March 21, 1967 G. FORRESTER 3,310,169

AUTOMATIC PAPER FINISHING MACHINE

Original Filed March 13, 1961 11 Sheets-Sheet 1

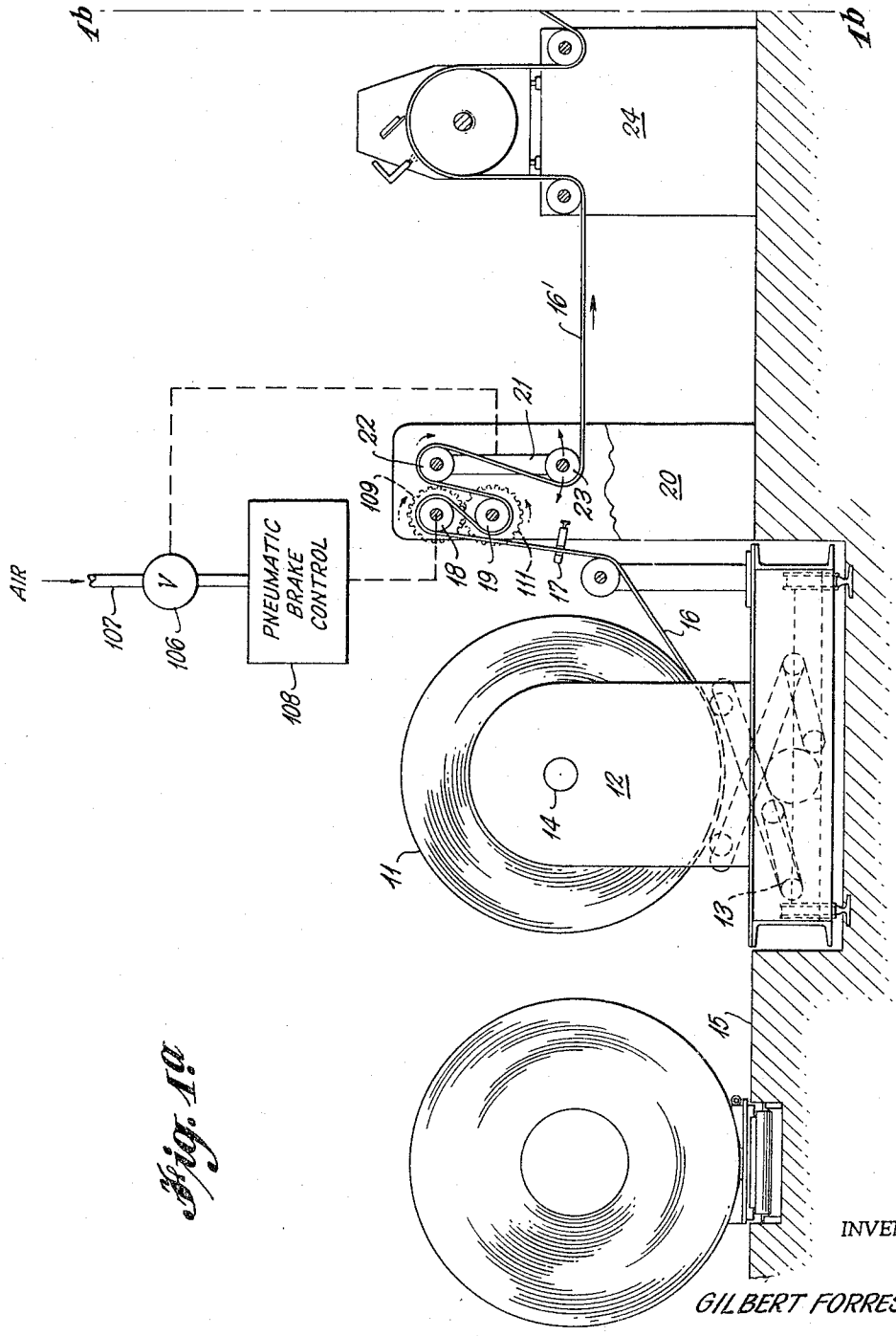


Fig. 1a

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GILBERT FORRESTER

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ATTORNEYS

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AUTOMATIC PAPER FINISHING MACHINE

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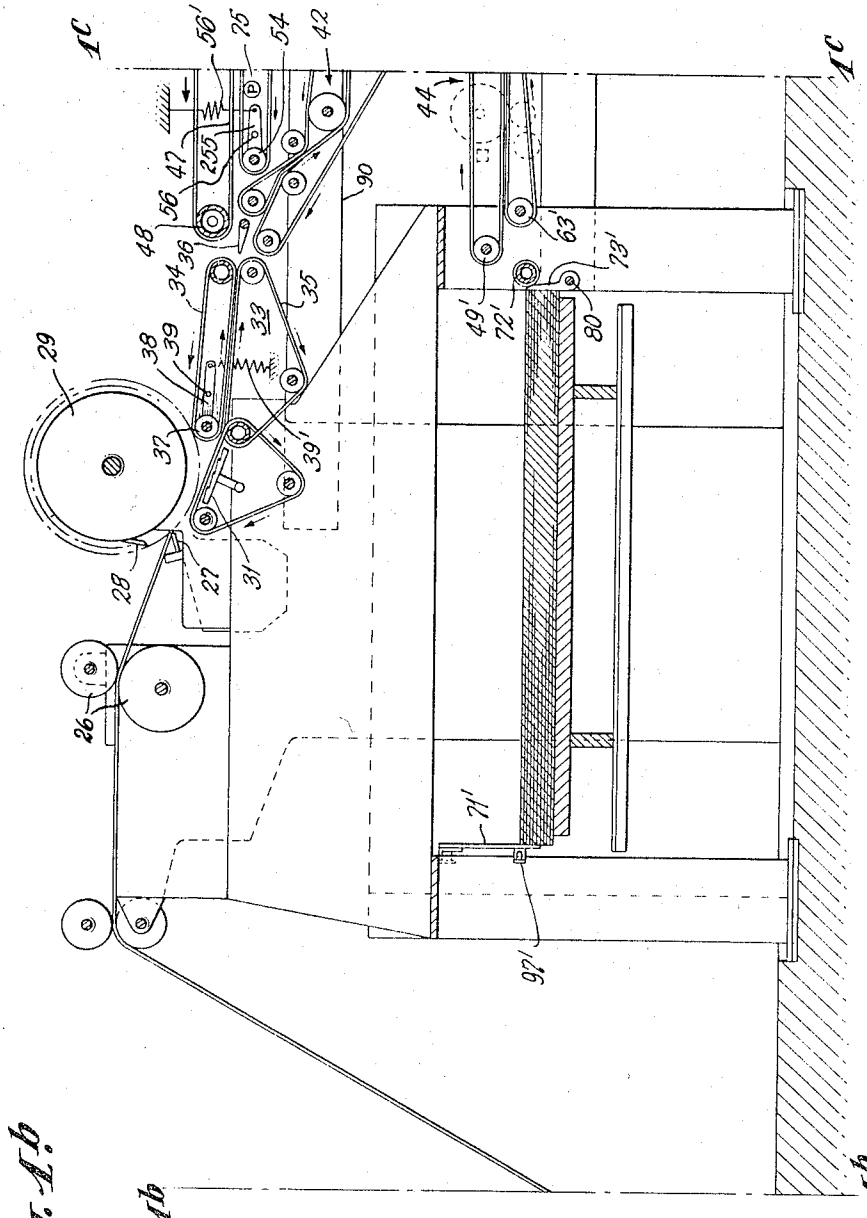


Fig. 1.b

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AUTOMATIC PAPER FINISHING MACHINE

