United States Patent [19]

Reed

[11] **3,924,846**

[45] **Dec. 9, 1975**

[54] **COLLATING METHOD AND APPARATUS**

[75] Inventor: **David A. Reed**, Easton, Pa.

[73] Assignee: **Harris-Intertype Corporation**, Cleveland, Ohio

[22] Filed: **May 7, 1973**

[21] Appl. No.: **357,772**

[52] **U.S. Cl.** **270/56**; 270/58

[51] **Int. Cl.**[2] **B65H 43/02**

[58] **Field of Search** 53/53, 54; 2720/54–56, 58, 52; 271/57

[56] **References Cited**

UNITED STATES PATENTS

2,879,636	3/1959	Zuercher	53/53
3,193,283	7/1965	Smith	271/57 X
3,519,264	7/1970	Beacham et al.	270/58
3,578,310	5/1971	Carson	270/54
3,608,888	9/1971	McCain et al.	270/54
3,709,485	1/1973	Acquaviva	270/58 X

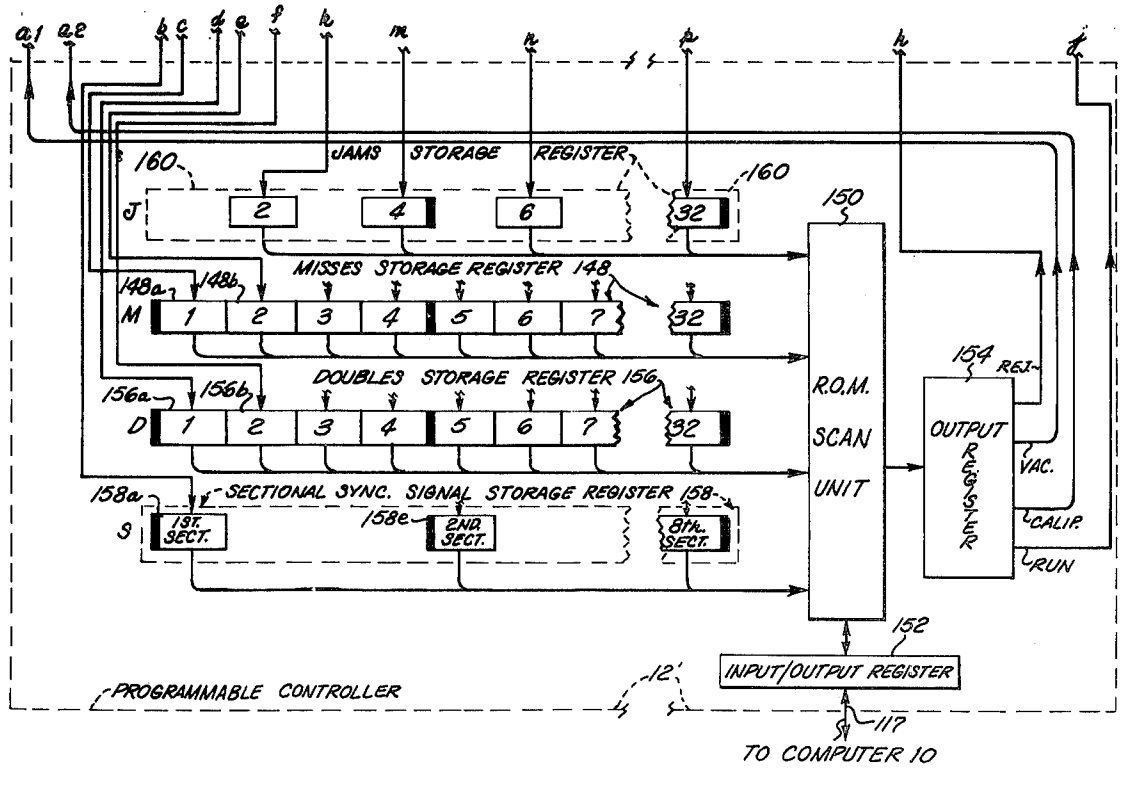
Primary Examiner—Robert W. Michell

Assistant Examiner—Vance Y. Hum

[57] **ABSTRACT**

In a collating method and apparatus for assembling a book, magazine, or the like from a plurality of signatures, a conveyor moves successively through a plurality of signature feeding stations. Raceway jams along the path of the conveyor are sensed. Upon a raceway jam, the collating apparatus is stopped automatically and a fault status signal is stored. After an operator has manually cleared the jam and restarted the machine, the magazine which was nearest the jam detector when the jam occurred, is tracked through the collating apparatus to a reject station where it is rejected. A predetermined number of magazines upstream from the one that was nearest and a predetermined number of magazines downstream from the one that was nearest are also automatically rejected when they arrive at the reject station. Following the sensing of a jam condition, downstream signature feeding stations are inhibited from feeding signatures to any of the magazines which are later to be rejected.

