the effective pulse 238 indicated by the bracket 238 in FIG. 7, the duration of the individual pulses vary down from 2.15 ms. to 2.10 ms. then vary up from 2.10 ms. to 2.176 ms. The reason being that there is some lag in reaction time to the logic pulsing in regards to the correction of speed. The non-pulsing interval indicated by the bracket 233 is of sufficient duration (2.170 ms.) so that pulses 238 and 239 will each appear to be effective in their own right. Effective pulse 239, because of
the later occurrence of the unconditional 10 ms. non-pulsing interval 234 is allowed to pulse only 1.389 ms. of the 2.176 ms. that would have pulsed otherwise. The example shown in FIG. 7 represents a pulsing sequence that may typically happen in the operation of the equipment disclosed depending on the friction coefficient of documents passing through and other environmental dependencies. The positive advantages of these relatively quick downswings and upswings of the output signal 232 from flip-flop 212 will be brought out in more detail in the description of the operation of the system. It should be appreciated that every document introduced into the transport path is never out of operative engagement with the feed wheel 26 or one or more of the faster rollers 25 downstream in the guideway 16. Furthermore, every document will be momentarily in contact with both the feed wheel 26 and the initial set of faster rollers 25 as it moves from one to the other along the transport path. When such occurs, the feed wheel 26, by virtue of its higher effective friction coefficient and the associated gripping pressures that are applied thereto, will dominate or override the faster rollers 25 and will hold the document down to the peripheral speed of the feed wheel. Once free of the feed wheel 26, each document will then be under exclusive control of the faster rollers 25 in the guideway and will be moved at a substantially higher speed than when under the control of the feed wheel. Until the trailing edge of the document passes by the sensor 24, the feed wheel 26 will continue to rotate and in so doing will advance the next successive document part way through the throat passage with the result that the leading portion thereof will project slightly beyond the feed wheel. Once the trailing edge of the leading document is detected by the sensor 24, the feed wheel is quickly stopped for a time interval that will vary dependent upon the length of the document with which it is in operative engagement.

OPERATION

Summarizing the operational modes of the system: A meritorious feature of the system is its capability of being operated at different throughput rates. In the illustrated embodiment of the invention this is demonstrated by two throughput speed modes, as shown in FIG. 9, A relatively fast 600 dpm hybrid asynchronously synchronous mode 242 or a relatively slow 400 dpm synchronous mode 244.

The faster 600 dpm is a hybrid mode, the reason being that for document lengths equal to or less than 6 inches, 258, the system illustrated herein operates synchronously, while for document lengths of greater than 6 inches and up to the maximum length of 8% inches, 260, the system operates asynchronously. It should be understood that the selected length of 6 inches which determines the maximum throughput is somewhat arbitrary and may be considered as representing those document lengths that statistically occur the oftenest, while lengths that are relatively greater than the above 6 inches or are exceptionally large may be considered to be processed at a slower asynchronous mode. Small and short documents will be sent through the system.

Referring to FIGS. 4, 6 and 9, synchronous operation 246 for the 600 dpm mode functions only when the document length is ≤ 6 inches. The synchronous time period of 95 ms. is the average time to process 6 inch documents. The 95 ms. time interval being the synchronous period, it also defines the constant throughput rate of 600 dpm for this mode because all documents < 6 inches will be given a simulated period that is 95 ms. When the binary counter 104 has been reset to zero, it will begin to count until it reaches 95 ms. Consequently at the time of reset of the document, the feed motor 60 will be turned off unconditionally for 95 ms. by virtue of the binary counter having been reset, thereafter the feed motor will turn on and stay on for 32.5 ms. unconditionally. It should be noted that the feed wheel flip-flop 136 will produce a drive signal unconditionally for the first 37.5 ms. but that for the first 5 ms. of that interval the drive signal will be suppressed by blocking action of the DMV unit 67. The sensing of the trailing edge of the preceding document by the sensor 24 will turn off the feed motor 60 any time after the mark 116 represented in the time scale of FIG. 4 and up to the 95 ms. mark 114 of this scale. If the trailing edge signal was sensed before 37.5 ms. (mark 116) had elapsed, then the feed motor will turn off right at mark 116. In the 600 dpm synchronous mode, when the binary counter attains 95 ms., (mark 114) the whole system recycles again.

For an asynchronous operation 248 the 600 dpm mode operates only when the document length is greater than 6 inches, the asynchronous period being variable and dependent on each document length. Once the binary counter 104 has been reset to zero, it will begin to count and by definition will continue until 95 ms. is reached. At the 95 ms. level, the binary counter will hold and will continue to hold until a document trailing edge is sensed which will reset and thereby start the recycling of the binary counter. For documents within the range of greater than 6 inches and up to 8% inches the document trailing edge may be sensed anywhere from 95 ms. to 138 ms. elapsed time respectively depending on the length of the document, thus the throughput rate will also vary from 600 dpm to 400 dpm respectively. Reference may be made to FIG. 9 where this asynchronous operation is denoted by slope 240. Concurrently with the resetting of the binary counter, the feed motor will turn off, then immediately turn on after the 5 ms. stopping interval, thus the entire sequence of events is reinitiated.

