

[54] **METHOD AND APPARATUS FOR PRODUCING COPYING SETS**

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 237,658, March 24, 1972, abandoned.

[52] U.S. Cl. **270/53; 270/58**

[51] Int. Cl. **B42b 1/02**

[58] Field of Search 270/53, 58, 60; 271/64

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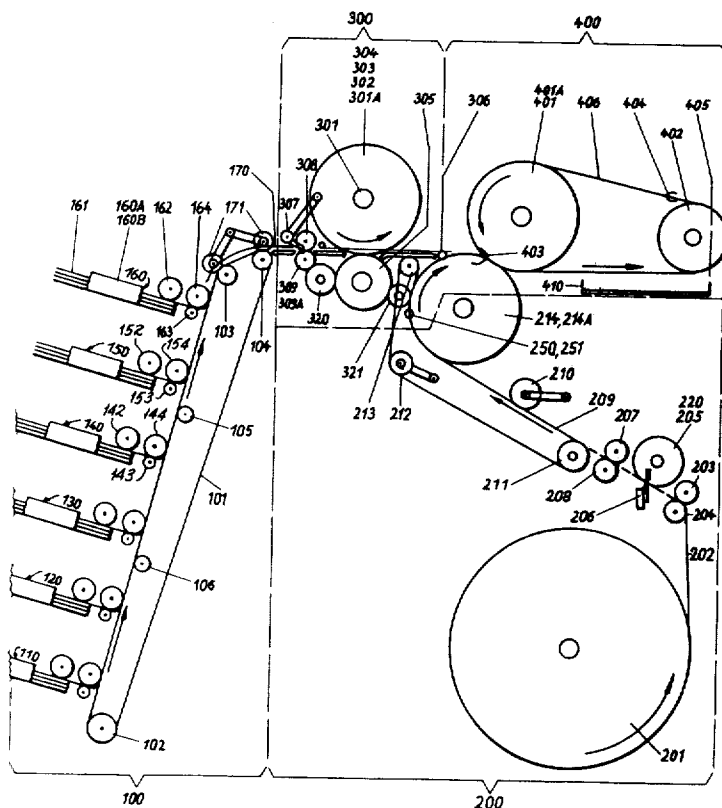
Attorney, Agent, or Firm—Bacon and Thomas

[57]

ABSTRACT

A method and apparatus for making copying sets with single use, throw-away carbon paper sheets interleaved between writing paper sheets, the apparatus automatically and continuously supplying multiple writing sheets to a processor for perforating and sequentially numbering the writing sheets, and automatically and continuously feeding the required number of carbon sheets having glue lines applied thereon for assembly with the writing sheets. Writing sheet misfeed detectors, double sheet detectors, and aligning means are shown, as well as a control system for synchronizing the various signal and operating functions of the apparatus.