15 Claims, 5 Drawing Figures



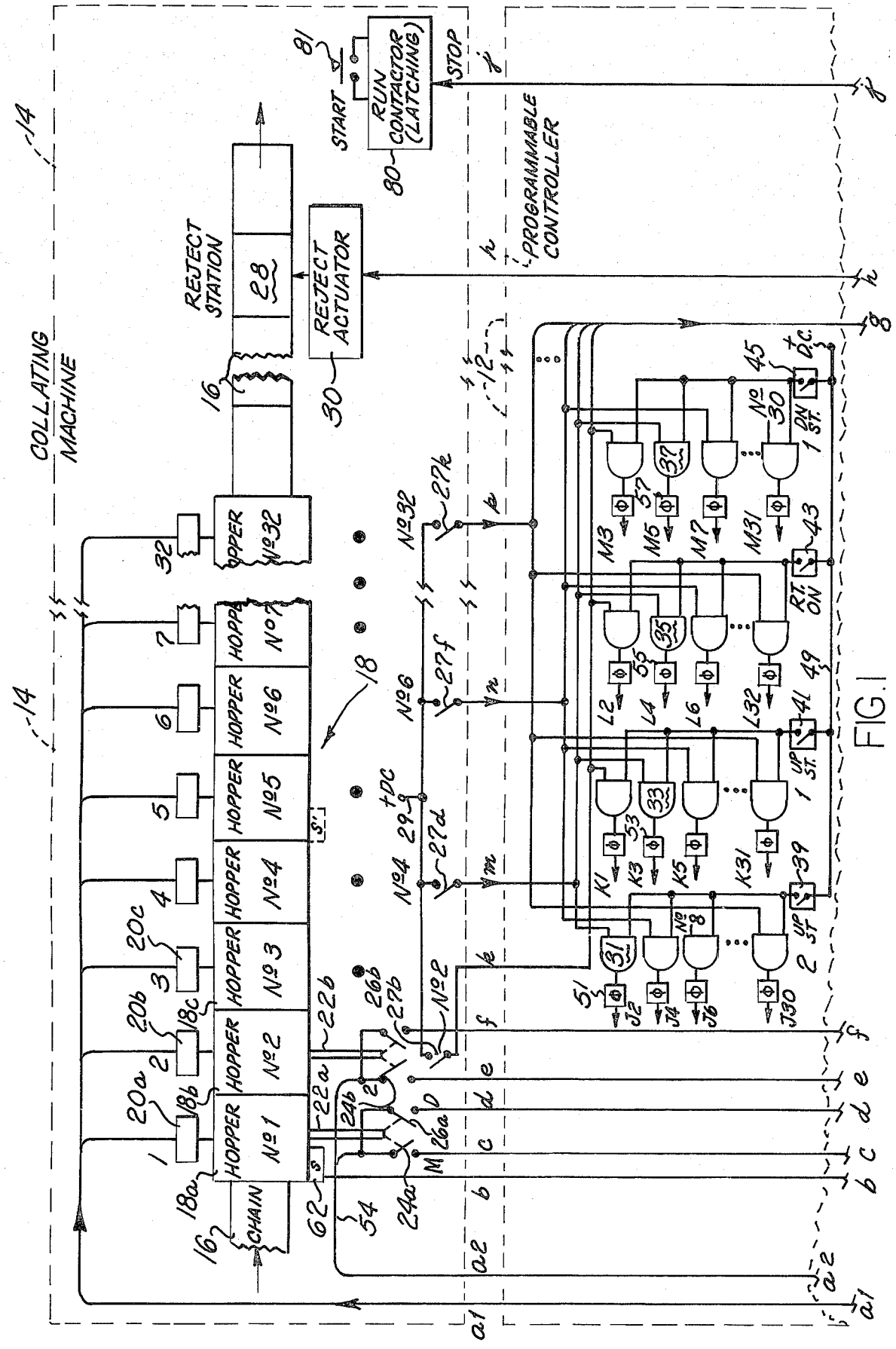

COLLATING MACHINE
REJECT STATION
REJECT ACTUATOR
RUN CONTACTOR (LATCHING)
START
STOP
PROGRAMMABLE CONTROLLER
HOPPER No 1
HOPPER No 2
HOPPER No 3
HOPPER No 4
HOPPER No 5
HOPPER No 6
HOPPER No 7
HOPPER No 32
CHAIN
1 DN ST.
1 UP ST.
2 UP ST.
RT. ON

