Feb. 11, 1969 J. R. WOODSIDE 3,427,655

METHOD FOR PRODUCING COLLATED PRINTED BOOKS

Filed July 15, 1966 Sheet 1 of 4

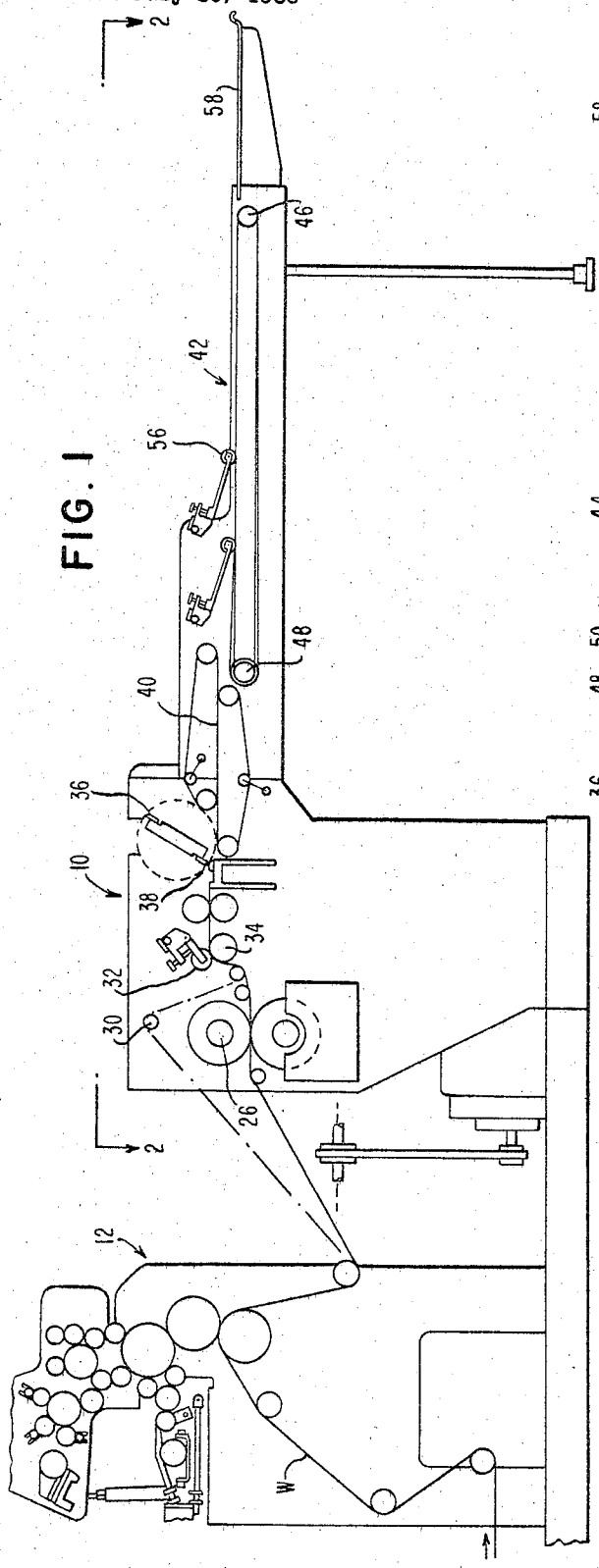


FIG. 1

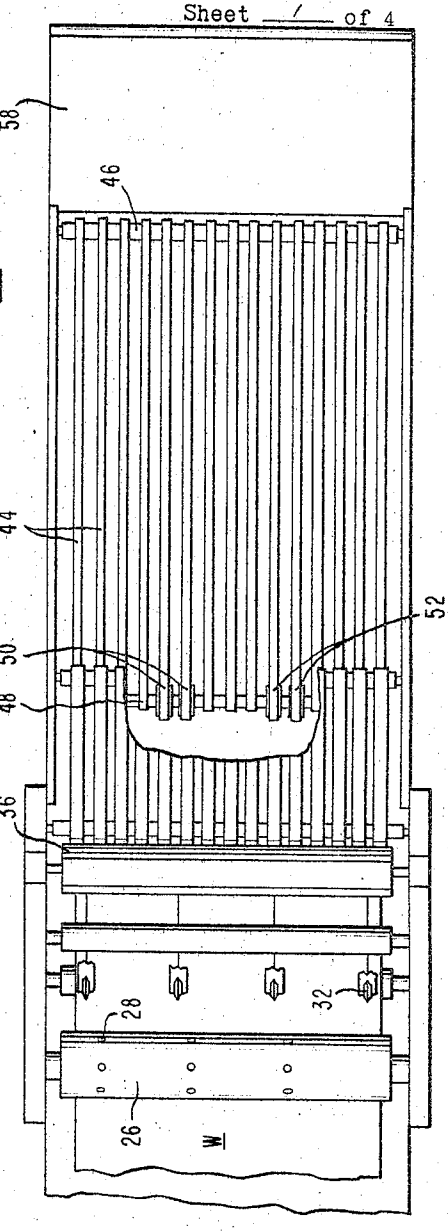


FIG. 2

INVENTOR
JOHN R. WOODSIDE
BY
ATTORNEY

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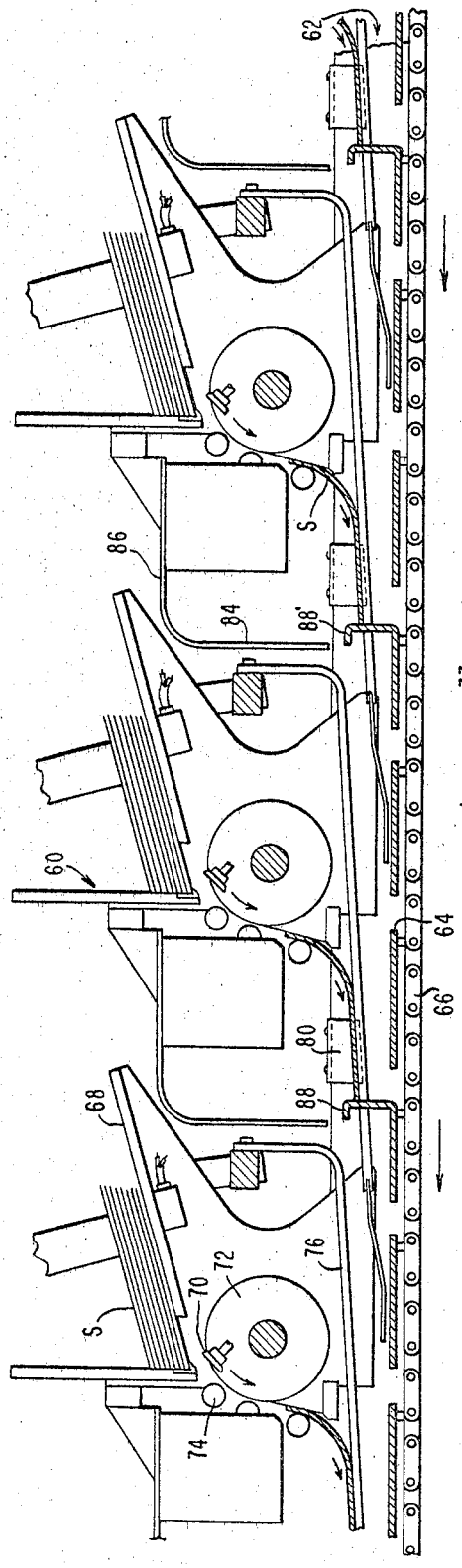