10 Claims, 10 Drawing Figures



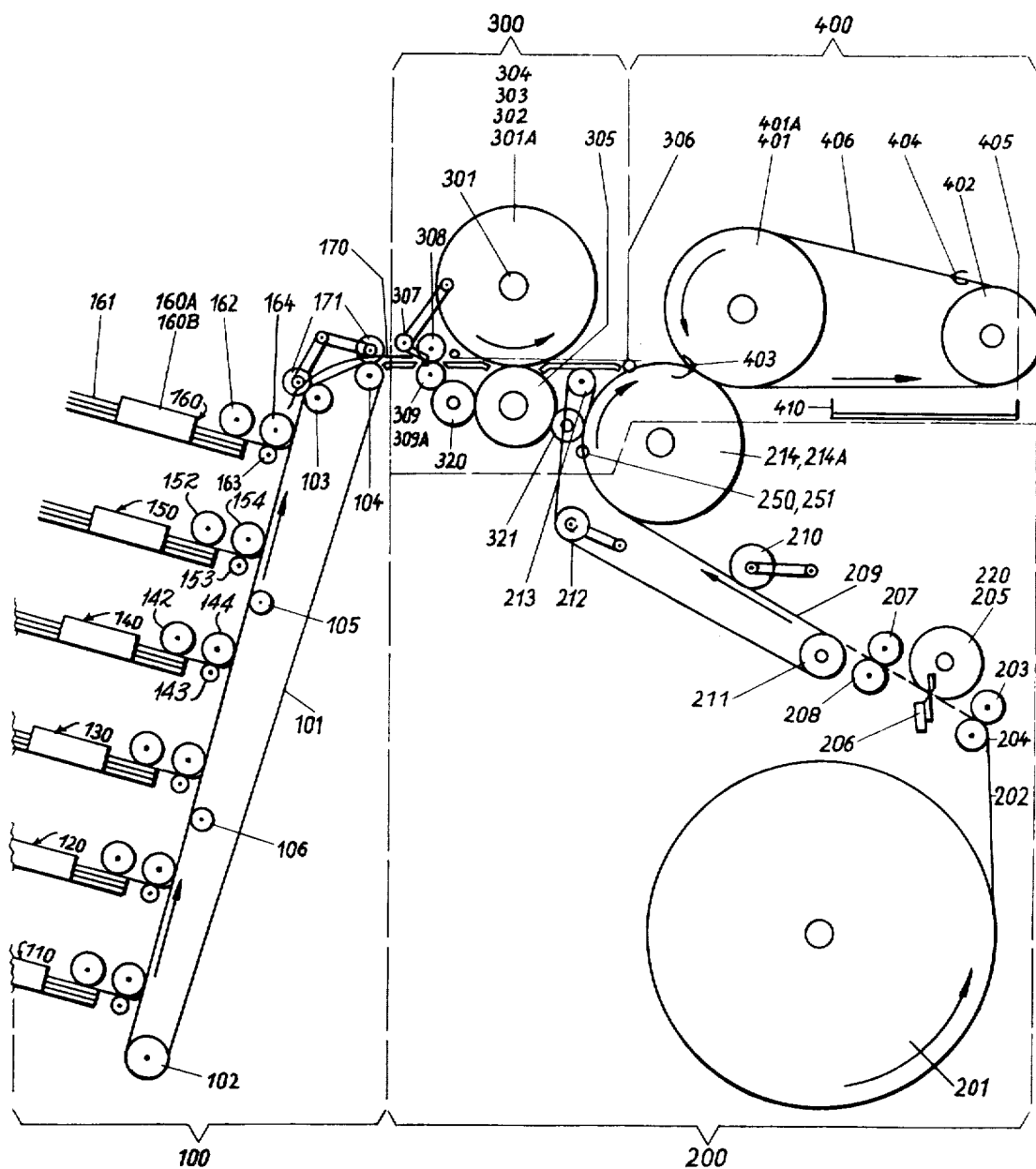


FIG. 1

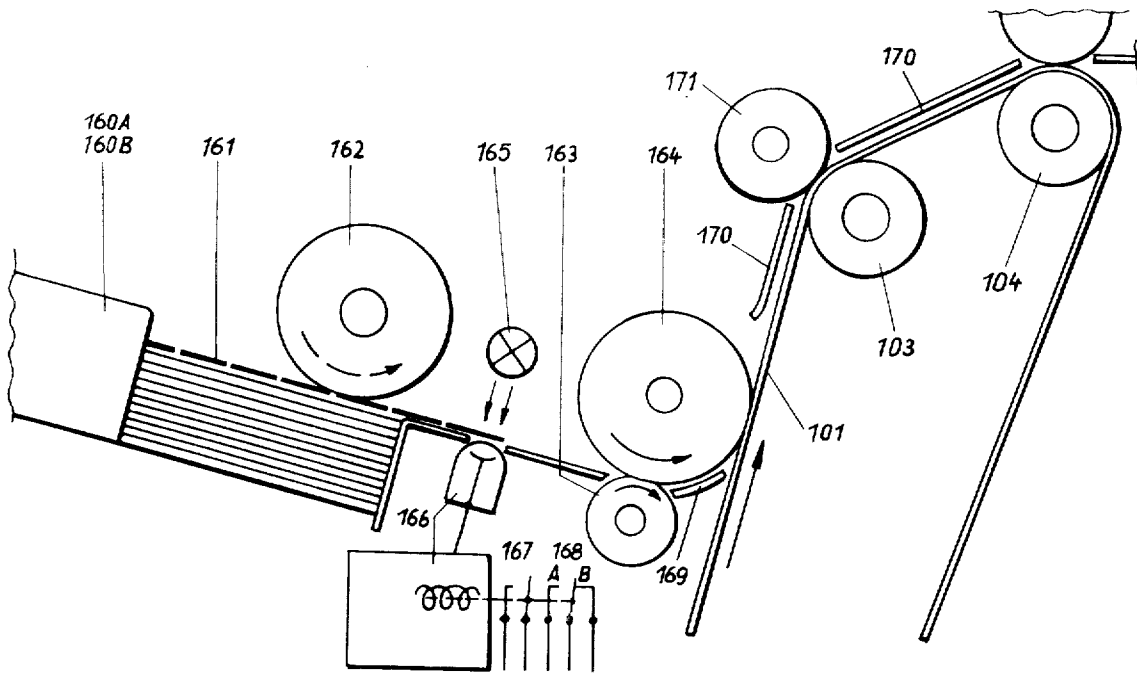


FIG. 2

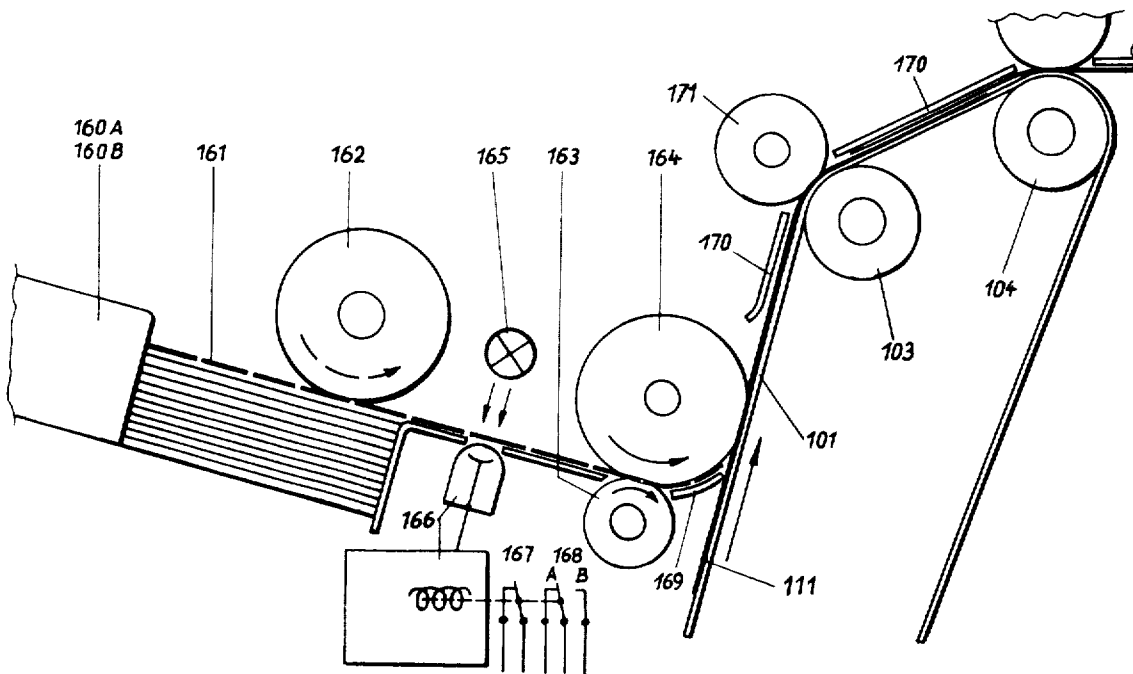


FIG. 3

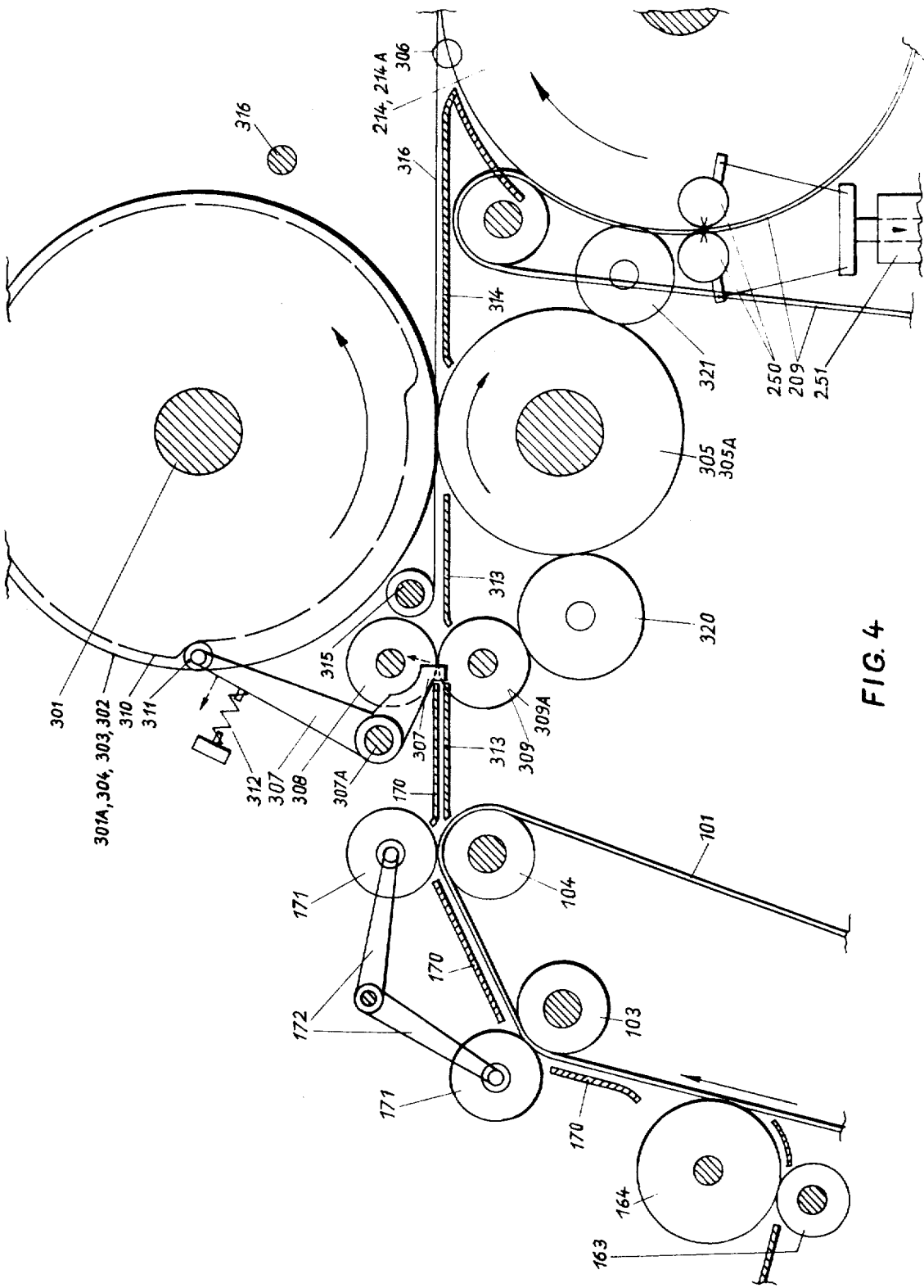


FIG. 4

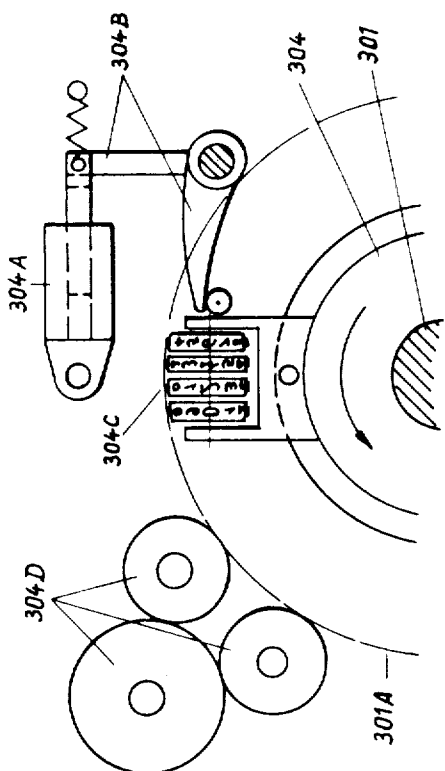


FIG. 5

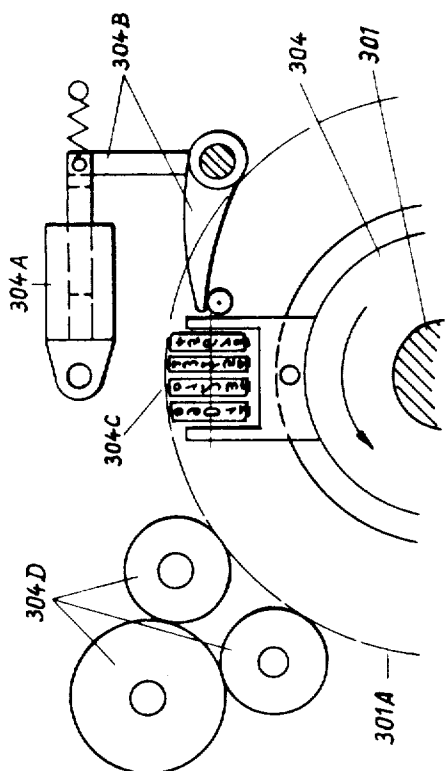


FIG. 6

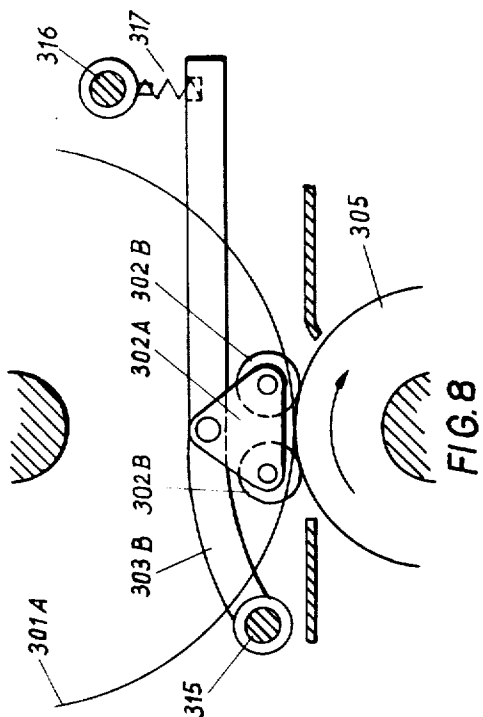


FIG. 7

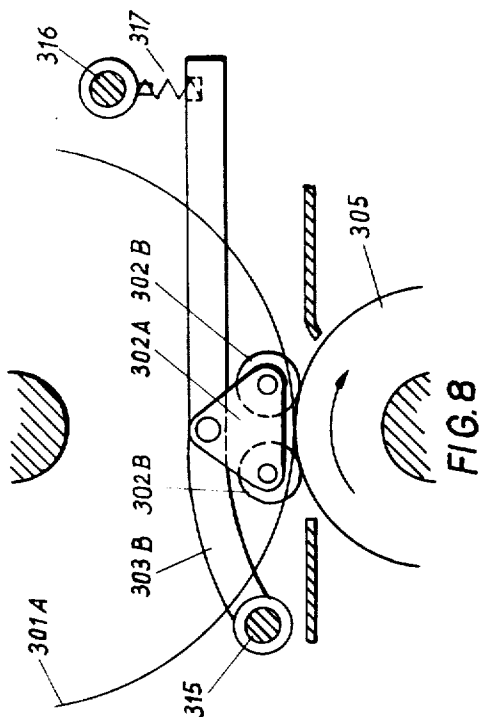


FIG. 8

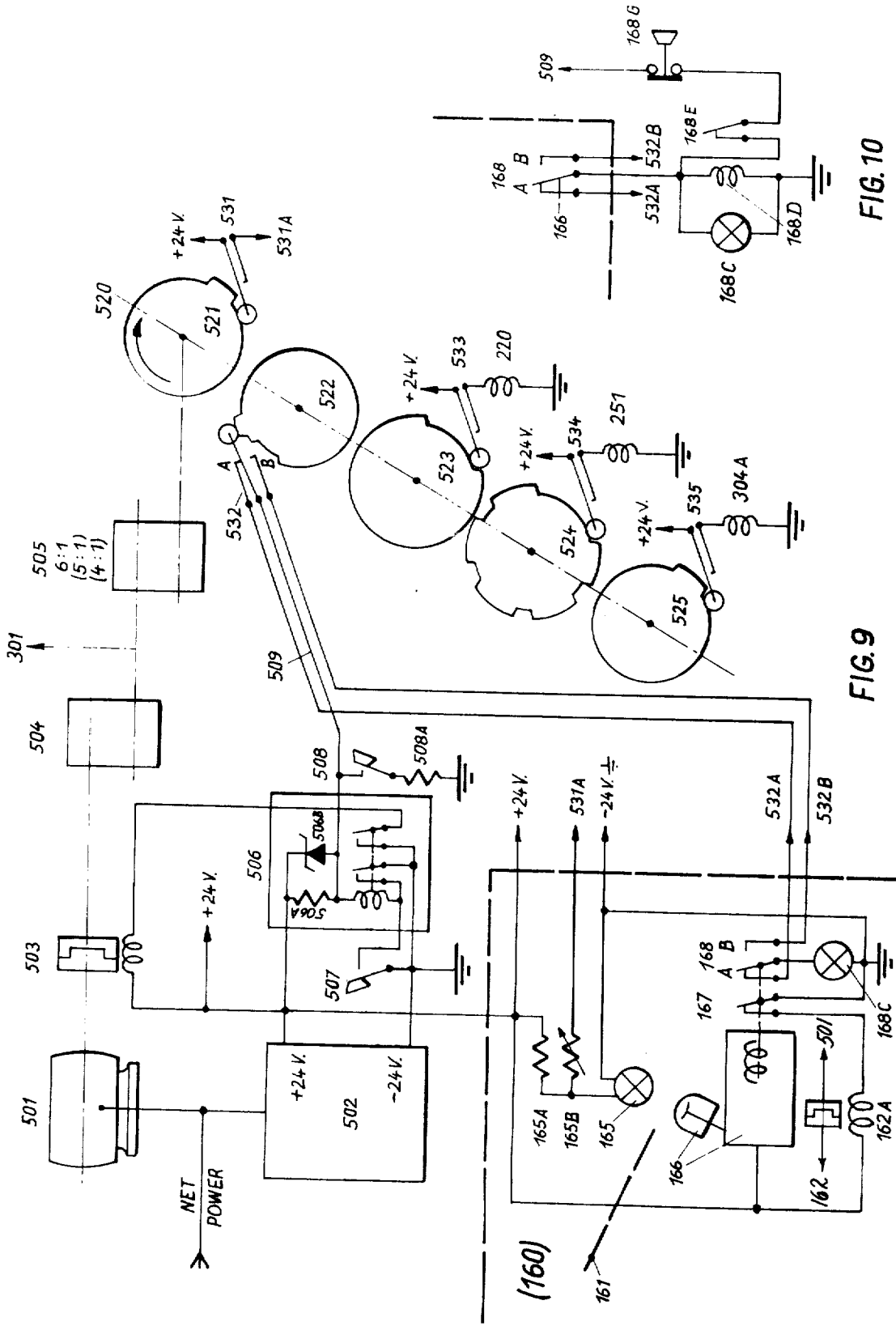


FIG. 10

FIG. 9

METHOD AND APPARATUS FOR PRODUCING COPYING SETS

CROSS REFERENCE TO OTHER APPLICATIONS

The present application is a continuation-in-part of my copending application Ser. No. 237,685, filed Mar. 24, 1972 for "Method and Apparatus for Producing Copying Sets of Writing Paper", now abandoned.

BACKGROUND OF THE INVENTION

Apparatus for automatically making copying sets of interleaved writing and carbon paper sheets are generally known in the art. Such a machine is shown in U.S. Pat. No. 2,621,040 to Rinehart. The present inventor, however, has recognized the need for a modern, high speed, automated copy set making machine that enables the writing sheets to be processed at a single processing station where the sheets can be perforated along tear lines and printed with any desired sequence of numbers before they are joined to carbon sheets along appropriate glue lines.

The need for a compact, high speed machine of this type having a capacity for making copying sets having varying numbers of writing sheets and having suitable malfunction control systems for automatically stopping the machine and indicating the malfunction also has been recognized. Also observed is the need for a machine of this type that is capable of processing writing sheets of all types and weights of paper without the danger of misfeeding and jamming the writing sheets.

SUMMARY OF THE INVENTION

The present invention relates to the method and apparatus for continuously making copying sets of the type mentioned above, wherein any number n if sheets of writing paper may be interleaved and joined with $n-1$ sheets of carbon paper to produce a copy set. The writing sheets normally are supplied from individual supply stacks or bins and the carbon sheets are cut from a single supply roll.

The writing sheets are advanced in a compiled, fanned relationship by a conveyor to a temporary alignment stopping position. The sheets are sequentially and individually accelerated from this position through a processor where the sheets are tear-line perforated and imprinted with suitable information; e.g., serial numbers.

Meanwhile, carbon paper sheets are being individually prepared by cutting them from a continuous roll supply and applying a glue line thereto. One less carbon sheet than writing sheets is prepared automatically so that no carbon paper or glue line is presented between individual copying sets.

The processed writing sheets are then sequentially advanced to the joining station where they are registered with carbon sheets (except one of the writing sheets which is not attached to an underlying carbon sheet) and discharged in joined pairs to a receiver.

In the receiver, the sheets complete a mutual joining process along the glue lines provided at the edge areas of the carbon sheets and completed copying form sets are obtained.