Original Filed March 13, 1961 11 Sheets-Sheet 3

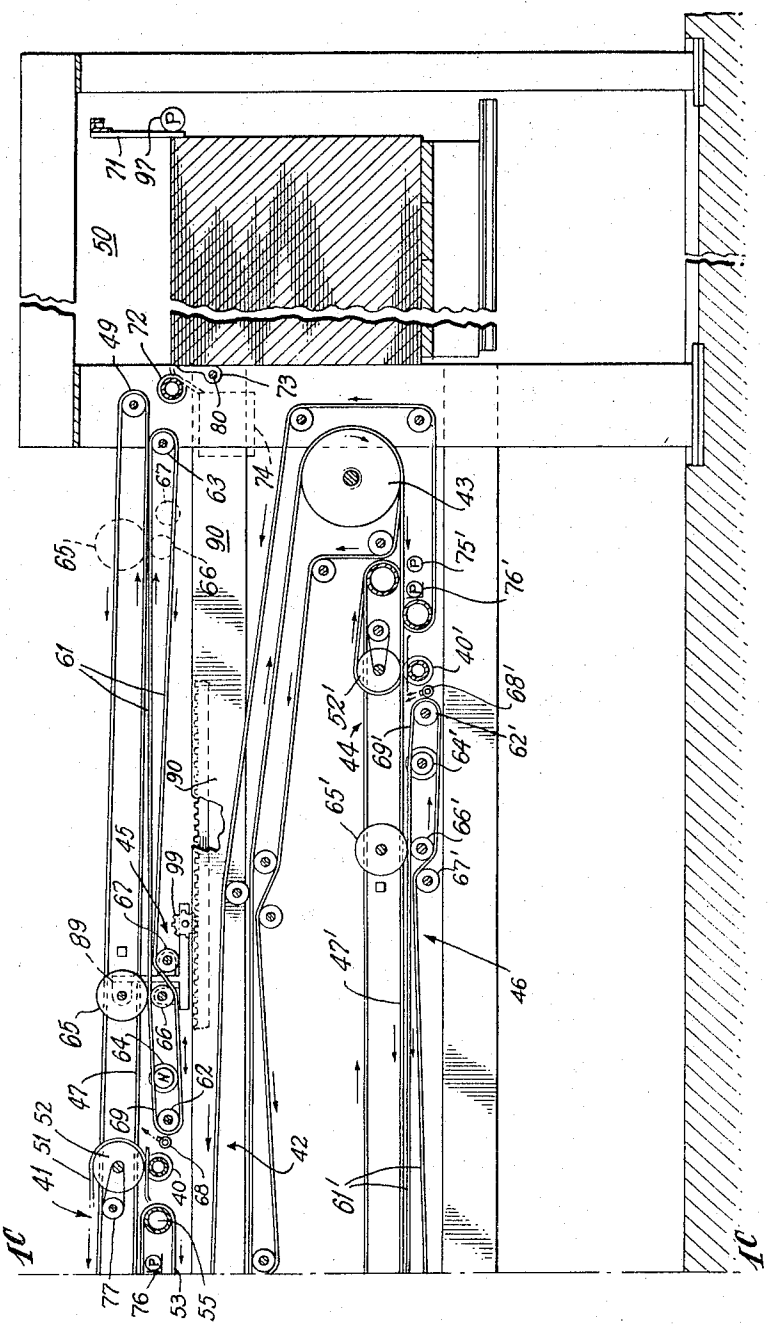


Fig. 1C

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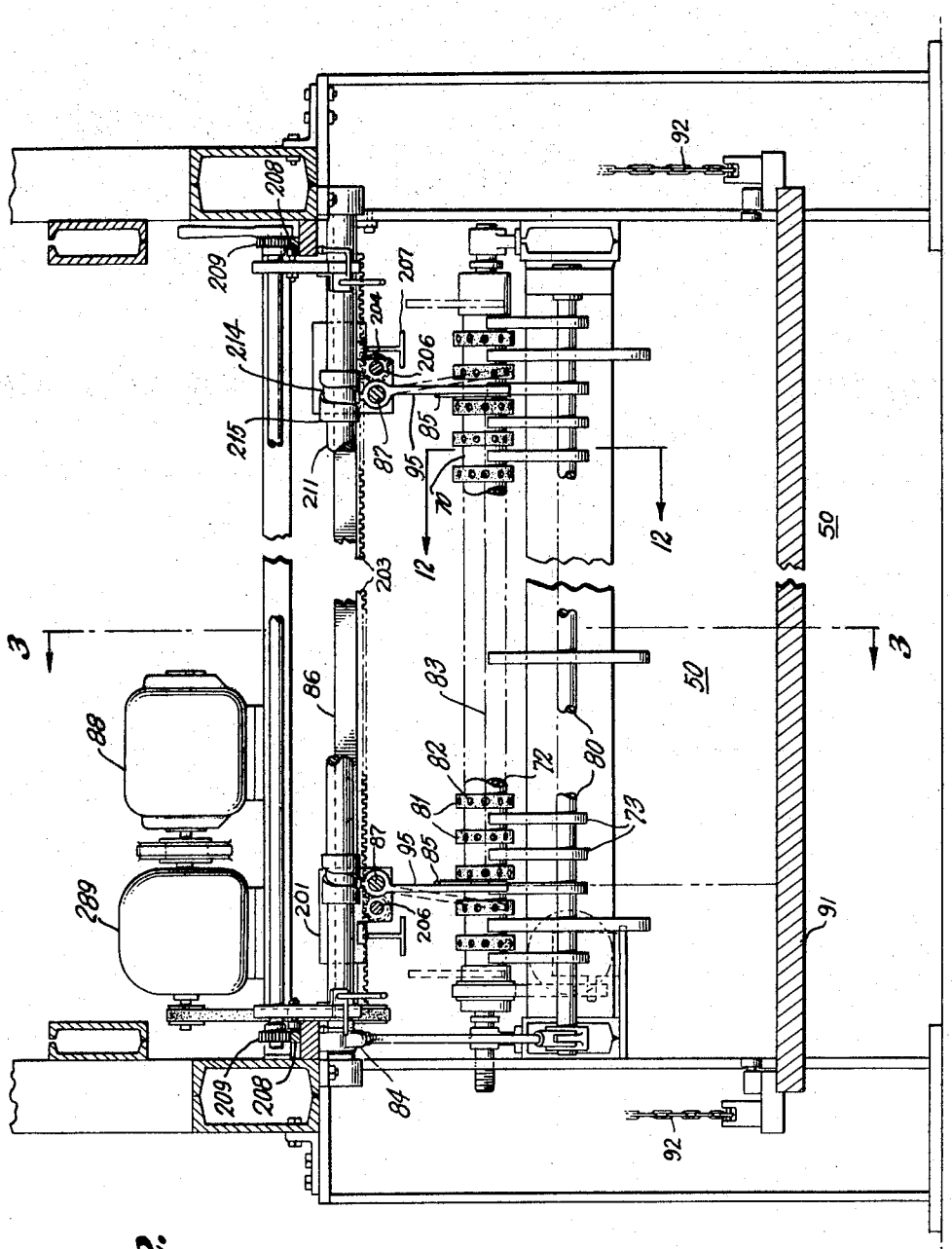


Fig. 2.

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AUTOMATIC PAPER FINISHING MACHINE

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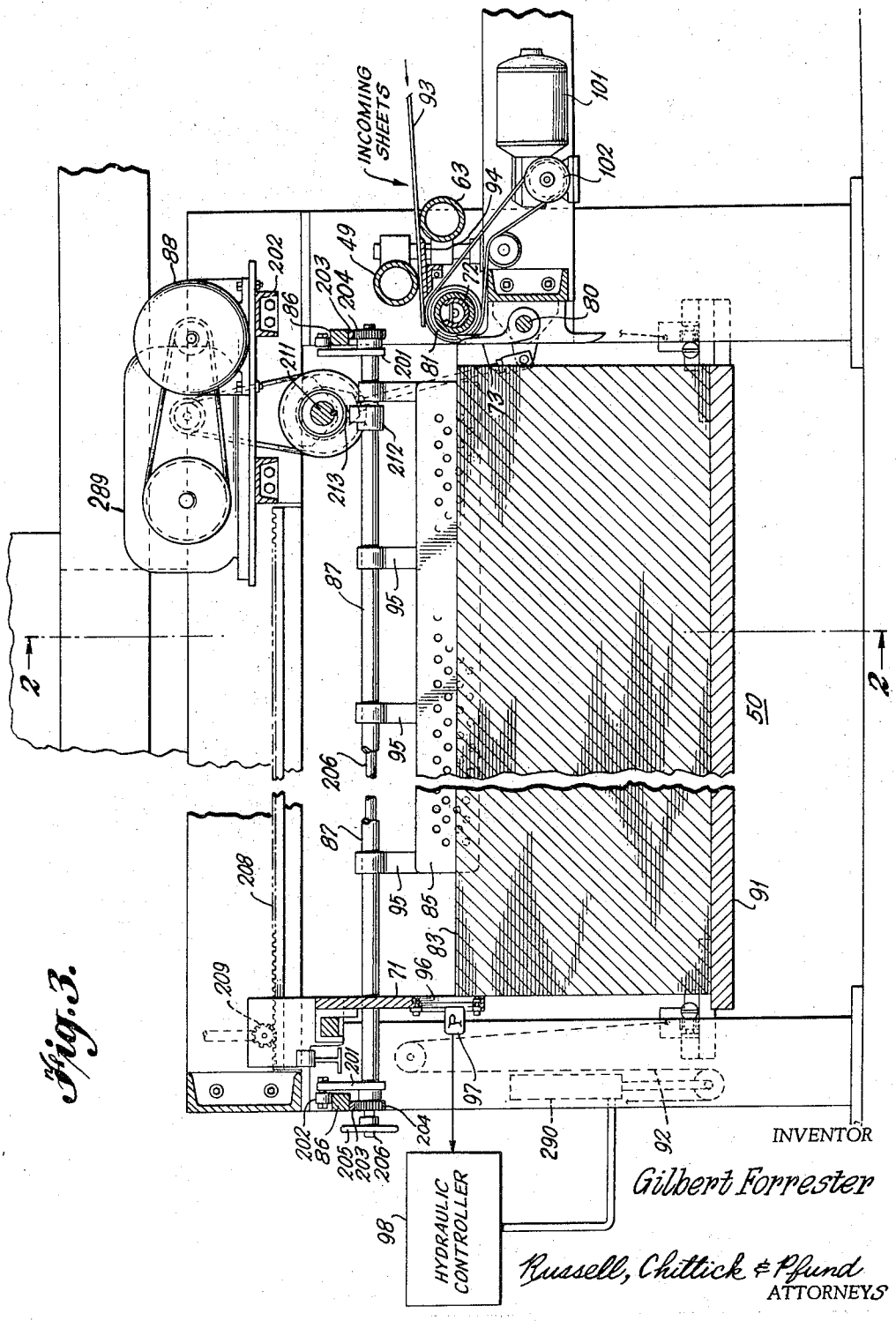


Fig. 3.

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AUTOMATIC PAPER FINISHING MACHINE

Original Filed March 13, 1961 11 Sheets-Sheet 6

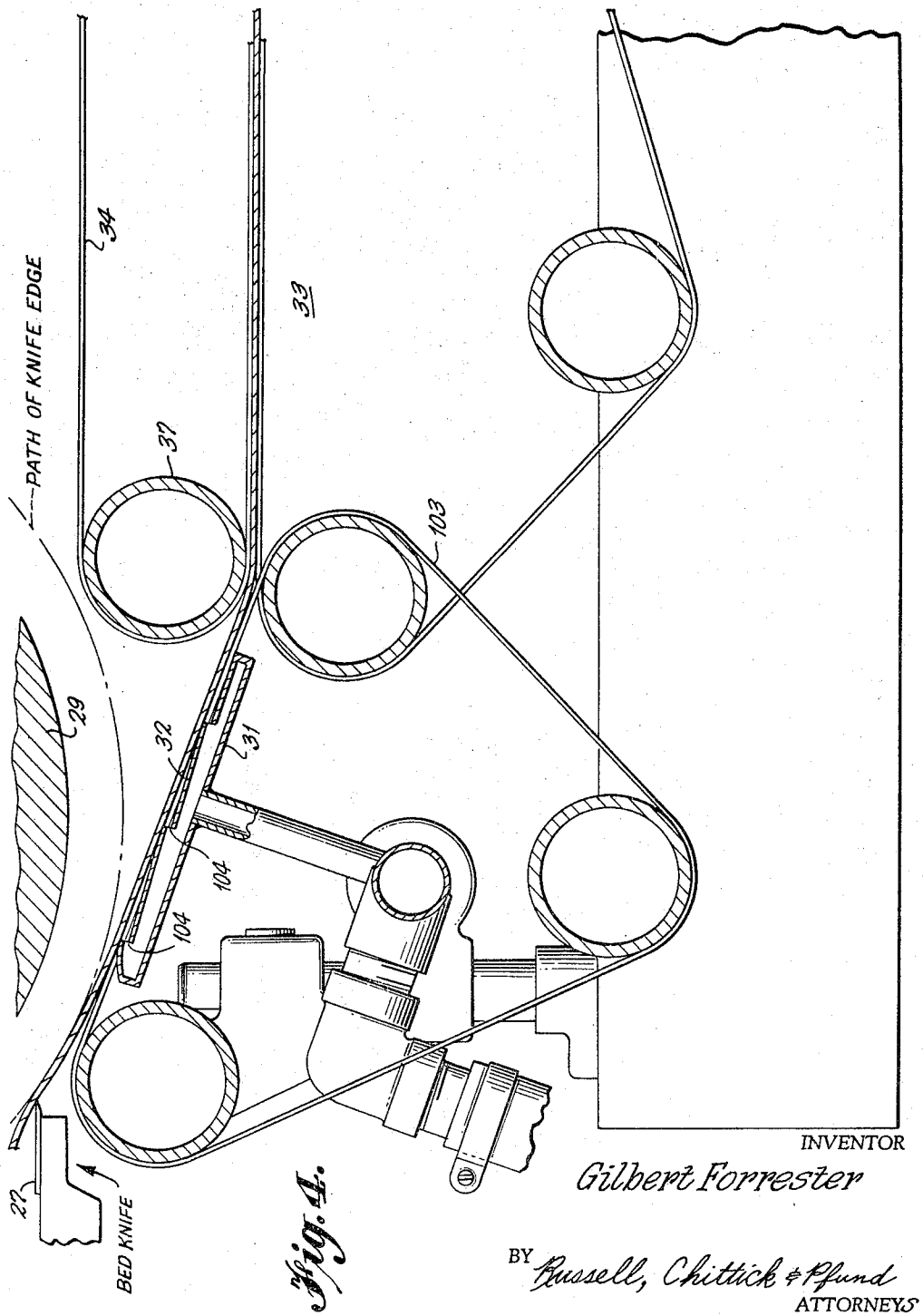


Fig. 4.