FIG. 3

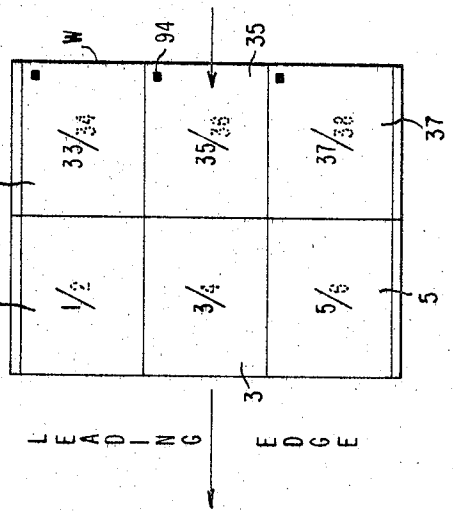


FIG. 4

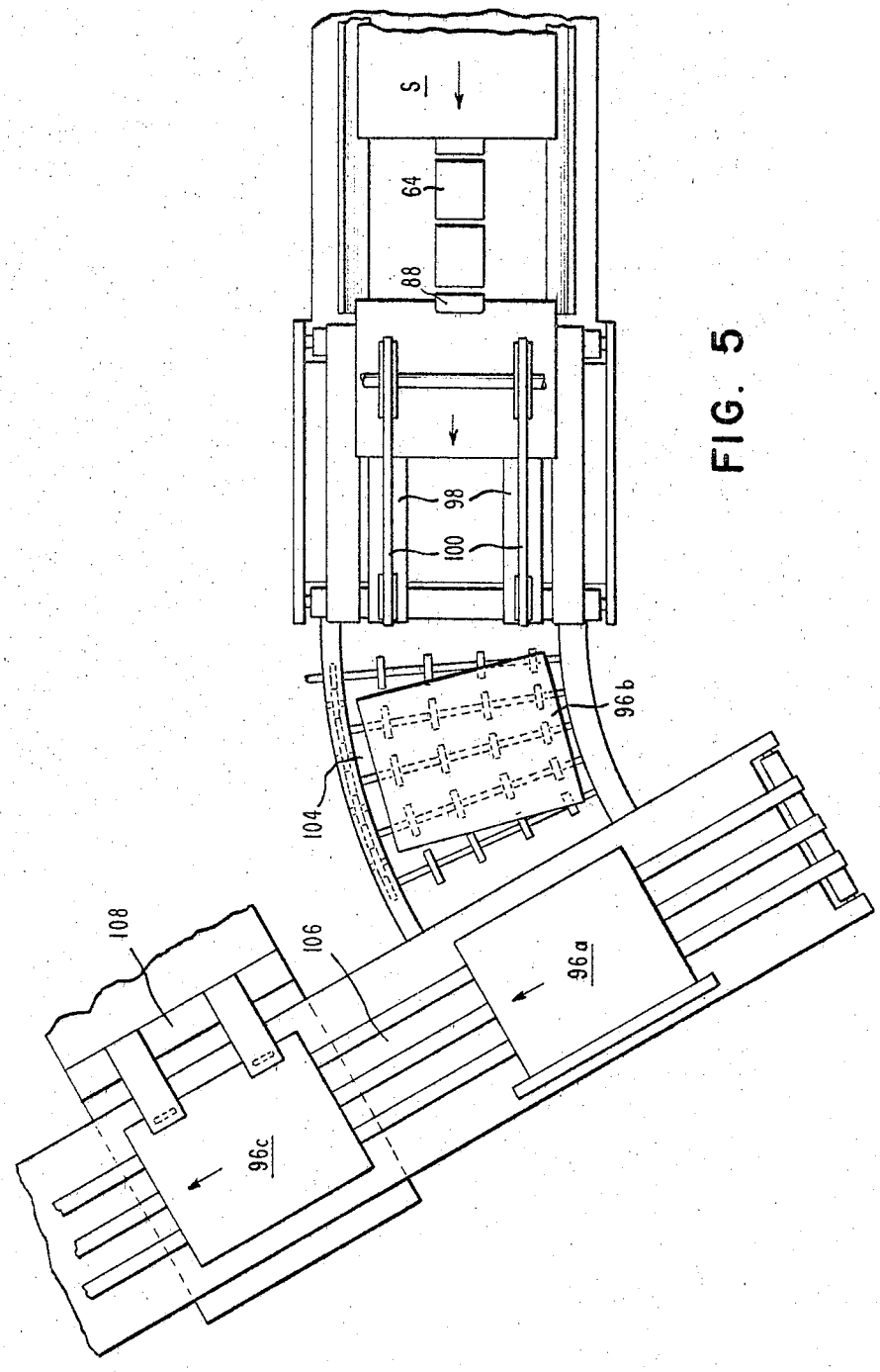


FIG. 5

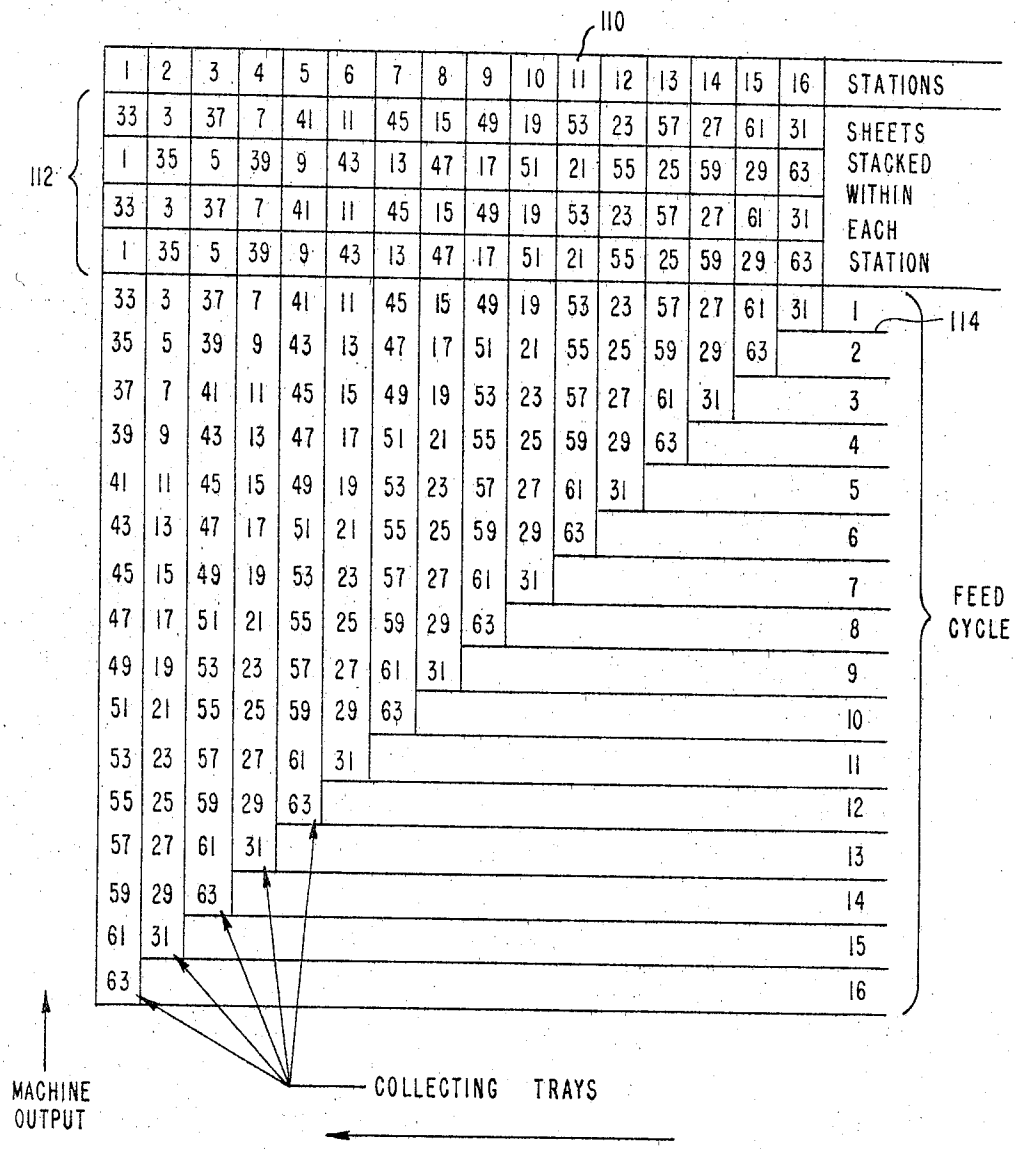

110
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 STATIONS
33 3 37 7 41 11 45 15 49 19 53 23 57 27 61 31
1 35 5 39 9 43 13 47 17 51 21 55 25 59 29 63
33 3 37 7 41 11 45 15 49 19 53 23 57 27 61 31
1 35 5 39 9 43 13 47 17 51 21 55 25 59 29 63
SHEETS STACKED WITHIN EACH STATION
112
114
FEED CYCLE
MACHINE OUTPUT
COLLECTING TRAYS

FIG. 6

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METHOD FOR PRODUCING COLLATED PRINTED BOOKS

John R. Woodside, Orient, N.Y., assignor to International Business Machines Corporation, Armonk, N.Y., a corporation of New York

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U.S. Cl. 270—18 4 Claims
Int. Cl. B41f *13/64;* B65h *39/00, 39/10*

ABSTRACT OF THE DISCLOSURE

A method for manufacturing a book of a predetermined number of collated sheets constituting a definite number of contiguous sections which involves the steps of printing a plurality of non-sequential sheets constituting a set repetitiously on a web, the number of sets so produced being equal to the predetermined number of sheets divided by the definite number of contiguous sections and the number of sheets per set being equal to the definite number of contiguous sections. The sheets of each set have respectively an identical ordered relationship to the sheets of contiguous sections of the book being collated. The sheets are then cut apart and stacked while maintaining the predetermined arrangement thereof. The stacks of non-sequential sheets are then placed in an ordered line for collation wherein successive stacks have