The 400 dpm mode 250 operates synchronously only, regardless of the document length. The synchronous period of 150 ms. is longer than the single period of any one document in the range of document under consideration. Because of the longer period (150 ms. v 95 ms.) all documents up to the maximum length of 8% inches must be each processed in this period, but because only one document can be processed per time frame or 150 ms. period, this operates to slow the throughput rate for this mode down from the previously described maximum of 600 dpm to a constant 400 dpm for this mode. Because the 400 dpm mode always operates synchronously, the explanation given for synchronous operation of the 600 dpm mode is equally applicable here. The only difference is the different time periods (150 ms. v 95 ms.) and the document lengths range (4% inches to 8% inches v 4% inches to 6 inches) respectively allowable for the 400 dpm mode versus the synchronous operation of the 600 dpm mode respectively.

Referring to FIG. 8, once the document period is ascertained, the document's length whether actual or simulated, will also be defined, which when combined with the peripheral speed of the document feed mem-
ber 26 will determine the throughput rate according to the following formula:

\[
\text{Throughput rate} = \frac{\text{document feed member speed}}{\text{document length (actual or simulated)}}
\]

An example of this is in the 600 dpm mode where throughput, would be as follows: In the synchronous mode for any document equal to or less than 6 inches (cut-off length), the simulated document length will be 6 inches. The average speed of document driving member 26 will be 60 ips (inches per second) as will be discussed in the subsequent paragraph, thus throughput rate is equal to 600 dpm (documents per minute).

Viewed in another way, the drive wheel 26, by imparting a desired peripheral velocity to documents passing thereby, may be regarded as a means of establishing an allowable throughput rate range within which the exact throughput rate for any given document will be a function of its own length.

Referring to FIG. 8, in all modes there is a need for interdocumental spacing. This is accomplished by turning off the high accelerating drive motor 60 for an unconditional 5 ms. interval depending on the document's length every time the trailing edge of the preceding document is sensed. The turning off and on of the motor 60 for this purpose has the net effect of lowering the average peripheral speed of the document feed means or wheel 26 down to 60 inches per second, and also of momentarily holding back the document 252 immediately subsequent to the document 254 whose trailing edge is sensed. An additional advantage gained from quickly turning off and on the motor 60 is the digitizing effect realized, thus separating overlapping documents in a manner similar to that done by the pressure actuator as will be explained in detail further on in this description. Further downstream from the document trailing edge detector 24 in the guideway are the document drive rollers 25 also operating on passing documents where the peripheral speed of such rollers is 150 inches per second. This relatively constant speed differential between the document feed wheel 26 and the rollers 25 has the net effect of spacing the documents. Given these speeds, the spacing between documents will be approximately 1½ times the length of the subsequent document according to the following formula:

\[
\text{SDL} = \text{subsequent document length}
\]

\[
\text{FR} = \text{speed of drive rollers (25)}
\]

\[
\text{ID} = \text{interdocumental spacing (IDS)} = \frac{\text{SDL}}{\text{DR} - \text{FR}}
\]

As an example of this, referring to FIG. 8, if DR 25 is equal to 150 ips, FR 26 is equal to 60 ips and SDL 252 is equal to 6 inches then IDS 256 is equal to 9 inches.

Referring to FIG. 7, it is desirable to keep the document driving member 26 rotating at a desired peripheral speed when its motor is turned "on" thereby in turn giving documents passing by the desired throughput rate. To accomplish this, a highly accelerating motor has been chosen to drive the document feed member 25 which has maximum peripheral speed substantially in excess of the desired peripheral speed. The pressure actuator 22 will impose high frequency braking thrusts against the document driving member 26 regarding its peripheral velocity and the throughput rate of documents passing therebetween down to a desired level. In the illustrated embodiment of the invention, only a maximum of approximately four of these effective logic pulses will occur in any given sequence, that is to say, in a total pulsing time frame of 10 ms., after which the circuitry is inhibited from energizing the pressure actuator for 10 ms. so as to compensate for mechanism time constants of the system.

Referring to FIG. 5 and FIG. 7, the exact interactions between the mechanism and the circuitry in regards to velocity control are as follows: After being reset by the detection of a slit 65 by the movement determining means 66-68, the status counting means 190 will commence counting. When the status counting means reaches its third counting stage or "Z3", the ideal or standard time counting means 194 will be reset and commence counting. If the next slit 65 is detected by said movement-determining means 66-68 in less than 2.176 ms. from the time that the last one was detected, then the cyclically movable member 26 is moving too fast. In such a case, the "Z1" stage will switch the flip-flop 212 "off" and 5 ms. later the "Z2" stage will switch the flip-flop 212 back "on" for briefly pulsing to energize the pressure actuator 22 and thereby brake the cyclically movable member 26 at least until the next subsequent slit 65 is detected. Alternatively, if the next slit is not detected until after 2.176 ms. from the time that the last one was detected, then the cyclically movable member 26 is moving slower than the desired ideal speed. In such a case, the "Z1" stage will switch the flip-flop 212 "off" and the "Z2" stage will be inhibited from turning "on" the flip-flop 212 thereby leaving flip-flop 212 in an "off" state with the result that the pressure actuator 22 will not be energized and thus no braking of the cyclically movable member 26 will be had until at least the time the next subsequent slip is detected.