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AUTOMATIC PAPER FINISHING MACHINE

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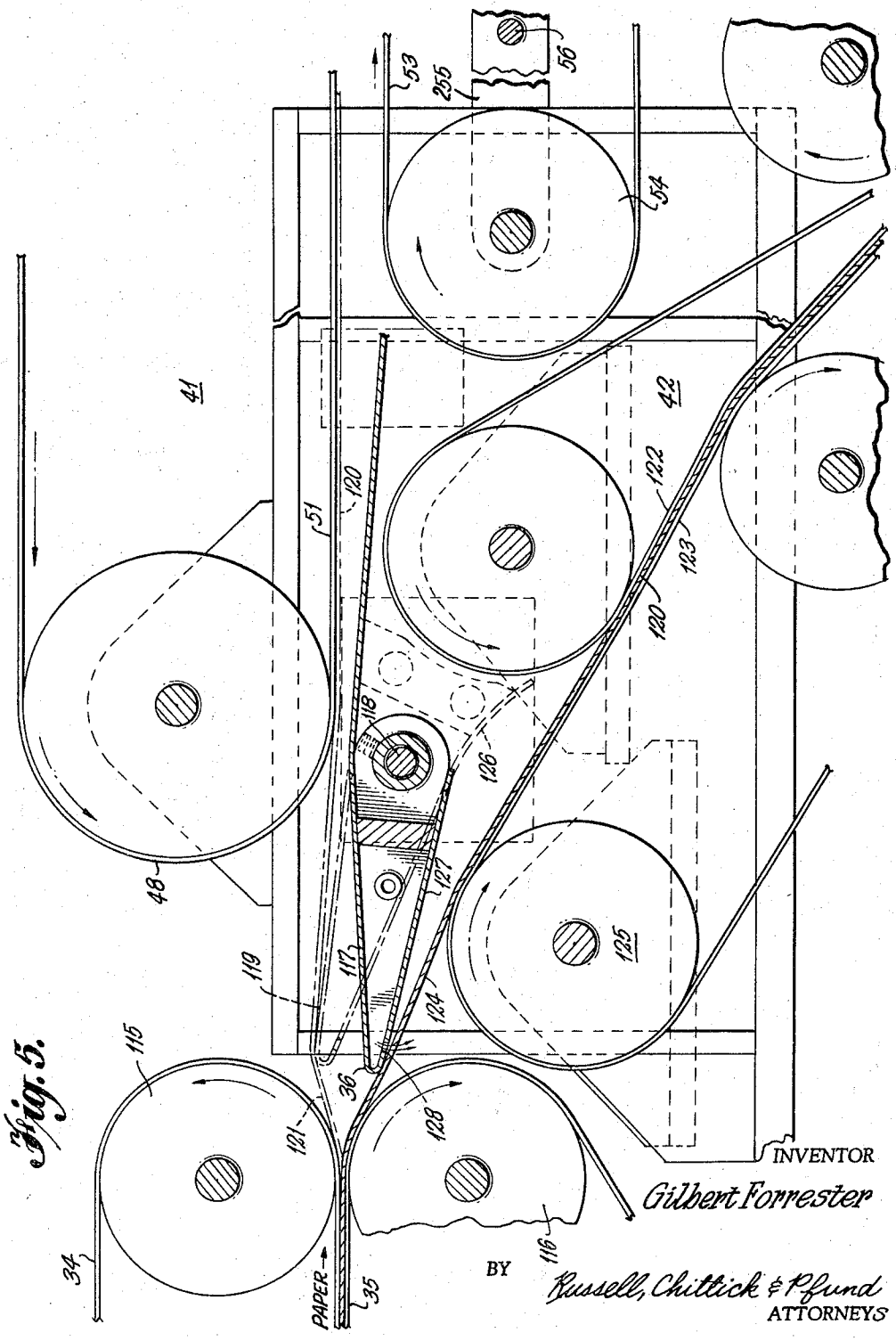


Fig. 5.

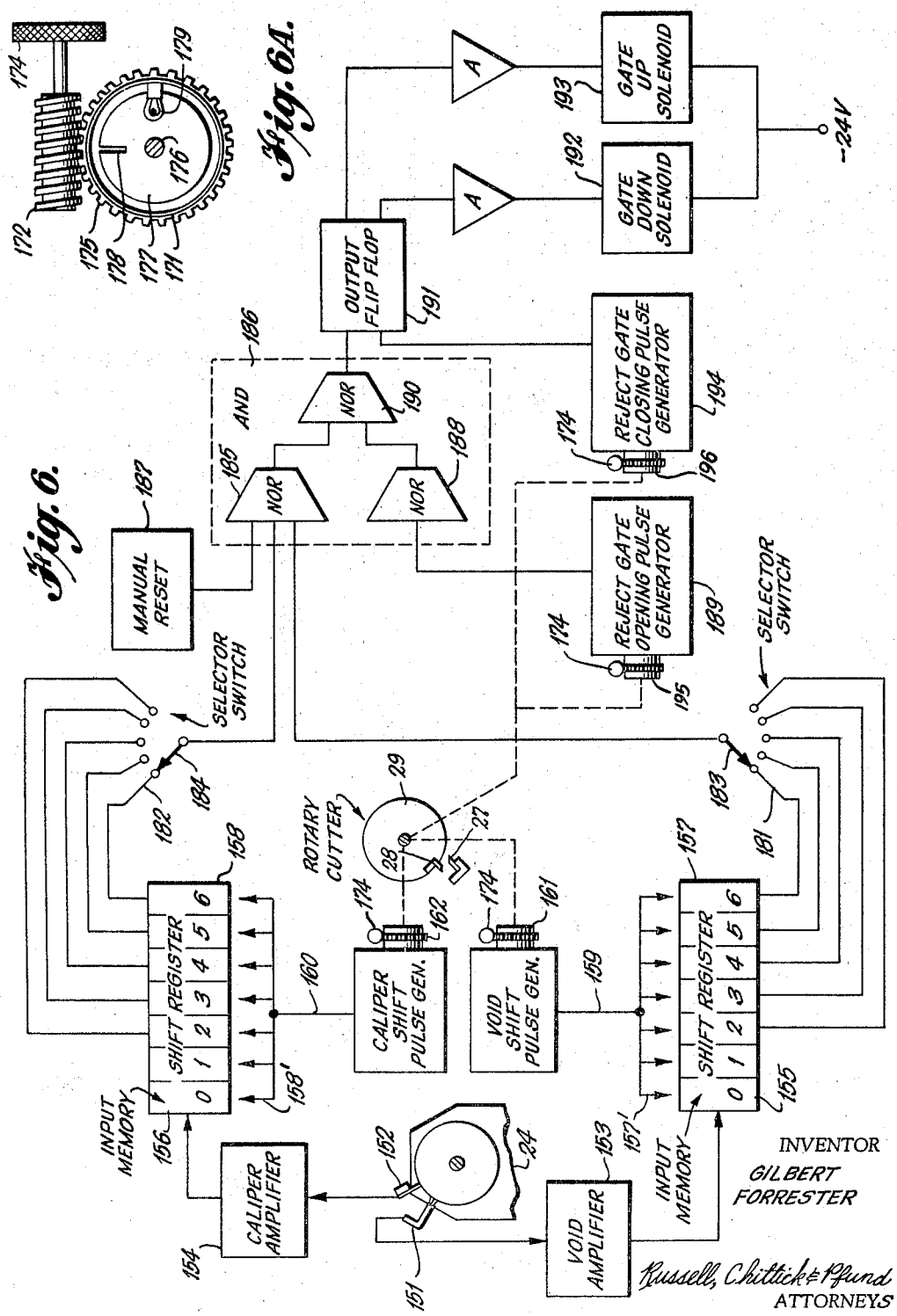
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AUTOMATIC PAPER FINISHING MACHINE

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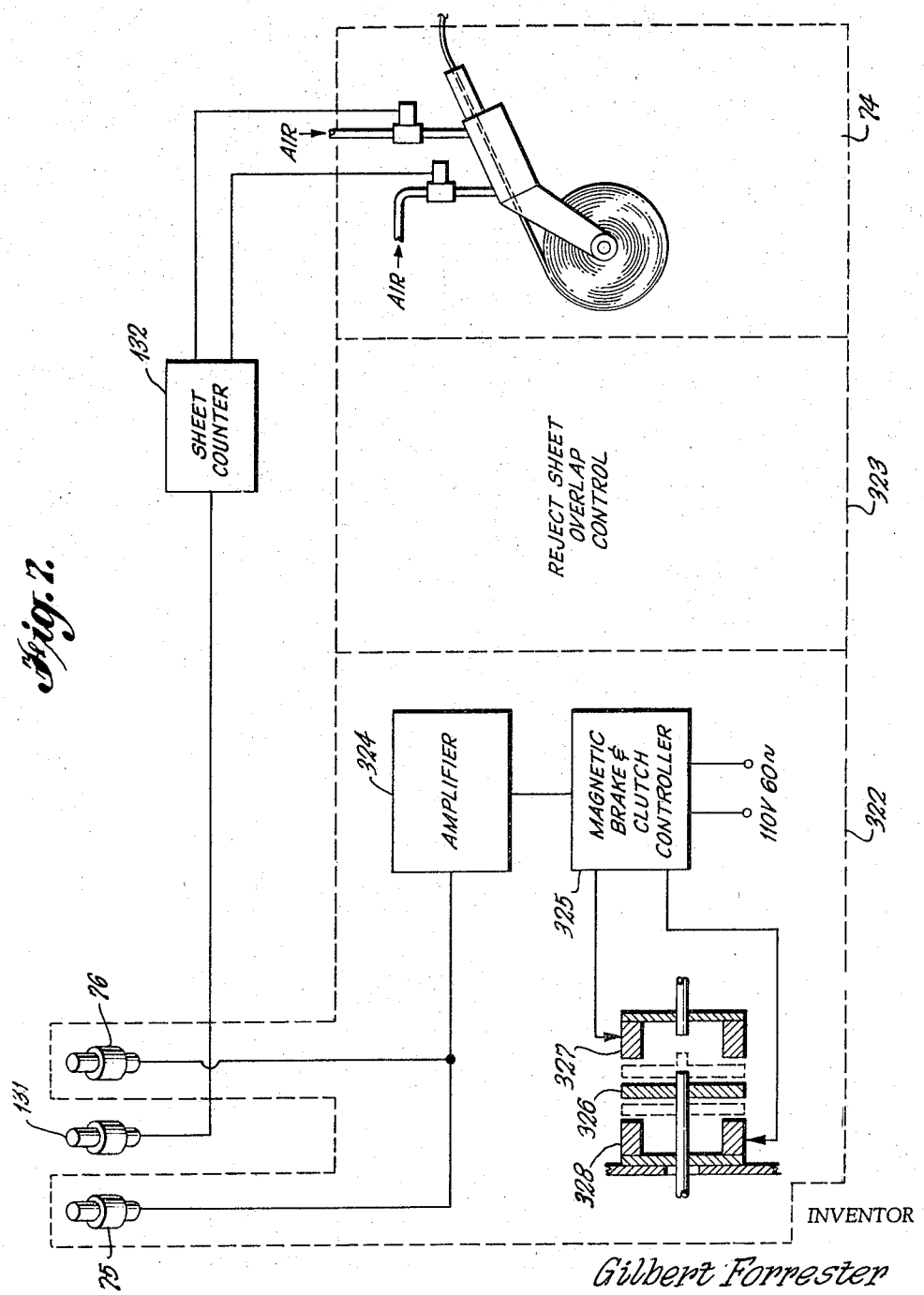


Fig. 7.