therein alternately from one end to the other the ordered sheets comprising the contiguous sections of the book being collated. A sheet is then removed from each stack and is deposited in a unique position to initiate an ordered sequence of collated sheets. The newly initiated ordered sequence of collated sheets are advanced along the stacks of non-sequential sheets in stack-by-stack progression and during such progression sheets are withdrawn from the stacks into alternate stacks of the sequential sheets of the contiguous sections of a book being collated. The sections so collated are then assembled and secured together.

This invention relates to a method for producing printed books and the like. In its more particular aspect, the invention relates to the printing, cutting and collating of page sheets constituting a book. The invention herein provides an alternative to the method and apparatus for producing printed publications disclosed in my copending application Ser. No. 525,950, filed Feb. 8, 1966, now Patent No. 3,370,843, issued Feb. 27, 1968.

In the conventional practice of producing printed publications consisting of separate sheets of paper stapled together along one edge, the printing operation is performed on a web of paper which is imprinted on both sides by passage through a pair of offset presses which are arranged in tandem. Each printing repeat may contain four sheets, for example, thus producing eight printed pages in each repeat. The printed web is cut between each printing repeat to form a press sheet. The press sheets are stacked after which they are separated into page sheets by the use of a guillotine cutter, or the press sheets may be folded into signatures and the associated signatures may then be gathered and separated into page sheets by use of a guillotine cutter.

After the press sheets have been separated into page sheets and have been stacked into piles, one pile for each page sheet of the final publication, a collating operation is performed to gather together in proper sequence the pages comprising the book. A conventional collator consists essentially of a moving sheet collection belt along which are placed sheet feeding stations into which the separate sheets are placed in the form of a pile.

Suction feed mechanism moves a one page sheet from the pile at each sheet feeding station and places it on a platform above the collection belt. Collating fingers extending upwardly from the sheet collection belt at predetermined equal intervals remove the sheets from the platform, one at a time, and place them all onto the sheet collection belt in tray locations by which they are advanced. The first sheet feeding station will deliver a sheet from the platform directly onto the sheet collection belt and subsequent stations will place subsequent sheets on top of the sheets from the previous sheet feeding station. If, therefore, the piles of sheets in the several sheet feeding stations are in proper sequence along the length of the collator, the sheets from the various stations will be in properly ordered sequence upon their delivery at the discharge end of the collator. In-line sheet stapling mechanism may be provided at the discharge end of the collator to insert two or more wire staples along one margin of the collated sheets, thereby forming the book, or they may be otherwise processed to join the sheets together into a unit.