FIG. 1

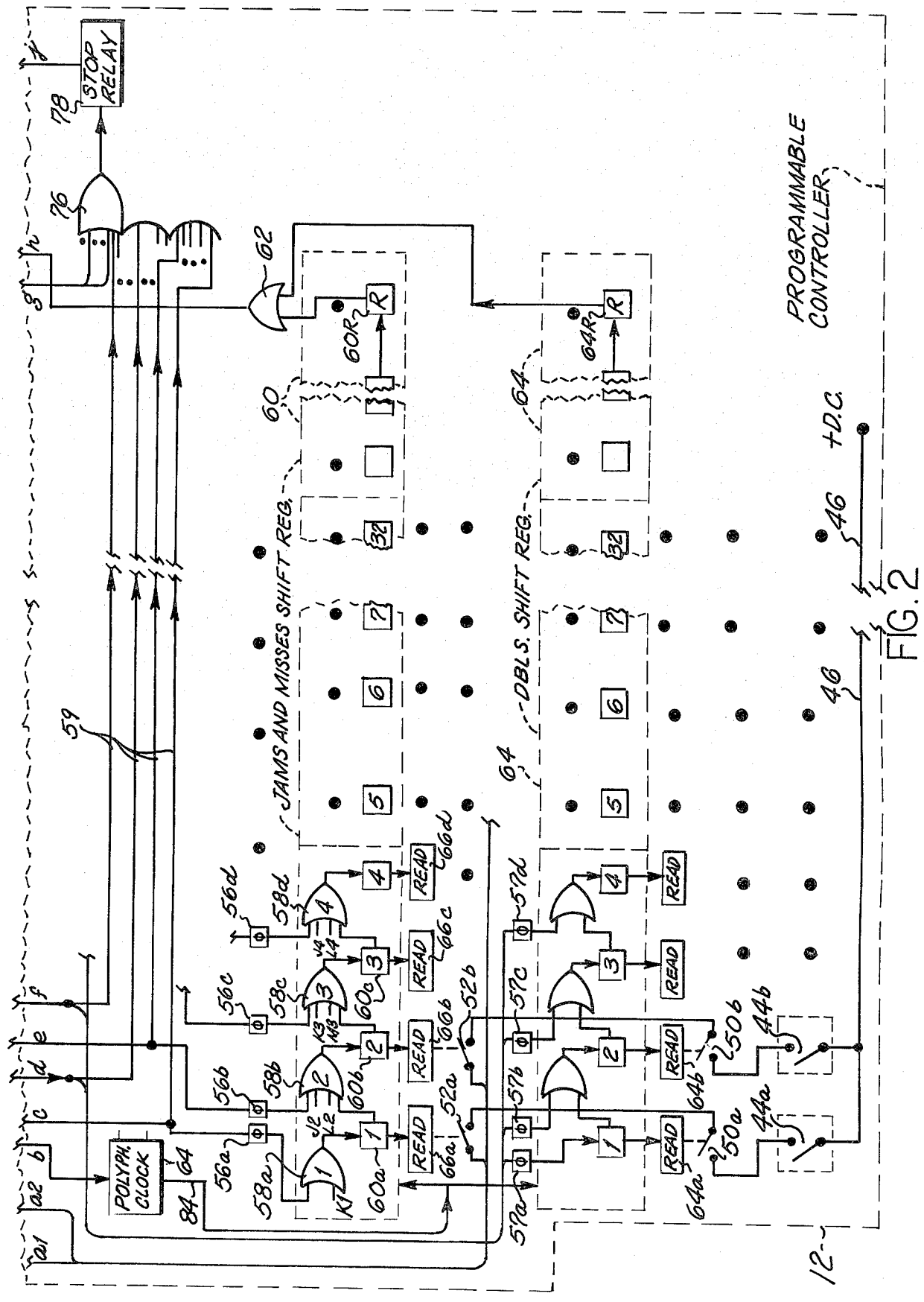

STOP RELAY
78
76
62
60R
R
60
64R
64
PROGRAMMABLE CONTROLLER
+D.C.
46
JAMS AND MISSES SHIFT REG.
DBL S. SHIFT REG.
59
POLYPH. CLOCK
84
READ
66a
66b
66c
66d
52a
52b
50a
50b
44a
44b
12