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AUTOMATIC PAPER FINISHING MACHINE

Original Filed March 13, 1961 11 Sheets-Sheet 10

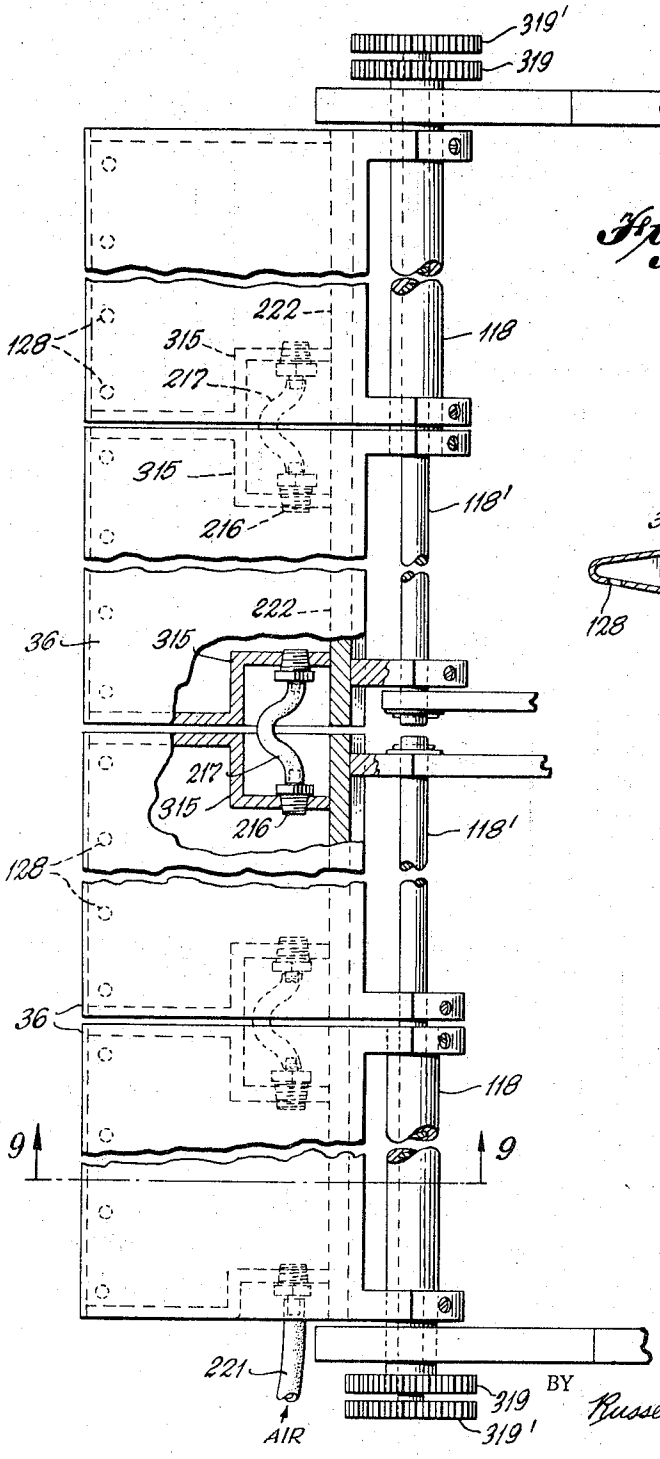


Fig. 8.

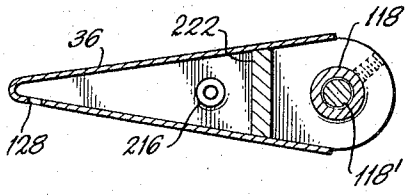


Fig. 9.

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March 21, 1967 G. FORRESTER 3,310,169

AUTOMATIC PAPER FINISHING MACHINE

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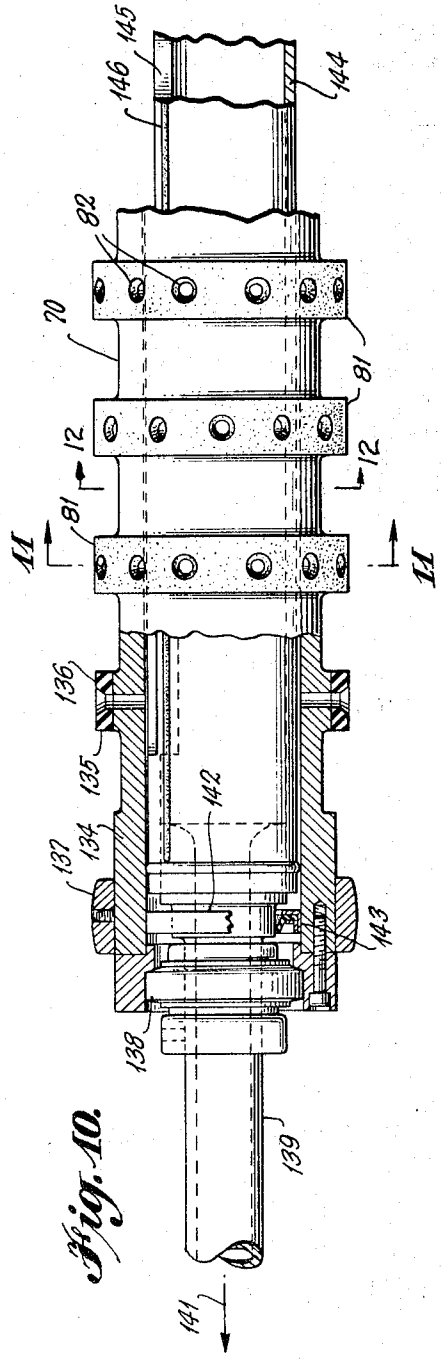


Fig. 10.

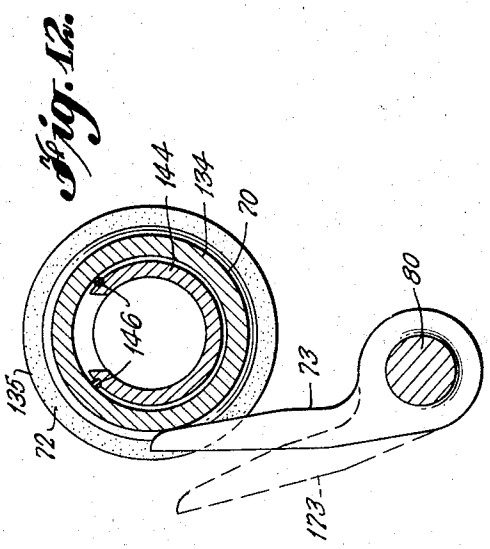


Fig. 12.

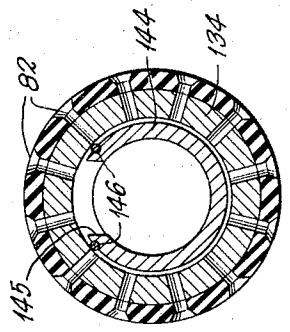


Fig. 11.

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United States Patent Office

3,310,169

Patented Mar. 21, 1967

3,310,169

AUTOMATIC PAPER FINISHING MACHINE

Gilbert Forrester, Falmouth, Maine, assignor to S. D. Warren Company, Boston, Mass., a corporation of Massachusetts

Continuation of application Ser. No. 417,533, Nov. 18, 1964, which is a division of application Ser. No. 95,374, Mar. 13, 1961, now Patent No. 3,216,296, dated Nov. 9, 1965. This application Mar. 4, 1966, Ser. No. 531,747

7 Claims. (Cl. 209—74)

This is a continuation of application Ser. No. 417,533, filed Nov. 18, 1964, now abandoned, which in turn was a division of application Ser. No. 95,374, filed Mar. 13, 1961, and now Patent Number 3,216,296 issued Nov. 9, 1965.

This invention relates generally to paper finishing machines which operate to inspect paper taken from a supply roll and cut into sheets of predetermined lengths and widths while at the same time sorting the sheets into separate piles of acceptable sheets and rejected sheets as determined by an inspection conducted on the continuous sheet taken from the supply roll.

Machines of this general type for inspecting a paper web, cutting it into sheets and sorting the good sheets from the bad sheets have been provided in the past. A primary objective of such machines is to provide operation which is as completely automatic as possible with the linear rate of travel of the paper through the machine as high as possible in order that the useful output of the machine may be a maximum and the cost of operation reduced as much as practicable. A basic limitation on the operating speed of these machines is the speed with which the paper sheets hit a fixed stop in the layboy to which the sheets are delivered for piling into large piles which do not require trimming to be suitable for shipment. The maximum speed at which the leading edge of the paper sheet can hit a fixed stop without damage to the paper is approximately 145 feet per minute. In order to operate the inspection and cutting portions of the machine at a higher linear rate and yet not exceed the safe speed at which the sheets are delivered to the layboy, arrangements which provide for overlapping of the sheets have been employed. When the sheets are overlapped after they have been cut the effective speed of the overlapped sheets is reduced by the ratio of the overlap involved.

In order for overlapping to be successful it is necessary to provide vertical separation between the trailing edge of a preceding sheet and the leading edge of the immediately succeeding sheet. This clearance in vertical position is necessary in order to avoid head to tail collisions between adjacent sheets when the fast moving sheet overtakes the preceding sheet which has been transferred to a slower speed conveyor. Since sheets may be rejected at any time and any number of successive sheets may be rejected the absence of sheets in the path of good sheets may result in the progression of the good sheets on the slow conveyor beyond the point where there is adequate vertical separation between the trailing edge of the last good sheet and the leading edge of the next good sheet. Thus control of overlap in conventional machines requires accurate speed control and accurate spacing between sheets.

The operating of the reject gate in prior art machines of this type has heretofore required an adequate separation between sheets and a synchronization of the operation of the reject gate to operate in the space between sheets.

The defect memory for sheet sorting machines has in the past generally been in the form of a rotating pin wheel which requires precise synchronization with the speed of the paper sheet moving from the unwinding stand through the cutter to the sorting apparatus in order that sheets arriving at the reject gate could be passed or rejected according to the defects detected. Another form of memory which has been used to sort articles in accordance with an inspection performed thereon has been the shift register. While shift register memories have been applied to machines which cut a paper strip and sort the sheets cut therefrom the mere application of such memories to existing machines has not resulted in a significant increase in paper handling speeds of such machines.

The primary object of the present invention is to provide a new and improved machine for cutting and sorting paper sheets from a continuous paper web which operates at a speed substantially higher than the speed of operation of current machines.

A further object of the invention is to provide a machine for cutting and sorting paper sheets which incorporates various novel arrangements for performing the required functions in order that substantially completely automatic operation can be maintained at a high speed of operation.

Another object is to provide an improved web tension control in a paper cutting and sorting machine.

A further object of the invention is to provide an improved overlapping section for a sheet feeding machine and controls therefor which permit the overlapping section to accept paper fed thereto at a higher rate of speed than has heretofore been possible.

Another object of the invention is to provide overlapping sections of the sheet feeding machine for both the good and reject paper paths which are arranged substantially to reduce the overall length of the machine and add to the convenience of operation while at the same time providing positive control of the overlap in both the good and reject sections without the danger of the machine becoming fouled by head to tail collisions of sheets following either path.

A further object of the invention is the provision of an improved retarding arrangement for sheets delivered from the overlap section of the machine to the layboy in order that the ultimate delivery speed of the sheets will be below that at which collision with a fixed stop will produce damage to the sheet.

A still further object of the invention is to provide an automatic layboy height control system whereby the layboy to which paper is delivered maintains the level of the top sheet at the optimum position for receiving sheets at high speed without fouling.

Another object of the invention is the provision of a reject gate structure and control system which permits operation of the reject gate intermediate the length of individual sheets thereby avoiding the requirement for operation of the reject gate in the space between sheets.

A still further object of the invention is to provide a device for paddling the sheets in the layboy into a uniform vertical stack which operates in conjunction with the sheet delivery and slow down system to maintain positive con-

trol of the sheet until it is in substantially its ultimate position in the layboy.