Referring to FIG. 5, another important aspect of the feed control subsystem is the indirect but substantial effect it has on separating a plurality of overlapping items or documents 10 passing between the cyclically movable driving member 26 and the pressure applying belt member 70 into a serial stream for efficient handling downstream in the guideway 16. The document feed member 26 moves in a first or forward direction at what approaches a normal or ideal speed. The belt member 70 moves at a second speed much slower than the normal speed of the drive member 26. As previously considered herein, the pressure actuator 80 will apply effective pulsating forces to the scrubber member 70 which will in turn apply the effective pulsating forces to the drive member 26 and any documents interposed therebetween in order to slow it down to approximately the normal or ideal speed.

When a single item or document 32 enters the area between the document drive member 26 and the belt member 70, the feed member 26 will be in operative contact with a first broadside surface of the document to move it in the first direction and at the peripheral speed of the feed member 26 due to its relatively high friction coefficient. The document 32 will be also exposed on its reverse or second broadside surface to the belt member 70, but will not be significantly affected by it due to the relatively lower friction coefficient between the foremost document's second broadside surface and the belt member 70, as compared to document's first broadside surface and the friction coefficient of the feed member, and likewise the second speed of the belt member 70 being so much slower than the
drive member's speed, it will not significantly affect the document.

When a plurality of documents are presented to the input end 14 of the transport path, the relatively low friction coefficient of the belt member 70 should be higher than the interdocument friction coefficient of any overlying documents 30 under ideal conditions and thus under ideal conditions the belt member 70 should be able to hold back and separate any overlying documents 30 thereby allowing only the foremost document 32 to pass through in the first or drive direction due to its higher frictional contact with the drive member 26. The above operation will operate under even less than ideal conditions which may occur when the moisture content of the documents is relatively high tending to make them stick or when static electricity attracts the documents to one another contributing to a relatively high interdocumental friction coefficient.

The present invention provides a solution for problems such as those encountered above. The document feed member 26 applies an initial high acceleration force in the first direction to the first broadside surface of the foremost document 32 and thereby also to the overlapping documents 30. The pressure actuator 80 applies sharp effective pulsating forces through the belt member 70 to one or more overlapping documents 30 and the foremost document 32 resulting in relatively high acceleration/deceleration forces being applied to those documents (See FIG. 7). The resultant braking impulses will overcome the inertia of the overlapping documents 30 due to their low interdocumental friction coefficient and thereby cause all of them to lose adhesion and separate from each other and the foremost document. Thus, in that instant when the documents movably slip with respect to one another, their interdocumental friction coefficient approaches zero thereby making them extremely susceptible to the now relatively much higher friction coefficients of the feed wheel 26 and the belt member 70 resulting in the advancement of the foremost document 32 and the holding back of the one or more overlapping documents 30. The only document that will pass through at any given time thereafter will be the front document 32 whose vertical location will be that of the peripheral surface of the drive member 26 because the first broadside surface of the document is in direct contact with the drive member 26 whose relatively high friction coefficient disallows any separation between the front document and the drive member. The advantages of such instantaneously high acceleration/deceleration braking forces would not be realizable with inexact and slower reacting analog systems but rather only with an effective digitizing pulsing system as has been described herein.

It is apparent from the foregoing description that the invention has the ability of taking successive documents from a hopper and feeding them serially into a transport path at a throughput rate that is constant for document lengths less than a given length and length-dependent if above the given length. A distinctive feature lies in coacting a document driving member that is accelerative in its effect with a speed retarding member that outputs, at a variable frequency, a stream of digitized pressure braking pulses of equal magnitude to slow the driving member and documents flowing therebetween down to a desired throughput rate. The resultant effect is to give very close control of the throughput rate by changing the frequency rate of the digitized power pulses and additionally any overlapping documents will be subjected to the shock effect of such digitized pulses to assist in their separation. After each document has cleared a predetermined downstream point, the document driving member will be abruptly powered down, and the shock of this interruption will be felt by the succeeding document and any other overlapping therewith and thereby loosening any statically or otherwise attracted overlapping documents to assure their separation. Downstream from the first document drive member is a second speed imparting member whose relatively higher speed creates a speed differential which, together with the throughput rate of the next subsequent document, will be effective to give an adequate spacing between documents in the transport path.

From the foregoing description of a specific apparatus illustrating the fundamental features of the invention, it will now be apparent to those skilled in the art that the invention may be constructed in a variety of forms without departing from the true spirit and scope thereof. Accordingly, it is to be understood that the illustrated apparatus disclosed herein is a preferred embodiment of the invention and that the invention is not to be limited thereby but only by the appended claims.