The invention further contemplates the provision of a unique writing sheet misfeed detector system which senses and initiates appropriate action when no sheet is fed to a certain "ready" position or when double sheets are presented at such position. Suitable means

are also provided to insure feeding of all the desired writing sheets to such ready positions before they are inputted to the writing sheet advancing conveyor which takes the sheets to the processor.

Variable numbers of writing sheets and carbon sheets can be run through the machine for making various sized copying sets, and the control functions of the apparatus can be simply synchronized for each throughput by the use of changeable control cams.

DESCRIPTION OF THE DRAWINGS

An example of the preferred embodiments of the apparatus according to the present invention is described in detail hereafter with reference to the accompanying drawing, wherein:

FIG. 1 is a schematic side elevational view of the apparatus of this invention; frames and drive means are not illustrated;

FIG. 2 is a fragmentary enlarged view of a writing sheet supply station and a portion of the sheet advancing means, the sheet being in ready position;

FIG. 3 is a view similar to FIG. 2, with the writing sheet about to be fed to the sheet advancing conveyor means;

FIG. 4 is a sectional view of the writing paper processing unit, the writing paper and carbon sheet interleaving means, and some associated mechanisms;

FIG. 5 is a schematic illustration of a perforating disc arrangement for the writing paper processing station;

FIG. 6 is a view similar to FIG. 5 but shows the alternate use of a perforation-circle-knife rather than a perforating disc;

FIG. 7 is a view similar to FIG. 5 and shows a rotary numbering means for the writing sheet processor;

FIG. 8 is a view similar to FIG. 5 and shows another writing sheet processor detail;

FIG. 9 is a schematic illustration of the cam shaft and control system comprising mechanical and electrical control element; and

FIG. 10 is a circuit diagram showing a self-holding device for storage of a malfunction signal.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The accompanying drawings illustrate preferred embodiments of the present invention used for producing copying sets of quick-separation type. For conciseness, some descriptive and structural terms may be somewhat abbreviated in the text. The term "copying set of quick-separation" may be abbreviated "copy sets" or merely "sets"; the term "writing paper sheet" may be abbreviated to "writing sheet", and the term "carbon paper sheet" may be abbreviated to "carbon sheet". The abbreviated terms, of course, are intended to be equivalent to the complete descriptive phrases in the present description.

As illustrated in FIG. 1, the preferred apparatus embodying the invention generally comprises a writing sheet supply or compiling unit 100, a carbon paper supply and preparing unit 200, a writing sheet processing unit 300, and a chains-gripper output 400. All parts are driven by a common main drive. The flow of power between the main motor and gearing is led via an electromagnetic clutch which will be described below and which enables immediate starting and stopping of the operation by electrical control means of the control system shown in FIG. 9. The shaft 301 which supports

multiple processing cylinders 302, 303, and 304 is termed a "one-revolution-shaft", meaning that all revolution numbers and all conveying speeds later mentioned are related to and synchronized relative to this shaft. During one revolution of shaft 301, for example, one writing sheet is conveyed, processed and joined with one carbon sheet, except that the preparing of carbon sheets will be interrupted after finishing each set so that a six-part set, for example, will consist of six writing sheets and five carbon sheets, as is conventional.

According to the invention, the production of the form sets is performed by joining n number of individual writing sheets, delivered from stacks of the supply component 100, with $n-1$ number of individual carbon sheets, delivered from the carbon paper unit 200, at position 306, arranged with the carbon sheet below and the writing sheet over the carbon sheet and discharging both sheets onto the collecting plate 410 by means of the chains-gripper output 400. The desired processing of the writing sheets, such as perforating the top margins thereof and numbering or otherwise printing each sheet, is performed at the processing unit 300; needed preparing of carbon sheets, such as unwinding a web 202, cross cutting the web into individual carbon sheets, and the lay-on of a double-side glue line, is performed at the carbon paper preparing unit 200. Sequentially and simultaneously with the number of revolutions of the shaft 301, the operating steps of producing, for example, six-part sets are: 1. Conveying, processing, and discharging on plate 410 a first writing sheet from the writing sheet supply station 160 without a carbon sheet, meaning, carbon paper unit 200 and the glueing device 250 are closed during the initial step; i.e., the first revolution of the shaft 301.

2. Conveying, processing of one writing sheet from the writing sheet supply station 150, and joining same to one prepared carbon sheet and discharging both onto the plate 410 on writing sheet from station 160, which is already positioned on the collecting plate 410.

3. - 6. Analogous operations corresponding to step (2) are carried out, but writing sheets are sequentially drawn from stations 140, 130, 120, and 110.

On the collecting plate 410, all sheets are discharged one upon another, and their mutual pressure completes the bonding of the sheets of the forms to each other. In this way, after 6 revolutions of the shaft 301, 6 steps are performed and one 6-part set is finished. Operation continues without interruption back through step (1). Since step (1) always is carried out without a carbon sheet, the produced sets are bonded within themselves but each set is separate from the next adjoining set.

Operation will be continued to obtain a desired number of sets, for example 25 sets, then operation may be interrupted and the built-up stack of sets removed by hand from the collecting plate 410. Quantities of 25 sets at 6-part operation or, for example, 50 sets at 4-parts or 3-part operation are usually stacked alternatively for the purpose of balancing the different thickness of top and bottom edges. For this reason the mentioned quantities are sufficiently large and descending the collecting plate 410 is not needed. However, the collecting plate 410 may be automatically descended if desired by any known means. For example, this arrangement may be useful when it is desired to simply compile sheets of writing paper alone.

WRITING SHEET SUPPLY AND ADVANCING COMPONENT

In FIG. 1 is shown schematically a writing sheet supply unit 100, with 6 writing sheet supply stations, which enables production of 6-part sets. Any other number of n stations can be used in accordance with the invention, and the below described control system will be adaptable to n numbers of writing sheets with supply stations or bins 160, 150, 140, 130, 120, and 110, etc. for the number of writing sheets desired.

The writing sheet supply stations 160, 150, are preferably arranged on a frame inclined to a vertical direction. A writing sheet advancing conveyor belt 101 is carried on rolls 102, 103, 104, the bearings of which are mounted also on this frame. The conveyor belt 101 runs in the direction indicated by the arrows and close to the conveyor feed rolls 164, 154, so that the feed rolls 164, 154, contact the conveyor belt whereby the writing sheets conveyed along 101 are maintained in contact with the belt. The counter rollers 105, 106 maintain the belt in a taut condition. A guide 170 and counter rolls 171 assure correct running of the compiled sheet sequence to the processing unit. The conveyor belt consists preferably of three plastic tapes with a width of approximately $1\frac{1}{4}$ inches, arranged side by side and spaced on $3\frac{1}{2}$ inch centers. The number of individual rolls 102-106 corresponds to the number of plastic tapes. The rolls are slightly crowned to maintain correct running of the tapes. The rolls 104 are the drive rolls for the conveyor belt. The writing sheet feed rolls 164/163, 154/153, ... are also provided in a number corresponding to the number of plastic tapes. The rolls 164, 154, are driven.

The spaces between stations are equal and approximately 25% smaller than the width of the writing sheets, the width being the short edge (across the top edge) of the writing sheets. The lines 161 schematically represent the short edges of stacks of writing sheets, meaning the sheets are supplied and conveyed in generally normal directions with respect to the long edges, i.e. the height, of the writing sheets.

All supply stations are of the same construction. Each one, for example, (referring to station 160) comprises a stack or a bin of writing sheets 161 held in place by guides 160 A, 160 B; a rotary separator 162, which may be any well-known friction or suction type and the rubber-coated feed rolls 163, 164. As shown in FIG. 2, between the separator 162 and feed rolls 163, 164, an electrooptical responsive control element is provided comprising, for example, a light source 164 which may emit a light beam in the visible or infra-red spectrum, and a radiant energy sensitive receiver and control means 166. The control unit 166 controls on-off switch 167 and a change-over switch 168. The light intensity of 165 is normally just sufficient to excite 166, meaning sufficient to cause movement of switches 167 and 168, which will be described later in connection with FIG. 9. The peripheral speed of conveyor feed rolls 163, 164 and the conveying speed of belt 101 is one writing paper feed station space per one revolution of shaft 301, and, moreover these parts run constantly. The shafts of the rotary separators 162, ... are connected via electromagnetic clutches 162 A, 152 A, ... (FIG. 9) to the main drive. Therefore, the separators are actuated only when the clutches 162 A, ... are electrically activated. This will be accomplished by closing

the on-off switch 167, whereby the drive or stop of the separators depends on the light intensity transferred from the light sources 165 to the light-sensitive receivers 166. The circumferential speed of the separators 162 is approximately four-tenths of the conveying speed of the conveyor belt 101 with respect to the conveyor feed rolls 163, 164.