Another object is the provision of an improved layboy and sheet delivery system which provides piled sheets ready for shipment without edge trimming.

These and other objects of the invention and the attendant advantages thereof will be apparent from the following detailed description taken in conjunction with the accompanying drawings wherein:

FIGS. 1A, 1B and 1C are views in side elevation which when assembled as indicated show the overall arrangment of a complete machine in accordance with the invention including in FIG. 1A a view in elevation of a pendulum tension sensing device and the associated control system for braking the paper web as it is fed through the machine;

FIG. 2 is an end elevation view of the delivery end of the machine;

FIG. 3 is a side elevation view of the layboy and delivery end of the machine viewed from the side opposite the view thereof shown in FIG. 1C; and including the photoelectric pile height control system;

FIG. 4 is a view in side elevation of a venturi sheet delivery device useful in the machine;

FIG. 5 is an enlarged view in side elevation of the reject gate showing its capability for operation in the region intermediate the ends of the sheet passing through the gate;

FIG. 6 is a block diagram of the shift register control system for the reject gate;

FIG. 6A is a detail of a delay adjusting device;

FIG. 7 is a block diagram of the photoelectric cell operated control system for the overlap sections of the machine;

FIG. 8 is a plan view of the reject gate;

FIG. 9 is a sectional view taken along the line **9—9** of FIG. 8;

FIG. 10 is a fragmentary view partly in section of a vacuum retarding roll;

FIG. 11 is a sectional view taken along the line **11—11** of FIG. 10; and

FIG. 12 is a sectional view taken along the line **12—12** of FIG. 2 showing the relation of the vacuum retarding roll to the paddle fingers.

The foregoing objects and advantages of the invention are achieved in the disclosed embodiment showing a machine which has superposed oppositely directed overlap sections for providing initial slowdown of sheets delivered by the high speed sheet delivery system from a paper cutter. A continuous web of paper is delivered at high speed to the cutter which cuts the web into sheets of predetermined lengths after which the sheets are oversped to provide a small predetermined spacing between sheets. The spaced sheets pass the reject gate to overlap sections which reduce the speed of the sheets by the factor involved in the overlap. Sheets which are rejected due to defects detected at the detector station are passed around a large diameter reversing roll and delivered to a similar overlap section for the rejected sheets which delivers rejected sheets to a layboy located substantially directly beneath the cutting knife station.

The operation of the gate is controlled by a shift register control system and operation of the reject gate can take place at substantially all positions along the sheet or between sheets. The only limitation on the operation of the reject gate is that the system should be adjusted not to operate the gate until the head of a sheet passing over (or under) the gate has reached a position of positive control between the high speed tapes. Actually for some types of paper the gate can be operated before the head of a sheet has advanced to a position of positive control since the inertia of the moving sheet will tend to carry the head of the sheet to the point where it can be gripped by the tapes for positive control.

The spacing between sheets is used to control the overlap sections which operate separately to feed sheets to the overlap systems and which are automatically stopped when no such sheet is being fed to the overlap conveyor. Thus constant overlap is maintained and the overlapped sheets do not progress to a point where a head to tail collision is possible since each overlap conveyor system is stationary in the absence of the delivery of sheets thereto. The speed of overlapped sheets supplied by the overlap conveyor system to the layboy is reduced by a vacuum retarding roll which operates continuously thereby delivering all of the overlapped sheets which have been released from the overlap conveyor irrespective of whether or not the overlap conveyor is in motion or stationary. This arrangement avoids the problem of arresting the freely moving sheets which have left the overlap conveyor or restarting them after they are arrested. The arrangement of the vacuum retarding roll at the layboy with the end paddle fingers, side paddles and the automatic height control for the top level of the paper in the layboy provides optimum conditions for even piling of the sheets with the result that paper may be piled at a maximum speed with substantial elimination of defective piling or jamming of the delivered sheets. The vacuum roll and side paddles pump air out of the pile with the result that air pillow effect is eliminated and an even edge pile is obtained which requires no trimming and is thus ready for shipment or use.

Referring now to FIGS. 1A, 1B and 1C a description of the overall machine will be given. The machine is supplied with paper from a suitable source such as roll **11** which is rotatably supported in an unwinding stand **12** where it is elevated by an hydraulically actuated elevator mechanism **13** to a position where the axis of the roll **11** coincides with chucks **14**. Chucks **14** are hydraulically advanced into the axis of the roll **11** and expanded within the roll core to support the roll for rotation and supply a minimal braking force during normal rotation of the roll **11**. Once the chucks **14** support the roll **11** the elevator mechanism **13** is retracted to the level of floor **15** in which position it is ready to receive the next roll when the machine is again loaded. The roll **11** is rotated to supply a web of paper **16** which is threaded through various guide, braking, drawing and control rolls as will now be described.

The web **16** is passed by an edge control **17** and over retarding or braking rolls **18, 19** which are positioned to provide contact with the paper web **16** over substantially greater than half of the peripheral area of the rolls **18, 19**. The rolls **18, 19** rotate with the application of a controlled amount of braking force applied to the axles thereof by a braking mechanism which operates in accordance with the displacement of a pendulum tension control device **21**. The pendulum device **21** has an upper idler roll **22** which is rotatable about a fixed horizontal axis from which depends the pendulum arm **21** which supports for rotation a lower tension sensing roll **23**. The pendulum arm **21** and the roll **23** are movable about the axis of the roll **22** and are urged downward by the weight of the roll **23** and arm **21**. If desired a suitable biasing force could be provided to position the roll **23** and arm **21**. The paper web **16** threaded to cross rolls **22** and **23** as shown acts in a counter-clockwise direction against the urging of the pendulum **21** to establish a variable position for the roll **23** along the arc of pendulum **21** in accordance with the tension in the paper web **16'** as it is delivered beyond the roll **23**.

The web **16'** next passes through a shock mounted defect detector stand **24** where the surface of the paper is examined for abrupt local thickness changes, lumps, wrinkles, voids and other defects which when detected produce an electrical signal which is utilized to reject the sheet of paper which is ultimately cut containing the defect detected in the stand **24**. Any of the well known defect detectors can be employed at the stand **24** for producing a suitable electrical signal.

The paper web **16** is drawn from the roll **11** through the tensioning stand **20** and the defect detector stand **24** by press rolls **26** which are driven by a suitable controlled speed power drive. The speed of the press rolls **26** in the present machine provides for delivery of the web **16** at a bedknife **27** at a linear speed of approximately 1100 feet per minute. The bedknife **27** operates with a rotating cutter **28** to sever the web **16** into individual sheets of lengths determined by the speed of the cutter **28** which is supported for rotation on the periphery of a rotatable drum support **29**. By controlling the speed at which the drum **29** is driven relative to the press rolls **26** an effective selection of the length of the sheets cut by the machine can be obtained.

The sheets cut by the knives **27, 28** have a tendency to follow the periphery of the drum **29**. To overcome this tendency a positive delivery control is provided by a venturi head **31** which operates to exhaust a film of air along a surface **32** thereof in the desired direction of travel of the paper sheets which results in a deflection of the sheets toward the surface **32** and hence provides positive control for delivery of the leading edge of the sheets to a high speed tape transport system **33**. A more detailed description of the construction and operation of the venturi delivery head **31** is given hereinafter in connection with FIG. 4 and in the copending application of Gilbert Forrester, Ser. No. 78,924, filed Dec. 28, 1960, assigned to the assignee of present application.

The high speed tape transport system **33** comprises a set of upper tapes **34** and a set of lower tapes **35** which have contiguous portions traveling in the same direction and between which the sheets are delivered to the region of a reject gate **36**. For this purpose the tapes **34** pass over a front roll **37**, the axis of which is supported by a yoke **38** pivoted to an axis **39**. The roll **37** is downwardly biased by spring **39'** and the tape **34** is thus maintained in positive contact with the tape **35** for the continuous run to the reject gate **36** thereby providing positive control of the sheet between the tapes and to present the sheet to gate **36** while traveling in a substantially straight path. The speed with which the tapes **34, 35** are run is slightly greater than the linear speed at which the web **16** is delivered to the bedknife **27** thereby providing a predetermined space between sheets at a subsequent point in the machine.

Conveyor system **33** and the reject gate **36** are effective to guide sheets delivered by the high speed tape conveyor system **33** to alternate paths. Sheets which have been cut from portions of the web **16** which contain no defects are passed over the top of the reject gate **36** to a high speed conveyor system **41**. Sheets which contain defects as detected at the defect detector stand **24** are deflected to an alternate path by raising the reject gate **36** to an elevated position prior to the time the leading edge of the defective sheet arrives at the gate **36**. This alternate path is defined by a tape system **42** which accepts sheets which pass below the reject gate **36** and guides them to a large diameter turn-around roll **43**. Sheets which are carried around the trun-around roll **43** are delivered to a high-speed conveyor system **44** for the reject sheets which is substantially identical with the high speed conveyor **41** for the accepted sheets. The high speed conveyor **41** delivers sheets to an overlap conveyor **45** and the high speed conveyor **41** delivers sheets to an overlap conveyor **45** and the high speed conveyor **45** and the high speed conveyor **44** delivers sheets to an overlap conveyor **46**. Since the operation and construction of the high speed conveyor **41** and overlap conveyor **45** are identical with the high speed conveyor **44** and overlap conveyor **46** only one such conveyor and overlap system will be described. The corresponding elements of the other conveyor system will be designated by therespective reference numerals primed. primed.

Referring now to the high speed conveyor **41**, the system comprises tapes **47** which extend from a roll **48** directly above the reject gate **36** to a roll **49** secured to a support adjacent a layboy device **50**. The tapes **47** provide the upper tapes in a high speed transport system extending between the rolls **48** and **49**. Operating in conjunction with the tapes **47** are tapes **51** which extend between the roll **48** and larger diameter disks **52** which are journalled on brackets keyed to shaft **77**, which may be pivoted to adjust the height of disks **52**. The tapes **47** and **51** are interdigitated in the region between the roll **48** and disks **52**. A set of tapes **53** extending between rolls **54** and **55** provide the lower tapes in the high speed transport system. All the tapes **53, 51** and **47** comprise the high speed transport system and are driven at the same linear speed. The axis of roll **54** is rotatably supported in a yoke **255** which is pivoted on a horizontal axis **56** and the roll **54** is upwardly urged by a suitable spring **56'** to press the tapes **53** against the tapes **51** and **47** directly thereabove. Sheets delivered by this high speed delivery system follow the tapes **47** into the region which is the input of the slow down and overlap system **45**. Upon exiting from between rolls **52** and mating corrugating rolls **40** the sheet is stiffened in the direction of travel by temporary corrugations produced by the interdigitation of disks **52** with collars on roll **40**.

The overlap system **45** comprises a set of tapes **61** which is moving at adjustable speed ratios of, for example, 2:1 to approximately 4:1 with respect to the high speed tapes **47**. The tapes **61** pass over rolls **62** and **63** and a retarding vacuum roll **64** which will be described in detail hereinafter. Adjustably positioned between the vacuum roll **64** and the extreme end roll **63** are a pair of contacting catching disks **65** and rolls **66** between which the top run of the tapes **61** pass thereby to provide a catching nip to engage the leading edge of sheets delivered by the high speed delivery system **41**. The range of position for the disks **65** and rolls **66** is indicated by the dotted position thereof at the right end of the tape delivery systems adjacent to layboy **50**. This adjustment of the position of the disks **65** and rolls **66** may be achieved by journalling the disks **65**, and rolls **66** in bracket **89** which is slidably supported on parallel longitudinal rails **90** and moved by a rack and pinion drive. Tape tension is maintained at all adjusted positions by an associated idler roll **67** movable with the disks **65** and rolls **66**.