What is claimed is:

1. A mechanism for feeding and separating documents in singular order from a stack thereof, comprising:
   - means for initiating the flow of individual documents from the stack;
   - feed means including a cyclically movable document drive member and carrying a frictional document engaging surface positioned adjacent to the initiating means to receive and to move each document along a feed path;
   - retard means for slowing the movement of each document along the path, said feed and retard means cooperating to form a throat passage therebetween through which the documents are singularly fed;
   - means for applying driving forces to said cyclically movable member tending to move the same and a document engaged thereby at a speed substantially in excess of a desired linear speed;
   - pulsing means for applying pulsating braking forces on said retard means to cause the same to transmit such pulses to said document drive member to slow its cyclical movement and a document engaged thereby down to said desired linear speed; and
   - means for varying the number of pulsating forces applied by said pulsing means to said drive member directly in proportion to the difference between said desired and excess speeds.

2. In a mechanism for feeding and separating documents, as defined in claim 1 wherein said means for applying driving forces further includes control means including:
   - means for sensing the trailing edge of a document at a point downstream from said feed means;
   - counter means for determining the standard time that an average length document should take to traverse the feed path;
   - means for terminating the advancing of said feed means when a document trailing edge has been detected by said sensing means; and
means for determining when both a trailing edge has been detected by said sensing means and said counter means has reached its standard time, whereby said cyclically movable member, in association with said control means, is operative to give a document with which it is in contact, a throughput rate proportional to its own length if longer than the average length, or if shorter, a throughput rate proportional to that of the average length document.

3. In a mechanism for feeding and separating documents as defined in claim 2 wherein said feed means further includes a drive roller for advancing documents which are positioned downstream from said cyclically movable member, said drive roller further having a speed substantially greater than the speed of said cyclically movable member thereby imparting a spacing interval between documents to a degree dependent only on this speed differential and the throughput rate for that document.

4. In a mechanism for feeding and separating documents as defined in claim 1 wherein said pulsing means includes:

means for detecting when said cyclically movable member has actually moved a predetermined distance;

first counter means that is resettable by a signal from said detecting means and operative, as it counts up, to output status signals indicating when said retarding means must not brake and subsequently in time when said retarding means may conditionally brake said cyclically movable member; and

second counter means resettable by said first counter means for determining the ideal time for the cyclically movable member to move the predetermined distance whereby said second counter means has counted up to its ideal time after said first counter means has outputted its status signal for braking, the cyclically movable member is moving faster than the predetermined speed and braking by said retard means will occur, otherwise, if the ideal time occurs before the status signal for braking then the cyclically movable member is moving too slow and no braking by said retard means will take place.

5. A control system for document feed and conditioning for serial travel along a guideway comprising:

means for successively feeding documents into the entrance of a document transport path;

means in the transport path downstream from said document feeding means for detecting the trailing edge of a passing document and for producing an electrical signal when such detection occurs;

means for operating the feeding means alternately at "on" and "off" periods of time and such that each "on" period is approximately equivalent to the transit time for a document to travel the distance from the entrance of the transport path to that point in the transport path when the trailing edge of such document passes said sensing means, said feeding means further operable to engage one side of each successive document and urge each such document down the transport path at a first speed, giving a throughput rate in excess of that desired where the throughput rate is a function of the speed imparted to and the length of the given document;

means for sensing the speed of said feeding means;

pressure actuator means positioned opposite to said feeding means and forming a throat therebetween through which the documents are successively advanced, said pressure actuator means being engageable with the side of each document opposite to that engaged by the feeding means and cooperating therewith for applying a pressure both on each such document and the feeding means, said applied pressure causing each such document to be gripped by said feeding means and said actuator means and further causing a retardation in the speed with which the feeding means urges each such document down the guideway;

pulsing means operable to transmit a stream of pulses spaced in time to said pressure actuator for causing the same to apply pulsating pressures upon the feeding means and any document passing therebetween;

means rendering said pulsing means responsive to said speed sensing means and varying the effective pressure applied by said pulses in proportion to the speed of said feeding means thereby acting to retard the feeding means down to a second speed giving the desired throughput rate range where the exact throughput rate for a given document is a function of its length; and

document advancing means positioned downstream from said trailing edge sensing means for imparting a third speed to each document passing thereby which is substantially greater than said second speed whereby interdocument spacing is achieved by the relatively constant differential between said second speed and said third speed, and the given throughput rate for the subsequent document.

6. In a document control system as defined in claim 5 wherein said feed control means further includes means operative to define a cycle period constituting the sum of each said "off" period and adjacent "on" period which is the time interval needed to process one document, said cycle period being characterized as synchronous to represent relatively short documents or being characterized as asynchronous to represent relatively long documents depending on the selected cutoff document length differentiating relatively long and short documents from one another, whereby said cutoff document length determines the boundary between synchronous operation with a constant throughput rate and asynchronous operation with a variable throughput rate.

7. In a document control system as defined in claim 6 including means for interrupting the operation of said feeding means for a finite time interval as the trailing edge of each document in transit through the transport path is sensed by said document trailing edge detecting means resulting in the lowering of the overall average of said second speed thereby establishing the desired throughput rate range and also providing for an absolute minimum interdocumental spacing.