Assuming that all the bins at the writing stations are filled with writing sheets, the normal intensity of light 165 reaches the light-sensitive receivers 166, 156, ... which causes closing of switches 167, ... and hence actuation of the separators. Writing sheets of all stations will be separated and advanced until they interrupt the electrooptical circuit between the light source 165 and the control means 166. This effects deactivation of the separator clutches which disengages the drive means to the separators 162. This results in stoppage of the writing sheet advance at the ready position shown in FIG. 2. Writing sheets that are immediately separated will reach this position in a period of time determined by the ratio of space between the separators and the light paths and the circumferential speed of the separators. However, writing sheets which slightly adhere on the stacks cause some slippage of the separators thereon and will reach in most cases the electrooptical circuit interrupting position with a slight delay. The invention provides a short correction interval (described below) to avoid misfeed signal errors caused by slightly late separated writing sheets.

After this short correction interval, light intensity of 165 will be increased by means of the control system to such a value that light lost by a writing sheet positioned in the light path will be equalized or offset. This will cause the separators to advance the writing sheets to the conveyor feed rolls 163, 164, ... which advance the writing sheets caught in their nips and lead them via guides 169, 159, ... onto the conveyor belt 101. The writing sheets will reach the conveyor in a fanned-out sheet sequence (FIG. 3) with the leading edges of the sheets spaced apart thereon a desired amount. The increased light intensity may be suspended after the writing sheets are caught by the feed rolls 163, 164, ... The overlapping of the fanned writing sheet sequence on conveyor 101 is roughly equal to the difference between the length of the short edges of the writing sheets and the space between the supply stations along the conveyor.

When the writing sheets of the above described sheet feeding sequence have left the light paths 165, 166, ... the interruption of light is ended, and the separators will be actuated again. Writing sheets from all stations will be again separated and advanced to the ready position. Writing sheets remain here until the next increase of light intensity continues the operation. The proper timing and phasing of light intensity increase is somewhat in advance of the ratio of the distance between the light path of the compiling station 160 and the feed rolls 308, 309 and the conveying speed in this space. Each following light increase has to be effected after exactly 6 revolutions of shaft 301. Thus, the sheet sequences will always be in succession, with the same overlapping as occurred with the first group of sheets advanced on the conveyor. In case of operating in a 5-part mode as opposed to a 4-part mode, light increasing has to be effected after exactly 5 revolutions of shaft 301 as opposed to 4 revolutions of the shaft. In this way, at the outlet of the supply and advancing compo-

nents 104/171 an endless sequence of groups of writing sheets is obtained, ready for further processing. The spacing between the leading edge of the last sheet of one group and the first sheet of the succeeding group is normally equal.

Initiation of the feeding sequences from the ready position by increasing the light intensity offers the possibility of applying an effective malfunction detection system at the writing sheet supply component. Malfunctions which are not self-corrected in the "correction" interval before the light intensity is increased will, by means of the later described control system, result in an interruption of the drive to the apparatus. The apparatus will be stopped immediately before a fault is irreparable. The station at which a malfunction occurs will be indicated by the lighting up of a signal lamp. The operator can discover, if the paper supply of a supply station is empty and he can distinguish with reference to the operating phase of the apparatus which actuation was stopped, if there are no separated sheets at the indicated station, or if there are two or more writing sheets (i.e., double feed) separated by the separator 162. After refilling an empty supply bin or by correction of the malfunction, operation of the apparatus can be resumed.

For this purpose, the instantaneous operating condition of the separators which are established by the change-over switch 168, ... and the on-off switches 167, ... will be compared with a reference pattern at the control system. For example, running of a separator at approximately 0.01 seconds before light increasing, means that no writing sheet was separated and advanced to ready position or that the paper supply of the respective station is empty; no running of a separator after increasing the light intensity indicates that two or more sheets are separated at the respective supply station.

The degree to which the light intensity must be increased for the purpose of detecting a multiple sheet feeding situation may be adjusted to the light absorption capacity of the particular type of paper at each station. This will be done electrically as will be described below in connection with the control system illustrated in FIG. 9.

For detecting the presence of a single sheet of writing paper in the light path of the electrooptical sheet sensing system, a relatively weak light is only required, being just of sufficient intensity to be sensed by the radiant energy receiver system 166. This weak light intensity is called "base intensity" and must always be available during operation of the apparatus. For sensing if two or more writing sheets are positioned in the light path, the light intensity increase has to be adjusted to somewhat more than the light absorption capacity of a single sheet of writing paper and to a somewhat less extent than the light absorption capacity of two writing sheets. It is to be seen that the permitted range is wide enough to eliminate undue influence due to slight variations of paper thickness and color. The influence of printed matter on the writing sheets is substantially compensated for because all the writing sheets of a particular supply station will have equal information printed thereon. The influence from exterior illumination can be kept insignificant by providing suitable shading for the light receptors against direct radiation.

Visible light, for example, that of glow-lamps will be sufficient for malfunction detection. However, because

the radiation of such glow-lamps consists mainly of invisible radiation in the infra-red range and since the normal light-sensitive receivers have greatest sensitivity also at the infra-red range, the malfunction detection system is substantially independent from exterior illumination influences. This independence can be improved, of course, by using light sources 165 and light-sensitive receivers 166 which are operated exclusively in the infra-red range.

CARBON PAPER UNIT

As shown in FIG. 1, a web of carbon paper 202 is unwound from a carbon paper supply roll 201 and fed into the cross cutting or carbon sheet cutter system 203-208. The width of the web corresponds to the long edge and the length of the web between cuts corresponds to the short edge of individual carbon sheets, obtained at the outlet 207, 208 of the cutter system. One cutting cycle produces one individual carbon sheet; the circumferential speed of revolving parts feeds on carbon sheet per one revolution of cutting cylinder 205. The cross cutting device is a conventional system and is not per se a part of the present invention. Therefore, no more detailed description is made here. To fulfill the requirements of the cutting device, it may be useful to provide well-known unwinding mechanisms, for example, a roll drive, a roll brake, and a constant-tension device.

For the purpose of preparing for each revolution of the one-revolution-shaft 301, one sheet of carbon paper, except for the first revolution per set, the cross cutting device is driven synchronously with the shaft 301 through interconnection of the electromagnetic clutch 220 (schematically shown in FIG. 1 as being associated with roller 205 and schematically shown in FIG. 9 associated with the cam disc 523) Drive transmission details and electromagnetic clutch 220 per se are not actually shown and constitute wellknown systems in the art. According to the invention, at the first revolution of shaft 301, that is, the revolution processing the foremost sheet of each group advanced by the conveyor 101 and the lowest sheet of writing paper belonging to an individual form set, the drive of the cross cutting device is interrupted by de-energizing the electromagnetic clutch 220. For the example of producing 6-part sets, at the following 5 revolutions of the shaft 301, the cross cutting device is activated by energizing the electromagnetic clutch 220. De-energizing and energizing the electromagnetic clutch 220 is performed by means of the control system shown in FIG. 9.

Individual carbon sheets are turned-out from the cross cutting device by the rolls 207, 208 and travel up the inclined conveyor belt 209 to the mixing cylinder 214. The conveyor belt 209 comprises preferably four plastic tapes with a width of about 1¼ inches, arranged side by side and spaced on about 2¾ inch centers. The mixing cylinder 214 is made of four discs with a width of about 1½ inches and having the same diameter as the outer diameter of interengaging gear wheels or discs 214 A, 301 A, and 401A. The idler rolls 212 are provided with guide barriers to maintain correct running of the tapes. The drive of the conveyor belt 209 is performed by the cylinder disc 214 and its associated gear wheel 214 A. Therefore conveyor belt 209 and the mixing cylinder have a greater conveying speed than the cross cutting device. To speed up the carbon sheets, counterpressure rolls 210 are provided. They catch

front edges of the carbon sheets and frictionally engage them with some slip on the conveyor belt 209 until the back edges of the carbon sheets have left the outlet rolls 207, 208. At this moment, the carbon sheets travel with conveying speed of 209 and successively are clamped between conveyor belt 209 and mixing cylinder 214. Clamping pressure will be adjusted by the idler roll 212. A fast clamping is needed to avoid displacing the advancing carbon sheets while they pass through the glue applying device 250 (FIG. 4).

At the glueing station 250 (FIG. 4), a double side deposit of glue lines is applied along opposite edge areas of the carbon sheets corresponding to the central area between the long edges of the writing and carbon paper sheets. The length of the glue lines will normally be made less than the full top edge width. Glueing starts at approximately one-half inch back from the leading edge and finishes at about one-half inch before the back edge. The glueing device comprises two opposite jets, supplied from a glue tank, for example, arranged some distance higher than the height of the jets. The flow of adhesive may be effected by the pull of gravity, and is controlled by valves actuated by a stroke solenoid 251 (FIGS. 4 and 9). The control system controls the energization of the solenoid 251 in properly timed sequence. The adhesive supply system and the controllable nozzle and glue tank is not per se part of the present invention. However, this invention does utilize a pair of oppositely aimed nozzles 250 to accomplish the adhesive applying operation and applicant is not aware of similar systems of this type.