The adjusted position of the disks **65** and rolls **66** corresponds to the length of sheet being cut by the cutter **28** and is adjusted to provide a grip on the leading edge of a sheet between the nip of disks **65** and rolls **66** when the trailing edge of that sheet is approximately over the roller **62**. The passage of a sheet to the position just described is assured by an upwardly directed air blast from a nozzle **68** which directs a continuous stream of air against the sheet to maintain it in contact with the fast moving tape **47**. As soon as the sheet has reached a position where its leading edge is engaged by the nip of disks **65** and rolls **66** and the trailing edge has cleared the air blast from the nozzle **68**, the leading edge is slowed down to the speed of tapes **61** with the result that the next oncoming sheet overtakes a portion of the spacing between sheets and the upward directed air blast from nozzle **68** directs the leading edge of the next sheet against the fast tapes **47**. The reflected air blast from this subsequent sheet is downwardly directed and presses the trailing edge of the preceding sheet against a portion **69** of the tapes **61**. Thus the trailing edge of the sheet is brought into contact with the slow tapes **61** and vacuum retarding roll **64** which continuously draws a vacuum to maintain contact with the paper and decelerate the trailing edge of the sheet simultaneously with the deceleration of the leading edge. Accordingly telescoping of the sheet is avoided since both the leading and trailing edges thereof are simultaneously decelerated to the same speed which is that of tapes **61**.

The delivery of succeeding sheets to the nip of disks **65** and rolls **66** produces an overlap of the upper sheet with the lower sheet on the slow tapes **61** in accordance with the relative speeds at which the sheets move on the fast and slow tape delivery systems. As succeeding sheets are delivered by the fast delivery system **41** a continuously overlapped stream of sheets is arranged on the slow delivery system **45** which transports the stream of overlapped sheets to the end of the slow tape system at roll **63**.

The overlapped sheets delivered beyond the roll **63** are free of further control by the tape systems and would ordinarily advance due to their own momentum to a stop **71** at the far side of the layboy **50** where they would fall onto the pile of previously delivered sheets accumulating in the layboy **50**. In the present system the delivery speed of sheets from the low speed tapes **61** is still in excess of the safe speed at which the leading edge of the sheet can be permitted to strike the fixed stop **71**. Accordingly further deceleration is required after the paper leaves the roll **63** and this deceleration is obtained by means of a second vacuum roll **72**. The vacuum roll **72** is rotating at a peripheral speed of approximately 145 feet per minute which is the maximum safe speed at which the leading edge of sheets can strike a fixed stop such as the stop **71**. Accordingly the overlapped stream of sheets delivered from the roll **63** passes over the vacuum roll **72** and only the bottom sheet thereof is effectively retarded by the action of the vacuum roll **72**. As this sheet is decelerated it continues to move until it passes beyond the vacuum roll **72** and the next higher sheet will become the sheet which is decelerated by the vacuum roll **72**. Thus each sheet in turn of the stream of overlapped delivered sheets will be decelerated just prior to having its leading edge hit the fixed stop **71**. By providing a two-stage deceleration system for the sheets which are initially traveling at 1100 feet per minute, safe delivery against the fixed stop **71** of the layboy **50** can be achieved.

The height of the top sheet in the layboy **50** is controlled by a photoelectric sensing control system described hereinafter in detail in connection with FIG. 3. Also associated with the layboy **50** and vacuum roll **72** are paddling fingers **73** which periodically paddle the trailing edge of sheets in the top portion of the layboy to maintain the stack uniformly vertical. In addition a ream ticket inserter **74** may be provided for marking the stack of sheets in accordance with a predetermined quantity of paper such as a ream.

The overlap conveyor **45** in the accepted sheet path is controlled by a pair of light source and photcell devices **75, 76** arranged to detect the presence of the paper sheet in the high speed delivery system **41**. The devices **75, 76** may be, for example, minature photoelectric scanners type SA-IRM manufactured by Farmer Electric Products Co., Inc., characterized by a light source arranged to project a beam of light to a surface from which it may be reflected to a light sensing element housed in common with the light source. For this purpose the photocells **75, 76** are arranged to detect reflected light from their internal sources which is reflected downwardly from a paper sheet traveling between the tapes **47** and **53** to impinge upon the photocells in devices **75** and **76**. In the absence of a sheet in the high speed conveyor system **41** no light is reflected. The spacing between the source-photocell devices **75, 76** is adjusted to be such that it exceeds slightly the greatest spacing between sheets which is expected in normal operation of the apparatus. Thus for a normal run of good paper sheets spaced by a predetermined distance in the high speed conveyor **41** at least one of the photocells **75** or **76** will be energized at all times even when the space between sheets is positioned above the photocells. In this manner the absence of both photocell signals is necessary to indicate the absence of a sheet in the high speed system **41** and when both photocells **75, 76** fail to produce an output signal the overlap conveyor **45** is stopped. Conversely if either photocell **75** and **76** is producing an output signal the overlap conveyor **45** is started and maintained running at normal speed. In similar manner the control of the overlap conveyor **46** for rejected sheets is controlled by signals from a pair of spaced source-photocell devices **75', 76'** in the high speed conveyor system **44**. The operation of the conrtol systems for the overlap conveyors **45, 46** will be described in detail connection with FIG. 7.

Referring now to FIG. 2 an end view of the delivery end of the machine with the relationship of the paddle fingers **73** to the vacuum retarding roll **72** is shown. The fingers **73** are fixed at spaced intervals to a rocker shaft **80**. The retarding roll **72** has a plurality of collars **81** in which are arranged a plurality of peripheral ports **82** which communicate with the interior of the roll **72** for drawing air into the ports **82** when they are upwardly positioned as will be more clearly described in connection with FIG. 10. The collars **81** are separated by reduced diameter portions **70** which provide recesses for the paddle fingers **73** across the discharge end of the machine. The roll **72** provides retarding force and the fingers **73** provide paddling along the entire width of the paper sheets which are piling in the layboy **50**. The photocell control system for the pile height in the layboy maintains the top sheet in the layboy at a controlled level indicated at **83** in FIG. 2.

The operation of the fingers **73** is controlled by a conventional reciprocating drive mechanism which drives shaft **80** from an eccentric bearing **84** mounted on rotating shaft **211** to provide a suitable number of paddling strokes for each sheet delivered across the surface of the retarding roll **72** as determined by the speed of shaft **211** driven by an adjustable speed drive **289** and motor **88**. Also operated by the shaft **211** are side paddles **85** which are adjustably positioned on a cross bar **86** to operate with respect to the side dimensions of the pile as determined by the size sheet being processed by the machine. Shaft **87** is given a rocking motion by the action of collar **212** which carries a finger **213** extending into an eccentric groove **214** cut in slidable cam **215**. The paddles **85** are supported from rocker shafts **87** by means of a plurality of parallel links **95** which are rigidly affixed to the shaft **87** and firmly secured to the paddles **85**. This rigid support for the paddles **85** maintains accurate perpendicularity of the face of the paddles **85** and prevents deflection of the paddles **85** when they press against the edge of the stacked sheets.

The rocking shaft **87** is suspended on brackets **201** which are suspended by needle bearing rollers **202** which ride on horizontal rails **86**. The rails **86** have a gear rack **203** attached on the bottom edge which is engaged by pinions **204** at each end of shaft **206**. A hand wheel **205** provides for rotating a shaft **206** and hence the pinions **204** to maintain the paddles **85** parallel to the center line of the machine for all adjusted widths thereof. Locking means **207** is provided for securing the adjusted position of the shaft **206**. A similar position adjusting arrangement for the backstop **71** is provided by rack **208** and pinions **209**.

The sheets are piled in the layboy **50** on a platform **91** which is supported at four corners by chain supports **92** which have their length adjusted by a suitable hydraulic actuator controlled by the pile height control system. This system is arranged to raise the platform **91** by means of hydraulic pressure and to lower the platform **91** by periodically releasing pressure in the hydraulic system in response to a photocell control system operating at the top edge of the pile to maintain the top edge pile height at the level **83** indicated in FIG. 2.

Referring now to FIG. 3 a side view of the layboy and vacuum retarding roll arrangement is shown, the view being from the side opposite that shown in FIG. 1C. Incoming sheets arrive in the direction of arrow **93** and pass over a delivering plate **94**. After passing the lower roll **63** the sheets are free of positive control by the over-

lap tape conveyor system. The bottom sheet in the overlap stream passes over the surface of the vacuum retarding roll 72 and is in contact with the surface of the collars 81 to be gripped by the action of the suction through the ports 82 therein. This suction is only effective for the ports which are in a position at the top of the roll 72 and hence the necessary suction is maintained since these ports are substantially closed by passing sheets. The bottom sheet of the overlapped stream is thus delivered first to strike the backstop 71 of the layboy 50 and succeeding sheets are delivered to the layboy as they become the bottom sheet. The side paddles 45 are provided with a plurality of parallel rigid supports 95 as previously described to maintain the side edges of the pile even and vertical.

The backstop 71 is provided with an elongated slot 96 in which a photocell—housed in common with a light source in device 97—can be adjusted in the vertical direction to be positioned at the proper height for maintaining the level 83 of the piled sheets at the desired height. The photocell device 97 can be similar to devices 75, 76. The vertical position of photocell device 97 is adjusted to maintain the level 83 approximately at the height of the axis of rotation of the retarding roll 72. The light source in the device 97 is directed toward the pile of sheets and when the top edge 83 of the pile is present the edge of the sheets reflect light into the device 97 which contains a photocell sensitive thereto to produce an output signal to a remotely positioned hydraulic controller 98. The hydraulic controller 98 releases hydraulic pressure in actuator cylinders 290 as long as a reflected light signal is received by the photocell in the device 97 thereby lowering the platform 91 and lowering the height of the top sheet level 83 until no reflected light is received by the device 97. At this point hydraulic pressure controlled by the controller 98 is no longer released and hence the hydraulic system maintains the then height of the platform 91 until a new reflected light signal is received by the device 97. The arrangement is capable of controlling the height of the level 83 within the narrow limits of the adjusted position of the device 97.

The retarding roll 72 is operated at a suitable speed by means of a motor 101 and a gear reduction device 102 which provides continuous rotation of the roll 72 irrespective of the operation of the overlap conveyors in the machine. This provides the final speed reduction for the sheets to approximately 145 ft./min.

Referring now to FIG. 4 the details of the venturi air delivery head 31 will be described. The general theory of operation of venturi air delivery heads for paper sheets is described in the aforementioned co-pending application. In the operation of the present machine the rotation of the drum 29 brings the rotating cutter bar into contact with the bedknife 27 as previously described to sever sheets of predetermined length from the paper web fed to the bedknife position. A set of tapes 103 is arranged to travel from the bedknife position 27 to the input of the high speed tape system 33. To assure that the sheets will follow the tapes 103 the ventur heads 31 are positioned between the tapes 103 with a plurality of such heads spaced across the transverse dimension of the sheets traveling through the machine. A moving film of air tangential to the surface 32 of the head 31 is obtained by supplying air under suitable pressure to the interior of the venturi heads 31 where it escapes through tangentially directed nozzles 104. This film of air tends to attract the sheet which is emerging from the bedknife 27 and this force overcomes any tendency that the sheet may have to follow the peripheral surface of the drum 29. The sheets are thus delivered to the input of the high speed tape system 33 without danger of jamming.