8. A control system for document feed and conditioning for serial travel along a guideway comprising:

means for successively feeding documents into the entrance of a document transport path, said feeding means being further operable to engage one side of each successive document and urge each such document down the guideway at a first speed
means in the transport path downstream from said feeding means for detecting the trailing edge of a passing document and for producing an electrical signal when such detection occurs; means for controlling the operation of the feeding means for an "on" interval and then an "off" interval constituting a period for the processing of a document, said period can be selected to be synchronous representing relatively short documents or asynchronous representing relatively long documents depending on the standard document length selected to differentiate between relatively long and short documents whereby said standard length determines the boundary between synchronous operation with a constant throughput rate and asynchronous operation with a variable throughput rate where throughput rate is a function of the speed imparted to and the length of the given document; means for sensing the speed of said feeding means; pressure actuator means positioned opposite to said feeding means and forming a throat therebetween through which the documents are successively advanced, said pressure actuator means being engageable with the side of each document opposite to that engaged by the feeding means and cooperating therewith for applying a gripping pressure on each such document; pulsing means operatively coupled to said speed sensing means and operable to transmit a stream of pulses spaced in time to said pressure actuator for causing the same to apply alternating gripping and releasing pressures on the document driving means and any document passing therebetween, the number of said pulses per document varying in proportion to the speed of said feeding means thereby to brake said feeding means down to a second speed less than said first speed; means for interrupting the operation of said feeding means for a finite time interval as the trailing edge of each document in transit through the transport path is detected by said trailing edge sensing means thereby providing an overall average third speed for the system which is less than said second speed, said third speed serving to define the desired throughput rate range where the exact rate is a function of a document length; document advancing means positioned downstream from said trailing edge sensing means for imparting a fourth speed to each document passing thereby which is substantially greater than said third speed whereby interdocument spacing is achieved by the relatively constant differential between said third speed and said fourth speed, and the throughput rate of the subsequent document.

9. A control system for document feed and conditioning for serial travel along a guideway comprising: means for successively feeding documents into the entrance of a document transport path, said feeding means further operable to engage one side of each successive document and urge each such document down the guideway at a first speed in excess of the desired document throughput rate for the transport path; means in the transport path downstream from said feeding means for detecting the trailing edge of a passing document and for producing an electrical signal when such detection occurs;
means for operating the feeding means alternately at “on” and “off” periods of time and such that each “on” period is approximately equivalent to the transit time for a document to travel the distance from the entrance of the transport path to that point in the transport path when the trailing edge of such document passes said sensing means; means for sensing the speed of said feeding means; pressure actuator means positioned opposite to said document feeding means and forming a throat therebetween through which the documents are successively advanced, said pressure actuator means being engageable with the side of each document opposite to that engaged by said feeding means and cooperating therewith for applying a gripping pressure on each such document;
pulsing means operatively coupled to said speed sensing means and operable to transmit a stream of pulses spaced in time to said pressure actuator for causing the same to apply alternating gripping and releasing pressures on the feeding means and any document passing therebetween, the number of said pulses per document varying in proportion to the speed of said feeding means thereby to brake said feeding means down to a second speed less than said first speed;
means for interrupting the operation of said feeding means for a finite time interval as the trailing edge of each document in transit through the transport path is detected by said trailing edge sensing means thereby to provide an overall average third speed for the system which is less than said second speed thereby establishing the desired throughput rate range and an absolute minimum interdocumental spacing;
document advancing means positioned downstream from said trailing edge sensing means for imparting a fourth speed to each document passing thereby which is substantially greater than said third speed whereby interdocumental spacing is achieved by the relatively constant differential between said third speed and said fourth speed and the given throughput rate of the subsequent document.

11. In a feed control system for sequentially advancing objects from a collection station into a transport path leading to a discharge station comprising:
a. means for feeding objects from the collection station into and along the transport path at a given speed;
b. signal emitting means for sensing the passage of an object past a predetermined point downstream in the transport path from the collection station;
c. control means responsive to the signals emitted by said sensing means for controlling the driving of said feeding means, said feed control means will signal said feeding means to begin advancing a new object when said signal emitting means sends a signal to said feed control means indicating passage of an object and said feed control means counts up to a standard time for the passage of an object of predetermined length through the transport path whereby when a relatively shorter object passes through the transport path, then said feed control means will operate synchronously, giving the relatively shorter object a throughput rate that is a function of the predetermined object length’s throughput rate, and the given speed of said feedings means alternatively, when a relatively longer object passes through the transport path then said feed control means will operate asynchronously giving the relatively longer object a length dependent throughput rate for the given speed of said feeding means which will be varyingly less than that of the predetermined object length’s throughput rate.

12. In a feed control system as defined in claim 11 wherein said system further includes:
a. means for quickly bringing said feeding means to a non-feeding condition for a specified time interval upon non-receipt of a driving signal from said feed control means and for an indeterminate time interval thereafter terminable upon receipt of a new driving signal from said feed control means thereby lowering the average speed of said feeding means down to a predetermined level as well as providing an absolute minimum spacing interval between objects; and
b. roller means positioned downstream from said feeding means for imparting a predetermined speed to the objects, which is higher than the average speed of said feeding means thereby providing variable interobject spacing that is dependent on the speed differential between said feeding means and said roller means, and the given throughput rate for the object.