The discharge of each carbon paper sheet occurs at the interleaving or joining position 306, where the leading edges of individual carbon sheets will meet the leading edges of prepared individual writing sheets in underlying, aligned relationship, with each writing sheet on top of each carbon sheet, except the first writing sheet in a set, as described above.

WRITING SHEET ACCELERATING STATION, PROCESSING UNIT AND OUTPUT SYSTEM

The endless sequence of writing sheets obtained at the outlet of the writing sheet supply and advance component 100 will be divided into individual writing sheets in the order as supplied by the supply stations 160, 150,... The separation and acceleration of individual writing sheets is made simultaneously with alignment in the advancing direction. A sufficient orientation normal to the conveying or advancing direction is effected by the stack guides 160 A and 160 B, etc. Upon each revolution of shaft 301, the front edge of one writing sheet will reach the previously closed alignment stop 307 (FIG. 4). The start of the sheet feeding operation is set somewhat earlier in advance of the processor, therefore a short time interval for alignment is available. That means that the writing sheets may frictionally slip on the conveyor belt 101 and the counter rolls 171, so that the leading edges of the writing sheets rest briefly at the closed alignment stop 307. After the stop 307 is raised, the friction force on each sheet advances same to the nip of the writing sheet accelerating and feed rolls 308, 309 which also constitute a writing paper feed station for the processor 300.

The motion of the front stop 307 is controlled by the cam disc 310 via the actuating arm 307 with the cam follower roll 311 operating against the pressure spring 312, as shown in FIG. 4. Preferably the feed rolls 308

and 309 are composed each of four rubber-coated rolls having an axial length of 1¼ inches and being mounted in spaced apart relationship on the feed roll shafts. The two (or more, if desired) stops 307 will be assembled onto the stop shaft 307 A, operating in the spaces between feed rolls 308, 309. In FIG. 4, one space between the feed rolls 308, 309 is shown with one stop set 307 being in closed position. The feed rolls 308, 309 are driven constantly with a greater conveying speed than that of the conveyor belt 101. Therefore, after raising the stops 307, individual aligned writing sheets are pulled from the fanned sheet sequence and accelerated through the processing cylinders 302-304 and 305 to the joining position 306. Metal sheet guides 313, 314 prevent any dipping of the forward writing sheets. It is advantageous, for example, to provide two leaf-springs 316 fixed on the round bar 315, which may stabilize paper running.

Conveying speeds of the feed rolls 308, 309, of processing cylinders 302-304 and 305, of mixing or joining cylinder 214, and of gripper chain wheels 401 are equal and amount to some more than double the speed of travel of each width of writing sheet per one revolution of the shaft 301. In this way a sufficient time for alignment at the stop 307 is obtained.

Drive gearing of mixing cylinder 214 and chain wheels 401 includes shaft 301 with the gear wheel 301 A engaging the toothed wheels 214 A and 401 A, which have equal gear diameters, and 305 A which has one-half the number of gear teeth of 301 A. Intermediate toothed wheels 320 and 321 are provided to obtain similar rotating directions.

The roller system 305 preferably comprises a shaft and 3 roll elements mounted thereon. They are made preferably of solid metal. The surfaces of the rolls are hardened and ground to a precise diameter corresponding to the diameter of toothed wheel 305 A. The cylinder 302-304 is divided into discs with an effective diameter corresponding to the gear diameter of the toothed wheel 301 A. These discs are mounted concentrically onto shaft 301 and they may be shifted for adjusting and may be fixed after that. A pair of these discs having the reference numeral 302 are rubber-coated and they maintain the forwarding motion of the writing sheets by slight pressure against the cylinder 305. They have a width of about three-eighths inch and are spaced on the shaft normally so that they touch the writing sheets so that they engage the writing sheets about 2 inches apart from the top and bottom edges.

An alternate method for advancing the writing sheets in connection with the cylinder 305 is shown in FIG. 8. A support 302 A with two encased ball bearings 302 B is pivotally mounted on the lever 303 B. The lever is pivotally attached to the round bar 315 and urges the ball bearings by the pressure of spring 317 and the rod 316 against the cylinder 305. Maintaining the advancement of paper by the two ball bearings improves the prevention of adhering of writing sheets after the perforation and numbering of the sheets in the processing unit. In the same manner as the rubber-coated discs 302, a pair of bearing sets will be used.

Processing the writing sheet comprises, for example, line perforating the sheets at about three-fourths inch from the top edges and the numbering of the sheets individually. To carry out the perforation step, the cylinder disc 303 (FIG. 5) is furnished with a steel tape with cutting teeth 303 A which perform the line perforation

by pressure against cylinder 305. Suitable steel tapes with cutting teeth are available in the trade. The method of performing the perforation of course, does not per se comprise this invention.

Another perforation system is shown in FIG. 6, wherein a perforation-circle-knife 303 C is used. The rotary perforating tool 303 C is mounted in a manner similar to the support or holder 302 A, shown in FIG. 8. The pressure spring 317 for this application must be somewhat stronger, however. Using a perforation-circle-knife according to FIG. 6 may be preferred because a quick tool change is possible, though the time of sufficient operation will be shorter than that of the cutting teeth tape, since the cutting circumference is smaller.

To perform numbering of the individual writing sheets, a rotary numbering machine of suitable type, many of which are well-known in the art, will be mounted onto the disc 304 (FIG. 7). Adjusting of the number printing position will be made by shifting the disc 304 on shaft 301 and turning the numbering machine on the circumference of the disc 304 to the desired position on the writing sheets. The continuous switching of the numbering machine, which is needed after producing one complete set is performed by a lever 304 B, moved from the stroke solenoid 304 A, which will be energized at a suitable time by the control unit. The inking device 304 D required for number printing is of the usual type. Construction of a rotary numbering machine with accessories for continuous switching and inking is per se not part of the present invention. Suitable appliances to perform rotary numbering are customary in trade; therefore it is only schematically presented in FIG. 7 and not described in more detail. Processing of the writing sheets normally comprises perforating the sheets along a tear line and individual numbering of the writing sheets of each set. Hence, at the outlet of the processing unit, prepared writing sheets travel to the joining position 306.

A significant structural and process advantage is realized by the described writing sheet supply and advancing/processing arrangement, in that a single processor can prepare sequential writing sheets which are to be joined in a single form set. Thus, the writing sheets can be individually numbered or otherwise printed in any desired sequence and individually perforated in accordance with a desired pattern by a single processing station 300, located between the writing sheet supply means 100 and the carbon sheet joining location 306. Since the carbon sheets are joined to the writing sheets at a later point in time than the writing sheet processing operation, the carbon sheets in no way interfere with the processing operation.

Corresponding to the general description, prepared writing sheets and prepared carbon sheets, the latter excepted at the first step of one set, will meet at position 306. Since both sheets are advanced with the same conveying speed, they advance synchronously and reach the opened grippers of the gripper bar 403. With output chains 406 continuously operating between chain wheels 401 and 402, the grippers will be closed after engaging the sheets and will output them by release of the grippers at position 405. The pairs of sheets are thereby discharged onto the collecting plate 410, one upon another. To obtain a sufficiently large distance between the mixing cylinder 214 and the collecting plate 410, the length of the chains is made twice the

circumference of the cylinders 302-304. Therefore, two identical gripper bars must be provided on the chains 406 which operate in a similar manner. The construction of the chains gripper output is of a type well-known in the art, wherefore only some of the details are mentioned here: a pair of chains bearing two gripper bars will normally be provided. The gripper bars are assembled preferably with 4 or 5 gripper pairs. Motion of the grippers is perfected by each gripper bar via an actuating arm with a cam follower roll engaging a fixed cam which controls the gripper closing after the front edges of the sheets will have entered into the gripper openings. After lifting the grippers at position 405, they will remain opened until the next closing in advance of the position 306.

CONTROL SYSTEM

According to the present invention, the control of the primary functions of the apparatus of the invention is obtained by various electrical switch means, some of which are operated through a control cam system as shown in FIG. 9.

With reference to FIG. 9 a main drive motor 501 receives net power from the electrical supply mains and drives the one-revolution-shaft (FIG. 1) of the processing unit through suitable drive shafting. Between the motor 501 and shaft 301, an electromagnetically operated clutch 503 and reduction gearing 504 is provided. Motor 501 is also connected by shafting and gearing 505 to a cam shaft 520 having thereon control cams 521, 522, 523, 524, and 525. To enable control of the apparatus during the manufacture of form sets having varying number of sheets therein, the gearing 505 is variable and the cam discs 521-525 are also variable in the sense that they may be interchanged when desired by cam elements having suitable different contours thereon. Alternatively, the entire cam shaft 520 with the cam discs fixed thereon may be interchangeable for a different cam shaft having a differently contoured set of discs thereof. Still another method of obtaining the desired control functions which synchronize the various operations of the machine involves using a different set of gears between the gearing 505 and the cam shaft 520, each set of gears providing the desired drive ratio between the shaft 301 and the cam shaft 520.