My aforesaid application for patent teaches a departure from the conventional sheet cutting and collating operation whereby the number of sheets that can be collated in a single pass through the collator may be doubled. That function is accomplished by my earlier method by stacking pairs of sequential sheets in the same pile. My prior method proposed to print a plurality of page sheets on opposite sides of a paper web in repeats along the length of the web. Each repeat, it was suggested, will be at least two sheets deep and at least two sheets wide. The web was then cut into page sheets which were ordered in the direction of their movement. The cutting operation was performed on the printed web by the addition of rotary knives and slitting wheels to a conventional press sheet feeder.

Each pile of sheets delivered according to my first method consisted of several different page sheets in repeating sequence. In the case of a press sheet containing four page sheets, two piles were produced, each containing repeating pairs of different page sheets in a fixed sequence.

The fact that each pile of sheets contained a pair of sequential page sheets was utilized to advantage by removing every other collating finger from the sheet collection belt of the collator. Thus, two page sheets in numeric sequence were removed from each sheet delivery station and placed onto the sheet platform of the collator before a collating finger caused a transfer of the sheets from the sheet platform to the sheet collation belt.

The manufacturing of a book of collated sheets according to the present method comprises the steps of: printing a plurality of non-sequential sheets comprising a set repetitiously on a web, the sheets of each set having respectively an identical ordered relationship to the sheets of contiguous sections of the book being collated, cutting the sheets apart and stacking the sheets while maintaining the predetermined arrangement thereof, placing the stacks of unsequential sheets in an ordered line for collation wherein successive stacks have therein in sequence from one end to the other the ordered sheets comprising the contiguous sections of the book being collated, removing a sheet from each stack and depositing such sheet in a unique position to initiate an ordered sequence of collated sheets, advancing such newly initiated ordered sequences of collated sheets along the stacks of unsequential sheets in stack-by-stack progression, during said stack-by-stack progression withdrawing from the stacks of non-sequential sheets onto alternate stacks the sequential sheets of the contiguous sections of a book being collated and combining and securing the collated sheets of adjacent stacks.

The detailed performance of the method and suitable apparatus for performing the same, together with attendant advantages will become apparent from a study of the following specific description of one particular way of executing the method when read in light of the drawings, in which:

FIG. 1 is a side elevational view of an offset press and an associated paper slitter and cutter adapted for pile delivery;

FIG. 2 is a plan view of the slitter and cutter taken on line 2—2 of FIG. 1;

FIG. 3 is a fragmentary side elevational view of a sheet collator in which three sheet delivery stations are shown, parts being shown in cross section;

FIG. 4 is a plan view of a printed repeat;

FIG. 5 is a more or less diagrammatic plan view of a sheet collator and an associated wire stitcher; and

FIG. 6 is in the nature of a flow chart illustrating the manner in which the collating process of the present invention is performed.

In FIGURE 1, a printed web W is delivered to a web slitter and cutter **10** by the last press **12** of a pair of such presses arranged in tandem in conventional manner so that the web may be printed on both sides as it passes through the presses. The presses may be any suitable make, as for example, Speedflex offset presses, manufactured and sold by Western Gear Corporation of Lynwood, Calif. The configuration of the printed repeat may vary. It is sufficient to illustrate the novel method by showing a repeat pattern such as in FIG. 4, wherein three page sheets are printed across the width of the web and two different page sheets are printed along the length of the web. The number of page sheets across the web will ordinarily be determined and limited by the width of the press, while the number of different contiguous sheets along the length of the web will be determined by the number of different consecutive sheets to be provided in each pile, as well as by the diameter of the printing cylinder.

In FIG. 4, assuming web movement is in the direction of the arrows, pages 1 and 2 constituting the first pages in the first half of a book will be printed on sheet **1**. Directly following sheet **1**, pages 33 and 34 will be printed on sheet **33** constituting the first pages in the second half of the book. Successive pages for the first half of the book and for the second half of the book will follow in like manner. Thus, pages 3 and 4 will be printed on sheet **3** followed by pages 35 and 36 printed on sheet **35**; pages 5 and 6 will be printed on sheet **5** followed by pages 37 and 38 on sheet **37**. In each case, the even-numbered pages will be printed on the bottom of the web and the odd-numbered pages will be printed on the upper surface of the web. The sheet numbers assigned to FIG. 4 are taken from the facing page numbers of the respective sheets.

As the web W enters the slitter and cutter **10**, it may be punched if it is desired to use the sheets in looseleaf assembly. This operation may be performed as the web passes under a punch drum **26** which has therein three circumferential sets of punches **28** (FIG. 2) which are located along the length of the drum to coincide with the left margins of the respective sheets. In case a punching operation is not to be performed, the web, instead of being fed under the punch drum **26**, as shown in FIG. 1, will be fed around a guide roller **30** thereby bypassing the punch drum.