13. In a feed control subsystem as defined in claim 12 wherein said feed control means further includes:
a. settable counting means for defining a predetermined standard time for the passage of an average length object from the collection station at reset time to the predetermined downstream point;
b. first and second bistable means associated with said standard time counting means and said signal emitting means, and effective for resetting said standard time counting means upon the termination of said predetermined standard time and the sensing of the passage of an object by said signal emitting means; and
c. means for controlling said feeding means having a driving state defined by the resetting of said standard time counting means and having also a non-driving state defined by the sensing of said object by said signal emitting means.

14. In a feed control subsystem as defined in claim 13 wherein said standard time counting means of said feed control means further includes a low frequency time generator, a settable binary counter clocked by said low frequency time generator for indicating the standard predetermined time for an object of average length to flow from the collection station to the predetermined downstream point following said standard time binary counters resetting said signal emitting means.

15. In a feed control subsystem as defined in claim 14 wherein said standard time binary counter of said feed control means comprises a plurality of triggerable and resettable flip-flop stages progressing from low to high counting stages.

16. In a feed control subsystem as defined in claim 15 wherein said first bistable means of said feed control means further includes an AND gating means for outputting a signal when said standard time counting means has counted to its predetermined standard time, a high frequency time generator and a bistable device
clocked by said high frequency time generator and having an "on" state when said AND gating means outputs a signal, and an "off" state when said AND gating means does not output a signal.

17. In a feed control subsystem as defined in claim 16 wherein said bistable device of said first bistable means comprises a triggerable and resettable flip flop.

18. In a feed control subsystem as defined in claim 16 wherein said second bistable means of said feed control means further includes a first AND gating means for outputting a signal when said standard time counting means reaches its upper stages and said signal emitting means has sensed the passage of an object thereby additionally provided as a second AND gating means for outputting a signal after said standard time counting means has been reset, a high frequency time generator, a bistable device clocked by said high frequency time generator and having an "on" state when said first AND gating means outputs a signal and an "off" state when said second AND gating means outputs a signal, and a third AND gating means for outputting a resetting signal to said standard time counting means when said first and second bistable means are concurrently in their respective "on" states.

19. In a feed control subsystem as defined in claim 18 wherein said bistable device of said second bistable means comprises triggerable and resettable flip flop.

20. In a feed control subsystem as defined in claim 19 wherein said driving bistable means of said feed control means further includes an AND gating means outputting a signal after said standard time counting means has been reset, a high frequency time generator, a bistable device clocked by said high frequency time generator and having an "on" state for driving said feed means when said AND gating means outputs a signal, and an "off" state for not driving said feed means when said sensing means outputs a signal whereby said feeding means is driven from the time of reset of said standard time counting means until said signal emitting means senses the passage of an object at the predetermined downstream point whereupon said feeding means is turned off until said standard time counting means counts to its predetermined standard time to thereby trigger a reset thereof which will re-enable driving of said feeding means.

21. In a feed control subsystem as defined in claim 20 wherein said bistable device comprises a triggerable and resettable flip flop.

22. In a control system for controlling the throughput of objects along a transport path, the improvement comprising:

means for operating a cyclically movable member at an accelerating velocity for imparting a velocity to objects in the transport path passing thereby;

means for determining the velocity of the cyclically movable member and outputting a signal representative thereof;

control means operatively coupled to said movement-determining means for generating an output signal only when appreciable deviations in the velocity of the cyclically movable member from the predetermined velocity are encountered; and

pressure actuator means responsive to the output signal of said control means for applying pulsating forces to the cyclically movable member to reduce the velocity of the cyclically movable member and objects engaged thereby for controlling the throughput rate of these objects traveling along the transport path.

23. In a throughput control system as defined in claim 22 wherein the output signal generated by said control means is a plurality of sequential electrical pulses whose number varies proportionally to the extent of the deviations in the velocity of the cyclically movable member, and wherein the pulsating forces applied by said pressure actuator means against the cyclically movable member are proportional to the number of the output pulses generated by said control means.

24. In a throughput control system as defined in claim 23 wherein said pressure actuator means applies frictional braking pressures upon the cyclically movable member to retard its cyclical movement.

25. In a throughput control system as defined in claim 24 wherein said output signal of the velocity determining means is a plurality of output signals, each adjacent pair of which defines the actual time period it takes the cyclically movable member to move a predetermined distance.

26. In a throughput control system as defined in claim 25 wherein said control means includes a first timing means for prescribing a standard time period for moving said cyclically movable member a predetermined distance.

27. In a throughput control system as defined in claim 26 wherein said control means includes means for comparing said standard time period with said actual time period defined by said velocity-determining means and for causing said pressure actuator means to go into its "on" state when said actual time period is less than said standard time period.

28. In a throughput control system as defined in claim 27 wherein said control means includes a second timing means for setting a time frame every time the predetermined distance has been moved within which said actual time period will be compared to said standard time period.

29. In a throughput control system as defined in claim 28 wherein said second timing means of said control means includes a first count stage for indicating the permissible time that said comparison means may be switched off, a second count stage for indicating the permissible time that said comparison means may be switched on, and a third count stage for indicating permissible time that said first timing means must be reset, said second timing means being resettable by said velocity-determining means whereby the time interval between said second timing means resets is proportional to the actual time it takes the cyclically movable member to move a predetermined distance.