Referring now to FIG. 1A the operation of the web retarding rolls 18 and 19 will be described. As previously stated the web 16 traverses the rolls 18 and 19 and is in surface contact therewith over greater than 180° of the surface of the rolls 18 and 19. The web then proceeds over an idler roll 22 the rotating axis of which also provides the pivotal axis for the pendulum arm 21 supporting the tension roll 23. Thus the tension in the web 16 at the position 16' between the tension roll 23 and the defect detector stand 24 is effective to deflect the pendulum 21 in an amount which is determined by the tension in the web at 16' and the weight of the elements 21 and 23. This position of the arm 21 may be sensed by any suitable means and applied to a controller, if desired, or directly to a suitable valve 106 which controls the supply of air from an air line 107 to a pneumatic brake control 108. The pneumatic brake control 108 controls the brake operating to apply braking force to the rollers 18 and 19 which rotate in unison and opposite directions by virtue of the gear connections of their ortating shafts provided by gears 109, 111. This control system is arranged to decrease the braking force applied to the rolls 18 and 19 as the tension in the web at 16' increases and thus deflects the pendulum arm 21 in a counterclockwise direction about the pivot axis at the shaft of idler roll 22. This action is with respect to a predetermined deflected position of the tension roll 23 from the position shown in FIG. 1A since in the straight up and down position of the pendulum 21 no force is exerted against the web 16' in the horizontal direction. Accordingly the running tension of the web 16' will deflect the roll 23 and pendulum 21 by a slight amount after which the pneumatic brake controller will operate to maintain tension in the web 16' substantially constant. This action can be obtained by adjusting the brake shoes on the rollers 18, 19 not to engage and apply braking force when the system is arranged with the pendulum 21 in a vertical position but with the brakes so adjusted that braking force is begun to be applied when the pendulum 21 is deflected by a small amount by tension in the web 16'.

Referring now to FIG. 5, an enlarged view of the reject gate and associated rolls and tapes is shown. The reject gate 36 is located immediately subsequent the rolls 115, 116 which are at the downstream end of the high-speed tape system 33. The gate 36 is shown in its normal position with an upper surface 117 normally below the line of delivery of paper from between the tapes 34, 35 from the tape system 33. Sheets 120 which are without defects are thus delivered and travel over the surface 117 toward the tapes 51 which provide the upper tapes in the second high-speed delivery system 41. Positive control of the sheets occurs at the point above the roll 54 where the tapes 51 become contiguous with the tapes 53. The roll 54, as previously described, is carried by swinging yoke 255 pivoted on an axle 56 and upwardly urged to cause the tapes 53 to engage the tapes 51 and provide positive gripping of the sheets delivered to the tape delivery system 41.

The gate 36 is arranged to be pivoted about an axis 118 in order to reject defective sheets. For this purpose, the gate 36 is moved to the alternate position indicated at 119. It will be noted that the spacing between rolls 48 and 115 and the deflected position 119 of gate 36 are arranged and the relative proportions of the parts are so constituted that there is adequate clearance above the gate 36 in deflected position 119 for a paper sheet 121 to continue without binding. Thus a sheet which has its leading edge under positive control between the tapes 51, 53 or even a sheet which has not had its leading edge reach this position but which has sufficient momentum to carry the sheet to the position of tapes 53 will continue in its normal path even if gate 36 is deflected to the position 119 in the middle of the sheet. This action is indicated by the alternate position of the sheet 121 running to the tapes 53, 51 over the gate in position 119. Similarly, a rejected sheet which is deflected by the gate in position 119 to travel downwardly toward the high-speed tape system 42 comprising tapes 122, 123 will continue so to travel if the gate 36 resumes its normal posi-

tion as shown. Such a sheet is indicated at **124** and it can be seen that the sheet **124** travels with adequate clearance between the roll **116** and gate **36** and between roll **125** and gate **36**, to avoid binding of a sheet being thus conveyed.

As an aid in assuring that rejected sheets will follow the proper path from the gate **36** in deflected position **119**, a fixed curved deflector **126** is arranged to direct rejected sheets downwardly between the tapes **122**, **123**. The rejected sheets as they emerge between the tapes **34**, **35** are given an initial downward deflection before striking undersurface **127** of the gate **36** by virtue of the air blast escaping through ports **128** in the undersurface **127** under the leading edge of the gate **36**. Except for the ports **128**, the gate **36** is formed as an airtight enclosure through which air under pressure is supplied for producing the air blast through the ports **128** which is effective to downwardly deflect the sheets emerging from the tapes **34**, **35**. The overall arrangement of the reject gate **36** and the associated structure is thus capable of operation from the normal position shown at **36** to the deflected position at **119** irrespective of the presence of sheets in either path and the machine can, consequently, operate the reject gate **36** in mid-sheet and the control systems hereinafter described are so operated. Thus the control systems of the present invention are not limited to operation of the reject gate **36** between the sheets passing the reject gate position, and hence the operation of the system can be correspondingly increased in flexibility, since this limitation of former sorters known in the prior art has been removed.

Referring now to FIG. 6, a description of the shift register memory for operating the reject gate **36** will be described. Referring to FIG. 6 the construction and operation of the defect memory and reject gate control will be described. As previously stated suitable defect detectors are employed to inspect the web **16** and produce an electrical signal when a defect is detected. For the purpose of illustration two such detectors are schematically shown in FIG. 6, a void detector **151** and a caliper gauge **152**. The caliper gauge **152** may be set to produce an electrical defect signal for variations in the thickness of the web **16** outside predetermined limits. The defect signals may be amplified, if required, in respective amplifiers **153**, **154** and applied as the input to flip-flop memory stages **155**, **156**. The flip-flops **155**, **156** are set to a ONE state by defect input signals thereto and are reset by the application of a reset pulse to inputs **157'**, **158'** respectively. Upon the occurrence of a reset pulse to reset a previously set stage **155** or **156** an output pulse is produced which is the input signal to the first stage of six stage flip-flop shift registers **157**, **158**.

The shift registers **157**, **158** operate conventionally to advance the state of each stage to the next subsequent stage upon the occurrence of a shift pulse input on lines **159**, **160**. Thus if a void is detected by void detector **151**, for example, the input memory flip-flop **155** is set and upon the occurrence of a shift pulse on line **159** the memory flip-flop **155** is reset and the first stage of the shift register **157** is set. This action is repeated for each subsequent reset pulse on line **159** and hence the position of a set stage in the register **157** corresponds with the position of a defect in the web **16** at a point in the machine subsequent to the defect stand **24**. In conventional shift register terminology the ONES in the registers **157** or **158** are advanced stage by stage upon the occurrence of the shift pulses on lines **159** or **160**.

The shift pulses on lines **159** and **160** are derived in synchronism with the rotation of the cutter **28** but with adjustable phase relative to an arbitrary zero point such as the position where the cutter **28** engages the bedknife **27** to make a cut in the web **16**. For this purpose the drive for the drum **29** is applied to drive rotary pulse generators **161**, **162**.

The pulse generators **161**, **162** may be constructed as rotary distributor-type mechanical contact devices with a fixed contact mounted on the housing and adjustable through 360° about the axis of rotation of the rotating contact. Preferably however the pulse generators **161**, **162** are constructed as shown in FIG. 6A. In the pulse generator of FIG. 6A a cylindrical housing **171** is mounted for rotative adjustment by means of a worm gear **172**, manually driven by means of a knob **174**. The worm **172** engages gear teeth **175** on the housing **171**. Mounted on a shaft **176** is a disc **177** having a narrow radial slot **178**. Fixed to the inner wall of the housing **171** and on one side of the disc is a light source **179**. Aligned axially with the light source **179** on the opposite side of the disc **177** is a phototransistor, not shown, and associated circuit for producing an output pulse each time the slot **178** passes between the light **179** and the phototransistor. With this arrangement a resolution of one-half degree can readily be obtained. By pulse shaping, the reducibility of the pulse output with reference to rotation of shaft **176** can be maintained to any required degree of precision.

The ONES outputs of the last five stages of shift registers **157**, **158** are connected to selector switches **181**, **182** where wiper contacts **183**, **184** can be adjusted to select the output of any register stage after the first as the signal for controlling the reject gate **36**. The wipers **183**, **184** are connected as inputs to a NOR **185** in an AND gate **186**. An additional manual input **187** is applied to the NOR **185** for manually operated rejection of sheets. The AND **186** additionally includes a NOR **188** having an input from a reject gate opening pulse generator **189**. The outputs of NORS **185**, **188** are the inputs of a NOR **190**. The operation of the AND **186** produces an output signal to set a flip-flop **191** only if a ONE input to the NOR **185** is present when the pulse input to NOR **188** occurs.

The two outputs of flip-flop **191** are used to control the reject gate **36** by alternately energizing a down solenoid **192** or an up solenoid **193**. When the flip-flop **191** is set the up solenoid **193** is energized to raise the gate **36** and reject the next sheet. To close the gate **36** a closing timing pulse generator **194** applies a reset pulse to the flip-flop **191** thereby de-energizing the up solenoid **193** and energizing the down solenoid **192**.

The opening and closing pulse generators **189**, **194** include rotary pulse generator devices **195**, **196** similar to the devices **161**, **162**.

The operation of the shift register memory control will now be described. A defect passing the detector stand **24** causes a defect signal to appear at the input flip-flop **155** or **156** of the shift register **157** or **158** associated with that type of defect. This flip-flop remains set after the defect detector voltage pulse has returned to zero and is thus held or stored until the action of the shift pulse generators **161** or **162** causes it to shift to the next memory stage of the shift register.

The shift pulse generators **161**, **162** and the gate opening and closing pulse generators **189**, **194** are all geared to the rotary cutter drum **29** and rotate in synchronism with it. One pulse per revolution is delivered from each generator **161**, **162**, **189**, **194**. The angular positions at which the pulses are generated can be adjusted at each individual generator throughout 360°. Since the paper web moves a distance equal to one sheet length during one revolution of the rotary cutter drum **29**, the pulse generators **161**, **162**, **189**, **194** all deliver one pulse each per sheet length. The phase relationship between the various timing pulses depends upon the individual generator position adjustment made by rotating knobs **174**.

For any given sheet length the shift pulse generators **161**, **162** are adjusted so that the shift pulse occurs just as a projected or future cut line in the web **16** is at the respective detector location. Thus defect signals are stored in flip-flop **155** or **156** while the portion of the sheet subse-

quent to the defect passes under a detector and are shifted to the next stage in the shift register as the tail of the defective sheet passes the detector. At the same instant, the input memory is reset and thus readied to receive defect signals, if any during the passage of the next sheet.

The signal now representing a defective sheet, rather than appearing random in time as it does at the input to flip-flops **155** or **156**, shifts from stage to stage of the registers **157** or **158** with each succeeding revolution of the rotary cutter drum **29**. An output from the shift register occurs at the shift instant but delayed from the input to the first stage a time equal to that required for one sheet length of paper travel per stage of the register occurring before the output stage. The registers **157, 158** therefore accomplish only whole sheet length delays, the number of which depends upon which stage is selected as the output stage.

Since the distance from detector to reject gate **36** is known, the number of revolutions of the cutter drum **29** necessary to progress a given sheet from the detector to a position less than one sheet length before the reject gate **36** is also known. This number of revolutions is the number of stages that must be in the shift registers **157, 158**. One extra stage **155** or **156** is for input storage of the defect signal until the sheet tail reaches the detector location. Different sheet lengths will require a different number of shifts since the distance from detector to gate **36** must be divided into an integral number of sheet lengths. The selector switches **183, 184** provide for this adjustment.