FIG. 2

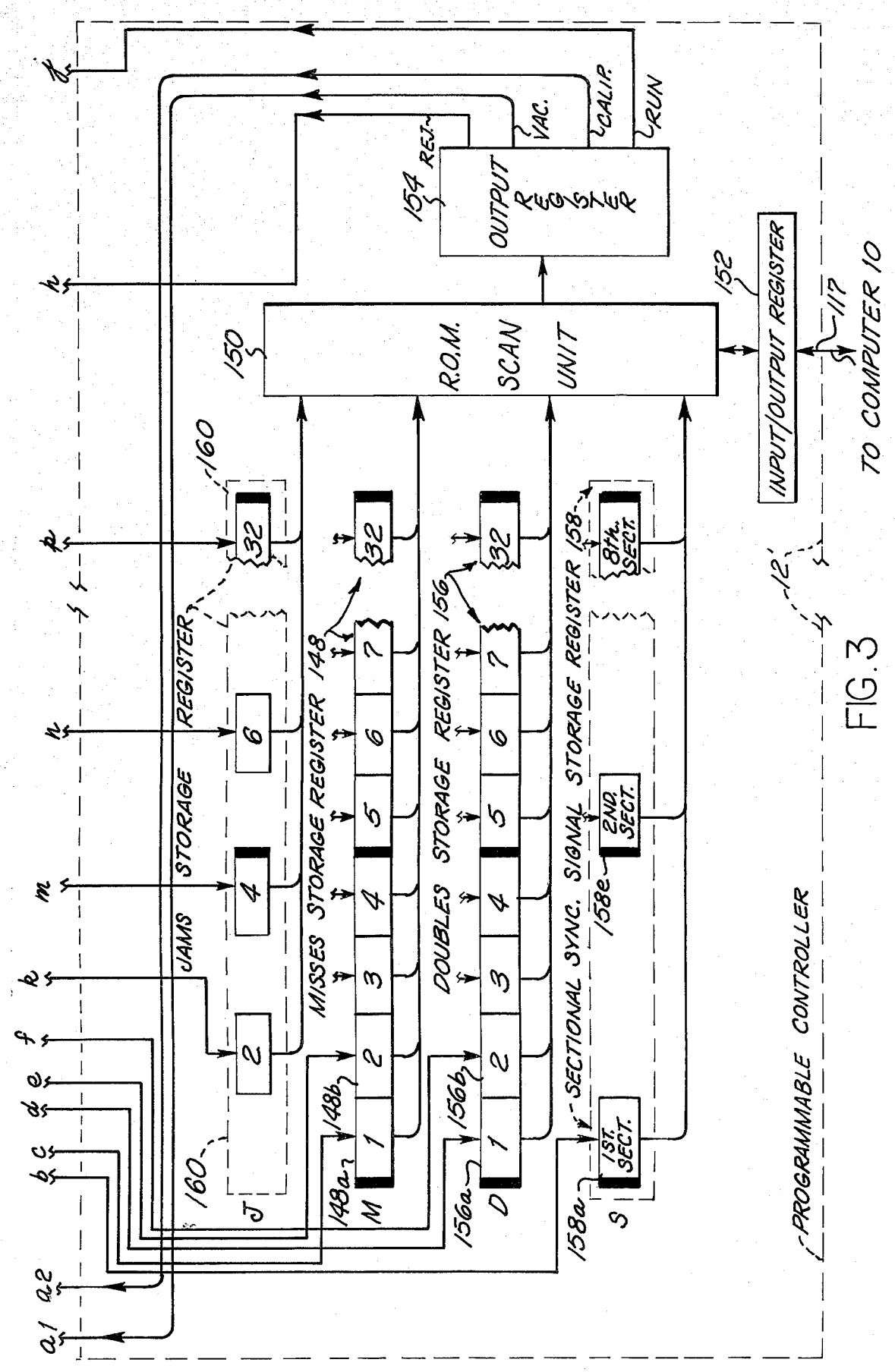

PROGRAMMABLE CONTROLLER
R.O.M. SCAN UNIT
150
OUTPUT REGISTER
154
REJ.
VAC.
CALIB.
RUN
INPUT/OUTPUT REGISTER
152
117
TO COMPUTER 10
12
JAMS STORAGE REGISTER
160
MISSES STORAGE REGISTER 148