30. In a throughput control system as defined in claim 29 wherein each said count stage comprises a triggerable and resettable flip-flop.

31. In a throughput control system as defined in claim 29 wherein said control means further includes said comparison means having a bistable device for driving said pressure actuator through a driving amplifier and an AND gating means for switching said bistable driving device through an interposed OR gate to its non-driving state whenever said second timing means first stage is on, second stage is off and third stage is off.
32. In a throughput control system as defined in claim 31 wherein said driving bistable device comprises a triggerable and resettable flip-flop.

33. In a throughput control system as defined in claim 31 wherein said control means having said first timing means further includes a plurality of stages wherein its final stage represents a predetermined elapsed time for a normal predetermined movement or a maximum velocity for the cyclically movable member, and a bistable device for sampling said first timing means periodically thereby determining whenever the final stage is reached and driving to limit velocity shall thereby cease.

34. In a throughput control system as defined in claim 33 wherein said sampling bistable device comprises a triggerable and resettable flip-flop.

35. In a throughput control system as defined in claim 33 wherein each said stage comprises a triggerable and resettable flip-flop.

36. In a throughput control system as defined in claim 33 wherein said control means further includes an AND gating means activated whenever said second timing means first stage is off, second stage if off, and third stage is on, thereby resetting said first timing means and said sampling bistable device.

37. In a throughput control system as defined in claim 36 wherein said control means further includes an AND gating means for switching said driving bistable device to its driving stage whenever said sampling bistable device is in its non-sampling state, said ideal time counting means not in its final stage and said second timing means first stage is off, second stage is on, and third stage is off.

38. In a throughput control system as defined in claim 37 wherein said control means further includes a delayed-pulse-blocking means wherein once having been activated by said driving bistable device driving for limiting velocity, will allow driving to continue for a predetermined time then block driving for a predetermined time by biasing said driving bistable device so it cannot be switched to its driving state thereby accounting for mechanical time constants in the system.

39. A control system for document feed and conditioning for serial travel along a transport path comprising:

means for successively feeding documents into the entrance of a document transport path;
means in the transport path downstream from said feeding means for detecting the trailing edge of a passing document and for producing an electrical signal when such detection occurs;
means for controlling the operation of said document feeding means at “on” and “off” periods of time and such that each “on” period is approximately equivalent to the transit time for a document to travel the distance from the entrance of the transport path to that point in the transport path when the trailing edge of such document passes said trailing edge detecting means, said “on” period of said document feeding means being conditioned for initiation in response to the receipt of a signal from said trailing edge detecting means;
document drive means positioned between the entrance of the transport path and said trailing edge detecting means and operable to engage one side of each successive document and urge each such document along the transport path at a first speed in excess of the desired document throughput rate for the transport path;
means for sensing the speed of said document drive means;
pressure actuator means positioned opposite to said document drive means and forming a throat therebetween through which the documents are successively advanced, said pressure actuator means being engageable with the side of each document opposite to that engaged by the document drive means and cooperating therewith for applying pressure on said document drive means and on each such document during its advancement through the throat;
pulsing means operable to transmit a stream of pulses spaced in time to said pressure actuator for causing the same to apply high and low pulsating pressures upon the documents driving means which are timed with the pulses and on any document passing therebetween;
means rendering said pulsing means responsive to said speed sensing means and varying the number of pulsating pressures applied by said pressure actuator means in direct proportion of the speed of said document driving means thereby acting to retard the driving means down to a second speed; and
document advancing means positioned downstream from said trailing edge sensing means for imparting a third speed to each document passing thereby which is substantially greater than said second speed whereby interdocumental spacing is achieved by the differential between said second speed and said third speed.

40. In a document control system as defined in claim 39 wherein said feed control means further includes means for assigning a time frame for processing each document through said throat, and means for varying the time frame for each document in accordance with the length thereof.

41. In a document control system as defined in claim 39 wherein said document feed control means further provides a time cycle constituting the sum of each pair of adjacent “off” and “on” periods, which is the time period for processing each document, said time cycle period assuming a synchronous mode for processing relatively short documents or assuming an asynchronous mode for processing relatively long documents, depending on the selected cut off length for differentiating the relatively long and the relatively short documents from one another with the result that said differentiating cut off length determines the constant throughput rate for synchronous operation and the maximum throughput rate for the system.

42. In a document control system as defined in claim 39 wherein said pulse control means further includes means for interrupting the operation of said document driving means for a finite time interval as the trailing edge of each document in transit through the transport path is detected by said document trailing edge sensing means whereby bringing said second speed down to an overall average speed for said document driving means less than said second speed.