The web is now cut in the direction of its movement by a series of four slitting wheels **32** which operate in conjunction with a back-up roll **34**. The outer slitting wheels **32** will trim the edges of the web as it passes thereunder. Ordinarily, ¼" is trimmed from each margin. The inner slitting wheels **32** will separate the web into three 8½" page ribbons. These ribbons pass under a pair of rotary knives **36** and **38** which sever the ribbons transversely to form 11" sheets. In the conventional press sheeting operation, only one rotary knife is ordinarily employed which effectively separates the printed web at each printing repeat to form a press sheet. In the modification shown herein, the two knives separate the web into page sheets. As the severed sheets move beyond the rotary knives, they are received in a pair of delivery belts **40**, which are positively driven to advance the severed sheets to a sheet conveyor **42**. The speed of the delivery belts **40** is somewhat greater than the speed of the sheet conveyor **42**. This differential in favor of the delivery belts **40** insures that a severed sheet being advanced thereby will be delivered to the sheet stacking conveyor **42** in overlapping relation to the sheet previously delivered thereto.

The sheet stacking conveyor **42**, as seen in FIG. 2, consists of a plurality of conveyor belts **44** which are trained about idle rollers **46** at the discharge end and about driven rollers **48** at the inner end. Two adjacent sets of rollers **50** and **52** supporting conveyor belts **44** along the inner margin of the outer sheets are enlarged so that the belts running thereover will be driven at a slightly greater rate than the remaining conveyor belts. This will tend to drive the outer sheets outwardly and away from the sheets at the center of the conveyor and thereby avoid lateral interleaving of sheets in adjacent conveyor runs. As the sheets are advanced on the sheet stacking conveyor, they are held in contact therewith by a series of tension rollers **56**.

The sheets in overlapped relation are delivered to a delivery platform **58** from which they are taken and jogged into piles. These piles, as it is evident, will now be made up of pairs of adjacent sheets such that pages 33 and 34 will overlie pages 1 and 2 in one stack; pages 35 and 36 will overlie pages 3 and 4 in a second stack; and pages 37 and 38 will overlie pages 5 and 6 in the third stack. Stacks of pages, such as those described, will be printed and formed until the sheets for the entire book have been produced. These stacks are now taken to a collator wherein consecutive pages of the first and second half of the book are separately gathered.

The collator will have a number of feed stations **60** such as the three stations shown in FIG. 3. The collator may, for example, be a sixteen station Gather-All sheet collator of the kind manufactured and sold by Didde-Glaser Inc. of Emporia, Kans. As shown fragmentarily in FIG. 3, the collator has a sheet collection belt **62** which operates under the sheet feeding stations **60**. This belt provides support surfaces **64** for the sheets which are fed thereto. In the present illustration, the belt comprises a sprocket chain **66** which is suitably driven along the length of the collator and which provides support for the sheet supporting surfaces **64**.

Each of the sheet delivery stations comprises a top loading bottom feed sheet hopper **68** adapted to hold a stack of sheets S in a somewhat inclined position directly over the sheet collection belt **62**. The hoppers provide access to the bottom sheet in a pile for a suction mechanism **70**, which, when operated, will engage the leading edge of the bottom sheet and withdraw that sheet from the pile, feeding the same between a feed roller **72** and one or more guide rollers **74** such that the sheet is deposited on a sheet platform which consists of a pair of laterally spaced rails, one of which is shown in FIG. 3 at **76**. Associated with the sheet platform and attached to the machine frame at opposite sides thereof are a pair of brackets, one of which is shown at **80** in FIG. 3, which are designed to catch the opposite marginal edges of a sheet being delivered and assist in the guidance of the sheet to the sheet platform. Also associated with the feed mechanism is a flexible sheet hold-down **84** which is supported over the sheet platform by means of a bracket **86** extending forwardly of each of the feed stations. The brackets in conjunction with the holddown member **84** insure that a sheet fed to the sheet platform will lie flat thereon and that a second sheet fed from another feed delivery station will be delivered on top of the sheet previously fed.

The sheet collection belt **62** is provided with a plurality of equally spaced upstanding collating fingers **88** which are shown in FIG. 3, and these fingers rise between the rails **76** comprising the sheet platform. Therefore, any sheet which has been deposited upon the sheet platform will be removed by a collating finger **88** as the collating finger engages the trailing edge of the sheet. The collating finger **88** will slide the sheet along the rails **76** of the sheet platform until it is free thereof, the sheet thereafter being carried along by sheet supports which run the length of the collator. A collating finger **88** will remove a sheet in turn from each of the sheet platforms as it is carried forward by the sheet collation belt **62**, such that it carries a sheet or sheets from one feeding station to another during each sheet feeding cycle. Thus, in the conventional practice, if a sixteen station collator is used, sixteen sheets will have been collated by a given finger as it moves from the rear end of the machine to the discharge end.