A control power supply 502 transforms the net power from the mains to a 24 volt, direct current control power supply.

The electromagnetic clutch 503 connects motor 501 to the machine drive train when the clutch magnet is energized. Energization of the clutch is normally accomplished by closing "start" switch 507 which energizes a self holding relay system 506 to complete the circuit through the clutch. The clutch is released by closing "stop" switch 508 which grounds the current through resistor 508 A.

As indicated previously, each writing sheet supply station is provided with a sheet feeding or separator motor or other suitable actuation 162 (see FIG. 2) which normally operates to separate a sheet 161 and feed same to a position between the light source 165 and the light sensing cell 166. Upon interruption of the light path between the light source and the sensing cell, the switches 167 and 168 are opened by the solenoid means associated with the sensing cell 166 to stop operation of the separator 162. Also, as indicated earlier, increase of intensity of the light source 165 overcomes

the interfering effect of the sheet 161 in the light path and causes closing of switches 167, 168 whereupon the separator 162 is activated to feed sheet 161 to the nip of rollers 163, 164. In FIG. 9, the control system for achieving these functions is illustrated. In the lower left hand corner of FIG. 9 a representative writing sheet supply station 160 is illustrated and shows sheet 161 outside the light path between light source 165 and the sensing/control means 166. The light source 165 is normally energized from the control power supply through a fixed resistor 165 A which may be selected to provide a sufficient intensity of light at light source 165 to energize means 166 for holding switches 167 and 168 in their closed positions as illustrated. Electromagnetic clutch 162 A which connects the drive motor 501 to the separator 162 is energized by the closing of switch 167 as shown. Sheet 161 therefore, under normal conditions, advances to a position interrupting the light path between 165 and the receptor cell 166. This results in switch 167 being opened and clutch 162 A being de-energized. The separator 162 stops at this point until the light intensity of 165 is increased. The increase of light intensity of 165 is controlled through the cam element 521 on cam shaft 520. The cam 521 synchronizes the operation of switch 531 with the one-revolution processor shaft 301 whereby a parallel resistor 165 B is sequentially cut into and out of the circuit to the light 165. Thus, at a proper moment in time as determined by the cam 521, the light intensity 165 is increased and the separator 162 advances sheet 161 to the rollers 163, 164.

A malfunction indicator light 168 C is associated with the writing sheet supply station 160. Energization of this light and automatic disengagement of motor 501 from the drive train of the machine is accomplished as follows. The relative angular position of a mode coordinating cam 522 on cam shaft 520 determines the relative position (A or B) of a switch 532 having an input line 509 and output lines 532 A, 532 B. Lamp 168 C may thus be energized with switch 168 in the A or B position at certain points in the operating cycle of the cam 522. Thus, if switch 532 is closed in the A position as illustrated, with sheet 161 not having interrupted the light path between 165 and 166, the malfunction signal light 168 C will be energized to indicate that the sheet 161 is not in the proper position. The relationship between the position of cam 522 and sheet 161 is scheduled so that a suitable delay time is allowed for sheet 161 to reach the light interrupting position where it belongs before the signal lamp 168 C is activated. Upon activation of signal lamp 168 C, the circuit to the self-holding relay 506 is grounded through lamp 168 C with the result being the same as if stop switch 508 was closed, resulting in disengagement of the motor 501 from the drive shaft beyond clutch 503. Assuming that the sheet 161 has advanced to its proper light interrupting position, the switches 167 and 168A are opened and the activation of switch 532A by cam 522 is of no consequence with respect to the signal light 168 C and the clutch 503.

The position B of switch 532 is the double sheet testing position. If two or more sheets 161 should be advanced to the light interrupting position between light source 165 and the light sensor apparatus 166, insufficient light intensity will reach the sensing apparatus 166 upon the occurrence of the increase in intensity of light source 165. As can be seen from the relative angu-

lar positions of cams 521 and 522, the double sheet test will be made just after the light intensity is increased. At this point the switch 532 is in the B position resulting in the supply stop current to the switch 168 B. If the sensor 166 does not receive the increased light intensity switch 168 will be in the 168 B position and lamp 168 C will be activated and clutch 503 disengaged. It should be noted that the light sensor apparatus 166 normally holds the switches 167, 168 in either the left or right positions, depending whether the sensing apparatus 166 detects the light from source 165 or not, respectively. That is, the switches 167, 168 are in the position illustrated in FIG. 9 when the light sensing apparatus 166 is activated by light source 165. In the absence of light energy, the sensor apparatus 166 holds switches 167, 168 in the opposite or B position of switch 168.

The cam 523 on cam shaft 520 controls the position of microswitch 533 which controls energization to the coil 220 of an electromagnetic clutch connecting shaft 301 to the cutting cylinder 205 (FIG. 1) at the carbon sheet cross cutting device. Likewise, switch 534 actuated by cam 524 controls energization of the solenoid 251 which controls the valves of the glueing device 250 (FIG. 1). The switch 535 actuated by cam 525 controls energization of the solenoid 304 A which controls in turn the continuous-switching of the writing sheet numbering device 304 C (FIG. 7).

FIG. 10 shows a self-holding device for obtaining constant energization of lamp 168 C despite a very rapid closing and opening of switch 532 A or B in the malfunction mode (i.e., signal lamp 168C energized, switch 168 A or B closed). The desirability of a circuit such as shown in FIG. 10 becomes apparent when one considers that the disengagement of clutch 503, while releasing the drive motor 501 from the rest of the machine, does not immediately result in stopping of the apparatus due to inertia of the various moving parts. Therefore, even though switch 532 A or B may be closed by cam 522 and the clutch 503 disengaged upon the occurrence of a malfunction, inertia of the parts may cause switch 532 to immediately open with the result that lamp 168 C would be extinguished and no signal light would be available to show the location of the malfunction in the writing sheet supply system. Accordingly, in FIG. 10 a circuit is shown whereby even momentary closing of switch 532 A or B during a sheet misfeed situation, will result in lamp 168 C being continuously illuminated. Lamp 168 C is connected in parallel with a solenoid 168 D which in turn activates a switch 168 E. Activation of solenoid 168 D such as when a potential is applied between switch 168 A or B and ground (occurrence of a misfeed) results in the closing of switch 168 E where it remains, resulting in lamp 168 C being activated directly by current received from line 509. The current from line 509 not only holds switch 168 E closed, but continuously activates lamp 168 C. In this position, the relative opening or closing of switch 168 A or B will not affect the illumination of lamp 168 C. Upon the location and correction of the misfeed in the writing paper supply station, the reset switch 168 G may be pressed to effect the opening of switch 168 E and the resetting of the circuit shown in FIG. 10 in preparation for the next misfeed sensing cycle. This enables the check time for malfunction detection to be kept at a very short interval. It should also be noted that the line current to line 509 in

FIG. 10 is obtained from the relay circuit 506. To prevent excessive voltage losses due to the energization of multiple signal lamps 168 C upon the occurrence of a multiplicity of sheet misfeeds, a Z-diode 506 B may be provided within the circuit of the relay 506 to limit the voltage loss to the Z-voltage of the diode.

It should be understood that the illustration in FIG. 9 assumes that a six-part form set is to be produced. The step down gear ratio at the gear box 505 therefore would be 6 to 1. If a five or four-part set was desired, then the step down gear ratio would be respectively 5 to 1 or 4 to 1. Alternatively, as described above the cam shaft 520 and the cam discs 521-525 may be made interchangeable to obtain a suitable synchronization of the control functions with the processor shaft 301.

There may be a cam disc 521 for each of the supply stations 160, 150, ... but preferably the single disc 521 is used with line 531A connected to each lamp 165, 155,...in parallel, through resistors 165 B, etc. The number of lobes provided on the cam disc 524 which controls the glueing device 250 will be one less than the number of n writing sheets in the produced form sets. This will prevent activation of the glueing device 250 in the absence of a carbon paper sheet being fed there-through at the beginning of each form set. This also corresponds to the withholding of the feeding of a carbon paper sheet which results once during the preparation of each form set by interruption of the carbon paper cross cutter 205 in accordance with the angular position of cam 523. That is, cam 523 interrupts the operation of the carbon paper cross cutting means 205 once during the preparation of each form set.