43. In a document control system as defined in claim 39 wherein each pulse in said stream of pulses is an electrical pulse.
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44. A control system for document feed and conditioning for serial travel along a transport path including, in combination:

means for successively feeding documents into the entrance of a document transport path;

means in the transport path downstream from said feeding means for detecting the trailing edge of a passing document and for producing a signal when such detection occurs;

means for controlling the operation of the feeding means at “on” and “off” periods of time and being receptive to the signal produced by said trailing edge detecting means for initiating the “on” period;

document drive means positioned between the entrance of the transport path and said trailing edge detecting means and operable to engage one side of each successive document and urge each such document along the transport path at a first speed in excess of the desired document throughput rate for the transport path;

pressure actuator means positioned opposite to said document drive means and forming a throat passage therebetween through which the documents are successively advanced, said pressure actuator means being engageable with the side of each document opposite to that engaged by the document drive means and any document passing through said throat;

means operable to transmit a stream of pulses spaced in time to said pressure actuator for causing the same to apply alternating high and low pressures upon the document driving means which are timed with the pulses and upon any document passing through said throat;

means rendering said pulse transmitting means responsive to the speed of the document drive means and varying the number of pulsating pressures exerted by said pressure actuator means in direct proportion to the speed of the document drive means thereby acting to retard the driving means down to a second speed.

48. In a document control system as defined in claim 47 wherein a document advancing means is positioned downstream from said trailing edge sensing means for imparting a third speed to each document passing thereby which is substantially greater than said second speed.

49. In a document control system as defined in claim 47 wherein each pulse of said stream of pulses is an electrical pulse.

50. In a feed control system for sequentially advancing objects from a collection station into a transport path leading to a discharge station comprising:
a. means for feeding objects from the collection station into and along the transport path;
b. signal emitting means for sensing the passage of an object past a predetermined point downstream in the transport path from the collection station;
c. control means responsive to the signals emitted by said sensing means for controlling the driving of said feeding means, said feed control means responding to the receipt of each signal emitted by said sensing means for initiating the advance of a new object from the collection station; and
d. counting means likewise responding to the receipt of each such signal emitted by said sensing means for counting up to a standard time for the passage of an object of predetermined length through the transport path when an object of a length equal or shorter to said predetermined length passes through the transport path, then said feed control means will operate synchronously giving the relatively shorter object a throughput rate common to all such equal or shorter length objects, and when an object longer than said predetermined length passes through the transport path then said feed control means will operate asynchronously giving the relatively longer object a length-dependent throughput rate for a given feeding means speed which will be varying less than said common throughput rate.

51. In a control system for limiting the velocity of a cyclically movable member for moving objects along a transport path, the improvement comprising:

means for driving the cyclically movable member at a velocity in excess of a reference velocity;

means for determining the velocity of said cyclically movable member;

control means operatively coupled to said velocity-determining means for generating discrete output pulses, the frequency of such pulses varying proportionately to the extent of the deviations in the
velocity of the cyclically movable member above
the reference velocity; and
pressure actuator means receptive to said output
pulses and operable to apply pulsating pressures to
said cyclically movable member at a frequency
proportional to the frequency of the output pulses
thereby to reduce the velocity of the cyclically
movable member.

52. In a control system as defined in claim 51 wherein
the pulsating pressures applied by said pressure actua-
tor means occur in a timed relation to said output
pulses.

53. In a control system as defined in claim 51 wherein
each said output pulse is an electrical pulse.

54. In a control system as defined in claim 53 wherein
said pulsating pressures are substantially equal in mag-
nitude to one another.

55. The method of controlling the feeding of docu-
ments into the inlet of a document transport path which
comprises:
feeding documents in overlapping relation to one an-
other into the inlet of a document transport path
formed between a cyclically movable document
driving member and a document separator mem-
ber;
moving said cyclically movable member in the direc-
tion to advance said document further into the inlet
of the transport path and at a speed in excess of
that desired for the document throughput rate in
the transport path; and
pulsating said separator member toward and away
from engagement with the cyclically movable
member as the latter is moving and upon any over-
lapping documents being fed through the inlet
thereby to cause the two members to alternately
grip and release such documents and thus separate
the overlapping documents one from the other
while at the same time retarding the cyclically mov-
able member down to a speed that will give a de-
sired throughput rate for documents passing
through the transport path.

56. The method of controlling the rate of advance-
ment of documents into the inlet of a document trans-
port path which comprises:
feeding documents into the inlet of a document trans-
port path formed between a cyclically movable
document driving member and a document separa-
tor member;
moving said cyclically movable member in the direc-
tion to advance each such document further into
the inlet of the transport path and at a speed in ex-
cess of that desired for the document throughput
rate; and
pulsating one of said members toward and away from
the other member as the cyclically movable mem-
ber is moving thereby to cause the two members to
alternatingly grip and release such documents as
they are fed through the inlet and to retard the cy-
clically movable member and the documents en-
gaged thereby down to a speed that will give a de-
sired throughput rate for documents passing
through the transport path.

57. The method of controlling the feeding of docu-
ments through the inlet of a document transport path
which comprises:
subjecting documents as they are being fed through
the inlet of a document transport path to pulsating
pressures of substantially uniform magnitude; and
varying the frequency of the pulsating pressures im-
posed on the document in direct proportion to the
speed of advancement of the documents into the
inlet of the transport path.

* * * * *
CERTIFICATE OF CORRECTION


Inventor(s) Jack Beery and Gerald A. DeCarteret

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

Col. 32, line 19, delete "trailing edge sensing means" and substitute therefor --document drive means--.

Signed and sealed this 18th day of February 1975.

(SEAL)

Attest: C. MARSHALL DANN
RUTH C. MASON Commissioner of Patents
Attesting Officer and Trademarks