The method herein can be clearly understood by reference to FIGS. 4 and 6. In both of these figures, the reference numerals designating the respective sheets are the same as the facing page numbers of said sheets, thus clearly relating FIGS. 4 and 6. The printing of the web of FIG. 4 has been referred to previously and partially explained. The first stage of the method is the printing of a pair of non-sequential sheets repetitiously on a web such that the sheets of each pair have, respectively, an identical ordered relationship to the sheets of the first and second half of the book being collated. Thus, assuming the printing and collating of a book having 64 pages, the repeat pattern as shown in FIG. 4 which is printed on the web provides this relationship. As explained, sheet **1** will have printed on the face thereof page 1 and on the opposite side will be page 2. Pages 1 and 2, will, therefore, be the first sheet in one half of the book. Sheet **33** will have printed on the face thereof page 33, while the opposite face will be page 34. Sheet **33**, therefore, will be the first sheet in the other half of the book. Sheet **3** will have on the face thereof page 3 and on the opposite side will be page 4, thus constituting the second sheet of the first half of the book. Sheet **35** will have on the face thereof page 35 and on the opposite face thereof page 36. This constitutes the second sheet of the second half of the book. The same relationship extends to sheets **5** and **37** and to all of the other printing repeats required for the entire book. This is what is meant when it is stated that the sheets of each pair have, respectively, an identical ordered relationship to the sheets of the first and second half of the book being collated, i.e., one and the other half of the book. The pattern of FIG. 4 will be repeated as often as necessary to produce the number of books required. Similar pairs of non-sequential sheets will be printed repetitiously on the web to provide the number of printed sheets necessary to produce the assumed 64 page book, as stated.

The sheets of the printed web are now cut apart and the sheets are arranged in stacks while maintaining the predetermined arrangement thereof. This operation is performed in the sheet cutter and conveyor of FIGS. 1 and 2. As the printed web emerges from the last printing station **12**, it enters the sheet cutter **10** wherein the rotary slitters **32** slit the web in the direction of its length. The rotary cutter having the knives **36** and **38** will cut the sheets in the transverse direction. The cutting operation is performed while the web moves forward. As the conveyor **40** delivers the cut sheets, sheets **5**, **3** and **1** will be delivered first, for example, with pages 1, 3 and 5 facing upwardly, for example. Sheets **37**, **35** and **33**, for example, will be delivered in overlapping relationship, respectively, to sheets **5**, **3** and **1**, respectively to maintain the predetermined arrangement of the sheets.

When a sufficient number of sheets have been so printed and delivered in collated stacks, these stacks of non-sequential sheets are arranged in an ordered line for collation wherein successive stacks have therein in sequence from one end to the other the ordered sheets comprising first and second halves of the book being collated. By this is meant the ordered insertion of the various stacks of paired sheets into the hoppers of a collator, for example, of the kind briefly described above. Let it be assumed for the purpose of this description that the collator which is fragmentarily shown in FIG. 3 has sixteen hoppers **60** for receiving stacks of sheets. In the conventional operation of a collator of this kind, each hopper **60** receives a stack of sheets which are all of the same kind. The ordered manner in which the sheets are arranged herein is represented, for example, in FIG. 6 wherein **110** represents the sixteen hoppers of a collator, such as the hoppers **60** in FIG. 3. The sheet stacks S of FIG. 3 are represented by the bracketed numbers **112** while the line **114** of FIG. 6 may be taken to represent the position at the first collator hopper in which the last sheets of the first and second halves of the book are stacked in alternate order.

Reverting again to FIG. 6, it can be seen that the first sheet hopper (reading from left to right) will be loaded, for example, with a stack of sheets made up of sheets **1** and **33** being, respectively, the first sheet in the first and second half of the book and representing, respectively, printed pages 1 and 2, and 33 and 34. The second hopper will be loaded, by way of the same example, with a stack made up of sheets **3** and **35** being, respectively, printed pages 3 and 4, and 35 and 36 constituting, respectively, the second sheet of the first and second half of the book. The third hopper, in continuation of the example, will be loaded with a stack composed of sheets **5** and **37** being, respectively, printed pages 5 and 6 and 37 and 38 and constituting, respectively, the third sheet of the first and second half of the book. The hoppers of the collator are loaded in this same manner until the 16th station is loaded with a stack composed of sheets **31** and **63** being, respectively, printed pages 31 and 32, and 63 and 64 and being respectively, the last page of the first and second half of the book being collated. This is what is meant when it is stated that the stacks of non-sequential sheets are placed in an ordered line for collation wherein successive stacks have therein in sequence from one end to the other the ordered sheets comprising the first and second halves of the book being collated. Additional clarification can be gained by a study of the sheet numbers in the stacks **112** in FIG. 6, where it is seen that the first sheet of the first half of the book is in the first stack, the second sheet of the first half of the book is in the second stack, the third sheet of the first half of the book is in the third stack, and so on. Related to the foregoing sequence is the fact that the first sheet of the second half of the book is in the first stack, the second sheet of the second half of the book is in the second stack, the third sheet of the second half of the book is in the third stack, and so on.