It should also be observed that if certain writing sheet supply stations are not filled with paper during the manufacture of form sets containing fewer writing sheets than there are supply stations 160, 150, ... , than suitable means will be provided to deactivate the sheet feeding and malfunction detecting circuits in each of the un-used writing paper feed supply bins. The machine may also be adjusted for producing three-part or two-part form sets by utilizing the apparatus as if a six-part form set were to be made, but filling the writing sheet supply station 160, 150, and 140 with sheets 1, 2, and 3 of the form sets and filling supply stations 130, 120, and 110 also with sheets 1, 2, and 3 of the form set. With this arrangement, the cam disc 523 would be changed so that the cutting and advancing of the carbon paper sheets would be interrupted twice during the processing of the six sheets. Likewise, cam disc 524 would also be changed accordingly.

What is claimed is:

1. A method for continuously producing quick separating copying sets having a plurality of n sheets of writing paper and $n-1$ sheets of carbon paper interleaved between the writing paper, the sheets of each set being joined along a bonded edge area, comprising:
 - a. Supplying continuously to a writing paper feed station, at timed intervals, groups of n aligned sheets of writing paper, the sheets of each group having their forward edges in spaced relationship with respect to each other along their direction of feed;
 - b. Accelerating and feeding from said feed station one writing paper sheet at a time from each of said writing paper groups to a writing sheet processing station at timed intervals, and processing each of said writing paper sheets;

- c. Advancing the processed writing paper sheets to a writing paper and carbon paper interleaving station, a single sheet at a time, in timed sequence with the processing of said sheets;
 - d. Supplying carbon paper from continuous roll stock to a carbon paper cutting and feeding station;
 - e. Sequentially cutting $n-1$ sheets of carbon paper from said continuous roll stock in timed relationship with respect to the writing paper feed and processing operation;
 - f. Feeding said carbon paper sheets to an adhesive applying station for adhesively preparing each carbon paper sheet by applying a glue line thereto along both sides of the carbon sheet edge area to be secured to the writing paper in each copying set;
 - g. Advancing each of said adhesively prepared carbon paper sheets sequentially to the carbon paper and writing paper interleaving station in synchronism with the individual writing paper sheet advance thereto, after a first sheet of writing paper in each group of writing paper sheets has passed through the interleaving station, the other writing paper sheets of each group meeting a sheet of adhesively prepared carbon paper in overlaying, aligned relationship to effect a preliminary joining of the $n-1$ writing and carbon paper sheets a pair at a time along mutual edge areas;
 - h. Discharging sequentially the said first sheets of writing paper and the $n-1$ pairs of interleaved writing and carbon paper sheets to a copying set collecting and stacking station;
 - i. Collecting and stacking in aligned, contiguous order and in sequence the discharged first writing paper sheets and the writing and carbon paper sheet pairs so that each first writing paper sheet of a copying set is overlaid with $n-1$ carbon and writing paper pairs, with the lower adhesively prepared edge areas of each carbon sheet of each pair contacting the writing paper sheet below same, whereby each discharged and stacked group of writing paper sheets and the interleaved carbon paper sheets finally are bonded together and form an adhesively joined copying set.
2. The method recited in claim 1, further wherein said writing sheets are sequentially and individually tear-line perforated and printed at said processing station.
3. Apparatus for continuously producing quick separation copying sets having n sheets of writing paper and $n-1$ sheets of carbon paper interleaved between the writing paper sheets, the sheets all being joined along a bonded edge area, comprising:
- a. Means for sequentially supplying and advancing a plurality of writing paper sheets in groups of n generally aligned superposed sheets to a writing sheet accelerating and feeding means, the sheets of each group being arranged so that their leading edges are spaced apart a predetermined distance in the direction of advancement;
 - b. Means for accelerating in timed sequence the individual writing sheets in each group generally in the direction of the advancing motion so that the sheets are sequentially separated from the following sheets in each group in a leading direction with respect to the paper advancing motion;
 - c. Means for processing said individual accelerated writing sheets;

- d. Carbon paper supply means in the form of a continuous roll;
 - e. Means for sequentially cutting $n-1$ sheets of carbon paper of a desired length from said supply roll in timed relationship with said writing paper processing means;
 - f. Means for adhesively preparing said carbon paper sheets sequentially, including means for applying a glue line thereto along both sides of an edge area of each sheet along the edge thereof to be adhesively joined in the final assembled copying set;
 - g. A writing paper and carbon paper interleaving means whereby advancing processed writing sheets may be sequentially brought in contiguous, aligned, overlaying relationship with carbon paper sheets and bonded thereto along a bottom of the bonding edge area of the writing sheets to form writing paper and carbon paper pairs;
 - h. Means for advancing said $n-1$ carbon paper sheets from said cutter means and through said adhesive preparation means to said interleaving means in timed relationship with the processed writing sheet advancements;
 - i. Means for controlling said carbon sheet cutter means and said carbon sheet advancing means whereby foremost sheets of said groups of n sheets of writing paper pass through said interleaver without joining a carbon paper sheet, but the remainder of said writing sheets of each group are joined to carbon paper sheets to form $n-1$ pairs of writing and carbon sheets;
 - j. Means for advancing sequentially from the interleaving means the said foremost sheets of the said groups of n writing sheets and $n-1$ pairs of writing and carbon sheets;
 - k. Means for collecting and stacking said foremost writing sheets and said $n-1$ pairs of writing and carbon sheets in aligned, contiguous and overlaying relationship whereby a lower adhesively prepared edge area of each carbon sheet in the stack contacts and becomes bonded to a writing sheet beneath it to form assembled copying sets having n sheets of writing paper and $n-1$ sheets of carbon paper interleaved between the writing sheets.
4. The apparatus recited in claim 3, further wherein said writing sheet supply means comprises:
- a. A sheet advancing conveyor and means for feeding writing sheets to said conveyor;
 - b. n writing sheet supply bins having separators for sequentially and in timed relationship separating individual writing sheets from stacked supplies in said bins, and feeding said sheets sequentially to an intermediate ready position and to said conveyor feeding means;
 - c. Means for controlling the operation of said separators whereby the writing sheets from the said bins are held at the ready position and subsequently advanced to the conveyor feeding means in timed relationship with said processing means;
 - d. The relationship of said conveyor feeding means and said conveyor being such that simultaneous feeding of writing sheets from all bins results in said writing sheets being disposed on said conveyor in generally aligned, fanned, orientation, with the leading edges of said sheets in the conveying direction being spaced apart a predetermined distance.
5. The apparatus recited in claim 4, further including:

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- a. Electrooptical misfeed detection means for sensing any missing writing sheets at the ready position in said writing paper supply means immediately after the point in time that said separators have completed their initial separation of writing sheets and advanced them to the ready position; 5
- b. Means responsive to said misfeed detection means for indicating the occurrence of a missing writing sheet and its location in the writing sheet supply means; and 10
- c. Means also responsive to said misfeed detection means for ceasing operations of said apparatus upon detection of such misfeed.
- 6. The apparatus recited in claim 5, further including:
 - a. Electrooptical means for detecting the presence of a double sheet feeding at the ready position of said writing sheets prior to the point in time said separators initiate the feeding of said writing sheets to said conveyor feeding means; 15
 - b. Means responsive to said double sheet detector means for indicating the occurrence of a double sheet at the ready position of said writing sheets, and the location of such occurrence; 20
 - c. Means also responsive to said double sheet detector means for ceasing operations of said apparatus upon detection of such double sheet feeding. 25
- 7. The apparatus recited in claim 6, wherein said indicating means includes a self-holding control circuit whereby said indicating means is activated and maintained in the activated position by a momentary control signal responsive to the occurrence of a malfunction. 30
- 8. The apparatus recited in claim 4, wherein said separator control means each comprises:
 - a. A drive means for each separator, said drive means being normally activated during operation of said apparatus; 35

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- b. Means for electrically controlling said drive means comprising a photocell circuit and a switch means controlled by said photocell circuit; said switch means being normally closed when said photocell circuit is uninterrupted and opened when the photocell circuit is interrupted;
- c. Said drive means being deactivated upon opening of said switch means, and activated when said switch means is closed;
- d. Said writing sheets interrupting the photocell circuit when they are advanced to the ready position by said separators when said drive means are activated, whereby the said switches are caused to open and deactivate said drive means.
- 9. The apparatus recited in claim 8, wherein said separator control means further includes means for intensifying illumination in said photocell circuit for overcoming the interrupting effect of a single sheet of writing paper after said writing sheets have been advanced by the separators to the ready position, whereby said switch means are closed and said separator drive means are re-activated to advance said writing sheets to said conveyor feed means, and control means for controlling said intensifying means whereby said intensifying means functions in timed relationship with respect to said writing sheet processing means.
- 10. The apparatus recited in claim 4, further wherein the timed operating relationship of said writing sheet separators, carbon paper cutting means, and carbon paper adhesive preparing means with respect to said processing means is controlled by means of a cam system, the cam system being variable for operating the above recited separators, cutting means, and adhesive preparing means at different timed relationships with respect to said processor. 40

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