The defective sheet level signal from the shift registers **157, 158** appears at the input to AND **186** at the shift instant and remains until the next shift instant. At the instant this level appears the head of the defective sheet is less than one sheet length from the gate. The exact distance can readily be calculated by subtracting the product of sheet-length and number of shifts from the overall distance between detector **151** or **152** and reject gate **36**. This distance less any distance the sheet travels during gate **36** actuation delay represents the maximum further delay that can take place and still make it possible to reject the sheet.

The delay or any portion of it can be accomplished through adjustment of the gate opening pulse generator **189** since the output from the AND **186** will not take place until the gate opening pulse from generator **189** occurs in conjunction with the shift register output. The signal from the AND **186** causes the output flip-flop **191** and power amplifier A to energize the reject gate solenoid **193** and the reject gate **36** opens to reject the defective sheet. The reject gate **36** is closed by the next pulse of the closing pulse generator **194** which is adjusted to operate after a delay sufficient to permit the rejected sheet to be under positive control of the tape system **42**.

FIG. 6 shows two output solenoids. Operation is similar if a single spring return solenoid valve or solenoid is used to open the gate. In either case the gate up solenoid is de-energized when the output flip-flop changes state.

Provision for manual rejection is possible by applying a manual reject pulse to the AND gate and holding it for coincidence with the gate opening pulse. If desired the gate closing pulse can be temporarily disabled by the manual pushbutton to prevent the gate from closing and reopening with each cycle.

The memory system just described provides for four delays from the time a defect is detected until the gate closes after rejecting the defective sheet.

These delays are:

(1) A delay in time equivalent to the time required for the passage of the paper a distance from the defect location to the tail of the sheet containing it. This is the time existing between a detector output and the shift pulse instant. The delay automatically works in time with machine speed and occurrence of defect signal. (2) The shift register delay is equal to the time required for the passage of a whole number of sheet lengths. The number (N) is the number of whole sheet lengths that exist between detector and reject gate. The delay is thus the time between the first shift instant after the defect signal and shift constant $N+1$ after the defect signal. (3) The third delay is a fractional sheet length delay. It is the time lag between the shift pulse and the gate opening pulse. (4) The last delay is the time that the reject gate remains open. The interval between the gate opening and gate closing pulse is this delay. All delays are in terms of distance traveled. Thus the time is automatically varied with changes in machine speed, and adjustments for a given sheet length hold under all conditions of speed.

Referring to FIG. 8, a plan view of the reject gate **36** is shown. The reject gate **36** may actually be divided into four or more sections which are operated respectively by co-axial drive shafts **118** and **118'** which are driven by suitable gears **319, 319'** at either end of the reject gate **36**. The division of the reject gate **36** into four transverse sections is for the purpose of permitting slitting the web **16** into four separate strips thereby to produce four sheets for each cut of the bedknife and cutter **27, 28** and selectively rejecting the slit sheets containing defects. Obviously, if only a single sheet is cut from the web **16** without longitudinal slitting, the gate sections **36** are operated in unison. Pressure is supplied to the interior of the gates **36** by a suitable connection with a flexible air line **221**.

FIG. 9 is a sectional view showing the arrangement of airtight portion of the gate **36** established by a bulkhead **222**. The entire assembly is mounted on the coaxial shafts **118, 118'** as previously described.

Where the reject gate **36** is to be divided into separately operable sections, air line connection between the separate sections is made by terminating each section with an airtight bulkhead of a recessed type **315** each provided with a suitable air line connecting fitting **216**, and connecting each adjacent pair of fitttings **216** with a flexible hose **217**. The position of the connecting fittings **216** within the recessed space formed by end walls **315** is such that normal motion of the separate reject gate sections **36** is not restricted by the hose.

FIG. 7 shows a schematic arrangement of the overlap tape control systems for the overlap systems **45, 46**. The control for the overlap system **45** is indicated within the dotted lines **322** with a similar system being provided for the overlap system **46** as indicated within the dotted lines **323**. Since these systems are identical, only one will be shown and described. The overlap conveyor **45** for good sheets is controlled by the system **322** which comprises the photocell devices **75, 76** which direct light upwardly to the undersurface of the paper passing thereover. The reflected light from a sheet directly over the devices **75, 76** produces an output signal which is amplified by amplifier **324** for controlling a magnetic brake and clutch controller **325**. When a signal is present from the photocell device **75** or **76** to the amplifier **324**, the magnetic controller **325** is supplied a signal to cause disc **326** to be engaged by translation to a rotating magnetic clutch element **327** which is driven at the operating speed for the overlap conveyor. When neither photocell devices **75, 76** produce an output signal indicating the absence of the sheet thereabove, the amplifier **324** produces no output signal which causes the controller **325** to energize the brake clutch **328** and de-energize the drive clutch **327**. Thus the disc **326** is translated to engage the brake clutch **328** and the rolls are immediately stopped in the overlap conveyor **45**. A similar action is provided by the reject sheet overlap controller **323** for the overlap tape system **46** under the control of photocell devices **75', 76'**.

In addition to the control of the overlap tape systems **45, 46**, FIG. 7 shows a sheet counter photocell **131** which actuates the sheet counter **132** for each sheet passing

thereover. The sheet counter **132** is arranged to have an output for every predetermined number of sheets counted which output can be applied to operate the air valves of the ream ticket inserter device **74** which device is known in the art and will not be further described.

In FIG. 10, the details of construction of the vacuum retarding rolls **64**, **64'** and **72**, **72'** are shown. The vacuum retarding rolls comprise a tubular casing **134**, the outer surface of which is formed into alternate collars **81** and reduced diameter portions **70** as previously described. The collars **81** have robber threads **135** through which ports **82** extend terminating in a chamfered surface aperture **136** in the treads **135**. The tubular casing **134** is provided with a drive pulley **137** for driving the rolls at the desired speed. The casing **134** is rotatively mounted on bearings **138**, the inner race of which is supported on fixed shaft **139**.

At one end of the tubular roll **134**, the fixed support **139** is a tubular shaft connected as indicated at **141** to a vacuum source and communicating with the interior of the fixed tubular chamber **144**. The air seal **142** rotates and provides a sliding fit with the outer surface of shaft **139** by means of a leather sealing lip **143** or the like. The tubular shaft **139** terminates within the roll **134** by connection to stationary tube **144** which has in its upper surface a slot **145** extending the width of the roll. Extending along the edges of the slot **145** on each side thereof are small gasket strips **146** which provide an air seal between the outer surface of the tube **144** and the rotating inner surface of the roll **134**.

In FIG. 11, the effect of the tube **144**, the slot **145** and gaskets **146** can be seen to provide suction to the ports **82** which are upwardly directed. As the roll **134** rotates, this suction is maintained on the ports **82** which are above the slot **145** to provide the retarding action on the sheet passing thereover.

In FIG. 12 an enlarged view of the roll **72** and paddle finger **73** similar to that shown in FIG. 3 is provided. As can be seen, the free end of the paddle finger **73** is recessed beneath the surface of the tread **135** on the roll **72** as provided by the reduced diameter portions **70** with which the fingers **73** are aligned. The free ends of the fingers **73** extend to the horizontal position of the axis of rotation of the roll **72** and provide in their extended position **173** the paddling action required for the back edge of the sheets in the layboy.

While a particular construction has been described it will be understood that the present invention is not limited thereto since individual features disclosed or the combination thereof required to obtain high-speed operation may be modified by those skilled in the art without departing from the spirit and scope of the present invention. Accordingly, the invention is to be limited only by the appended claims.

I claim:

1. A reject gate and associated structure for sorting paper sheets capable of operating said reject gate at substantially any sheet position comprising a horizontally pivoted hollow reject gate having air vents on the under surface of the leading edge thereof, means for delivering sheets substantially horizontally to pass over the top of said reject gate in its normal position thereof, a horizontal tape transport for positive control of sheets passing over the top of said reject gate, means for raising said reject gate during the passage of a sheet thereover for deflecting defective sheets, means for supplying pressurized air to the interior of said gate to deflect sheets downwardly when said gate is raised, a curved deflector at the pivot axis of said gate for downwardly deflecting sheets passing under said gate, and a tape transport system aligned with the direction of sheets guided by said deflector for positive control of rejected sheets, all of the structure being proportioned to provide a clear passage for paper sheets in either path for either position of said reject gate.

2. A reject gate and associated structure for sorting paper sheets capable of reject gate operation at substantially any sheet position comprising: a horizontally pivoted reject gate having a hollow interior and air vents at the leading edge of the underside thereof, means for delivering sheets substantially horizontally over said reject gate in the normal position thereof, transport means for positively controlling acceptable sheets as they pass over said reject gate, actuating means for raising said reject gate during the passage of an acceptable sheet thereover, means for supplying pressurized air to the interior of said reject gate in the raised position thereof to downwardly deflect following defective sheets passing under said gate, and transport means for positively controlling defective sheets deflected by said reject gate, all of said associated structure being positioned and proportioned to provide clear passage for paper sheets in either reject gate position.

3. A reject gate and associated structure for sorting paper sheets capable of reject gate operation at substantially any sheet position comprising: a horizontally pivoted reject gate having a hollow interior and air vents at the leading edge of the underside thereof, means for delivering sheets substantially horizontally over said reject gate in the normal position thereof, transport means for positively controlling acceptable sheets as they pass over said reject gate, actuating means for raising said reject gate during the passage of an acceptable sheet thereover, means for supplying pressurized air to the interior of said reject gate in the raised position thereof to downwardly deflect following defective sheets passing under said gate, and transport means for positively controlling defective sheets deflected by said reject gate, said delivery means and said two transport means capable of operating at substantially the same speed.

4. A reject gate and associated structure for sorting a stream of paper sheets adapted for reject gate operation at substantially any sheet position comprising: means for inspecting paper sheets and for generating delayed accept and reject signals based on the inspection, a horizontally pivoted reject gate positioned downstream from said inspecting means, means for delivering inspected paper sheets substantially horizontally over said reject gate in its lowered position, transport means for gripping the head of an acceptable paper sheet prior to passage of the paper sheet tail over the swinging end of said pivoted reject gate and for conveying said acceptable sheet downstream, actuating means for raising said reject gate in response to a reject signal during the passage of a gripped acceptable sheet over the swinging end of said pivoted reject gate to downwardly deflect following defective sheets, and transport means for gripping the head of a deflected defective paper sheet prior to passage of the paper sheet tail under the swinging end of said pivoted reject gate and for conveying said defective sheet downstream, said delivery means and said two transport means adapted to operate at substantially the same speed.

5. Apparatus of claim **4** further characterized by actuating means for lowering said reject gate in response to an accept signal during the passage of a gripped defective sheet under the swinging end of said pivoted reject gate.

6. The method of inspecting and sorting paper sheets comprising the following steps:

(a) inspecting a moving web of paper for defects and generating a delay accept or reject signal based upon said inspection,

(b) cutting said paper web into sheets,

(c) delivering acceptable sheets over a pivoted reject gate in its lowered position,

(d) gripping the delivered acceptable sheets and conveying them downstream,

(e) raising the reject gate in response to a delayed reject signal before the tail of the gripped acceptable sheet next preceding a defective sheet pases over the swinging end of the reject gate, and

(f) downwardly deflecting the following defective sheets.

7. The method of claim 6 further characterized by the following steps:

(g) gripping the deflected defective sheets and conveying them to a collection point, and

(h) lowering the reject gate in response to a delayed accept signal before the tail of the gripped defective sheet passes under the swinging end of the reject gate.

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