After the stacks of non-sequential sheets have been placed in this ordered line for collating, a sheet is removed from each stack and deposited in a unique position to initiate an ordered sequence of collated sheets. It should be noted that a single sheet is removed from each stack in each feed cycle, a feed cycle occurring during the time a single sheet is removed from each stack by the suction fingers **70** and the collating fingers **88** remove the sheets so removed to the next collating station. Thus, in FIG. 6 when the collating operation is started, sheets **1**, **35**, **5**, **39—25**, **59**, **29** and **63** will be simultaneously withdrawn from their respective stacks and will be deposited into the collecting trays of the collator. The collecting chain **66** advances continuously and by the time the respective collating trays have advanced to the next station, sheet **33** will be discharged and rejected; sheet **1** at station **1** now will be deposited on sheet **3** in the tray below; sheet **35** will be deposited on sheet **37** and sheet **5** from station **3** will be deposited on sheet **7**; sheet **25** in station **13** will be deposited on sheet **27** in the tray below; sheet **59** will be deposited on sheet **61** in the tray below, and sheet **29** will be deposited on sheet **31** in the tray below. It is now apparent that as the newly initiated ordered sequence of

sheets are advanced along the stacks of non-sequential sheets in the stack-by-stack progression and sheets are singly withdrawn from each stack of non-sequential sheets, they are arranged on the collecting trays in alternate stacks of sheets, wherein the sequential sheets of the first and second half of a book are in one stack and the sheets comprising the other half thereof are collated in an immediately adjacent stack. It should be noted at this point that initially a complete book half is not collated until the collating chain has moved from station **16** through station **1**. Incompletely collated stacks at the outset of a collaing operation are rejected.

At the 16th cycle, when the sheets have been withdrawn from their respective hoppers, the configuration of the various sheet piles will be as shown in FIG. 6, wherein the first completely collated half of the book comprising sheets **33** through **63**, for example, are at the output of the collator and will be discharged from the collator during the next cycle. Collating will now proceed through the next cycle wherein the second half of the book will be completed by adding sheet **1** at station **1** to sheets **3** through **31** which were gathered during the fifteen preceding cycles.

The first half of the book **96***a* is represented in FIG. 5 as having been deposited on the delivery chain **106** leading to the stitcher **108**. The delivery chain **106** is arranged to advance once during each two collating cycles. Therefore, when the first half **96***a* of the book is delivered to the delivery chain **106**, it will not advance immediately but will remain in position until the second half of the book **96***b* is delivered on top of the first half **96***a*. At this point the two book halves **96***c* will be advanced by the delivery chain **106** into registration with the stitching heads of the stitcher **108** where wire stitches or staples may be applied to bind the sheets.

It is possible to arrange the overlying non-sequential sheets for each hopper pile such that the front half of the book, i.e. sheets **1** through **31**, are discharged onto the conveyor of the stitcher first, and the back half of the book, i.e. pages 33 through 63, are discharged onto the front half. It is equally simple to arrange the non-sequential sheets for each hopper such that the back half of the book is delivered first, followed by the front half. The expressions "first and second half of a book," as used herein, are, therefore, not intended to be synonymous with "front and back half," but are to be understood as being the first and second collated halves in point of time.

While the specific example which has been set forth above results in the collation of book halves, it is clearly evident that the collating procedure may be carried on such that thirds, quarters, fifths, etc. of books can be collated according to the method. In the illustrative embodiment, the printing repeat includes only two-press sheets which permits the collation of book halves. If, however, the press cylinder is 33" in circumference, a three-sheet repeat can be produced which can be collated as a third of a book; if a press cylinder 44" in circumference is employed, repeats of four-press sheets can be produced, thus permitting collation of quarter books. Moreover, if two webs are printed at the same time, and are brought into registering overlying relation to each other for slitting and cutting, press cylinders, 22" in circumference on each press, will also provide the page sheets for collating quarter books.

The invention has been illustrated and described in a single embodiment. The essence of the invention may be enjoyed, however, even though additional steps are employed, and resort is had to equivalent or even different instruments for performing the same. Variations in the equivalent structures of the illustrated and described apparatus are also contemplated by the terms of the following claims.

What is claimed is:

1. The method of manufacturing a book of a predetermined number of collated sheets constituting a definite number of contiguous sections comprising the steps of: printing a plurality of non-sequential sheets constituting a set repetitiously on a web, the number of sets so produced being equal to the predetermined number of sheets divided by the definite number of contiguous sections and the number of sheets per set being equal to the definite number of contiguous sections, the sheets of each set having respectively an identical ordered relationship to the sheets of contiguous sections of the book being collated, cutting said sheets apart and stacking said sheets while maintaining the predetermined arrangement thereof, placing the stacks of non-sequential sheets in an ordered line for collection wherein successive stacks have therein alternately from one end to the other the ordered sheets comprising the contiguous sections of the book being collated, removing a sheet from each stack and depositing such sheet in a unique position to initiate an ordered sequence of collated sheets, advancing such newly initiated ordered sequences of collated sheets along said stacks of non-sequential sheets in stack-by-stack progression, during said stack-by-stack progression withdrawing sheets from said stacks of non-sequential sheets and depositing the same onto alternate stacks of sequential sheets of the contiguous sections of a book being collated, and combining and securing the collated sheets of adjacent stacks.

2. The method of claim **1**, in which said cutting operation is performing on said web while the latter is moving in the direction of its length.

3. The method of claim **1**, in which said web is imprinted on both faces thereof.

4. The method of claim **1**, in which said collating step is performed as a continuous operation.

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EUGENE R. CAPOZIO, *Primary Examiner.*

PAUL V. WILLIAMS, *Assistant Examiner.*

U.S. Cl. X.R.

270—58