DOUBLES STORAGE REGISTER 156
SECTIONAL SYNC. SIGNAL STORAGE REGISTER 158
1ST. SECT.
2ND. SECT.
8th. SECT.
158a
158e
148a
148b
156a
156b
160
J
M
D
S
a1
a2
b
c
d
e
f
k
m
n
p
r
h
32
6
4
2
7
5
3
1

FIG. 3

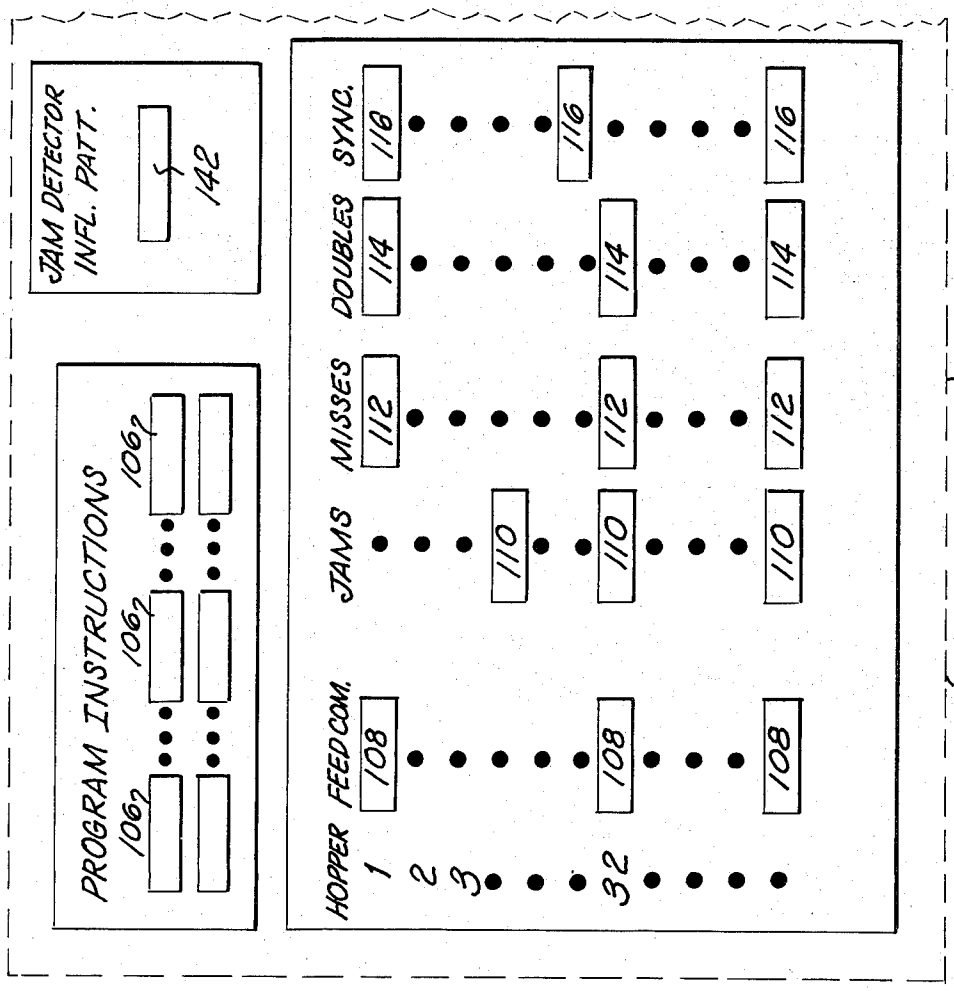

JAM DETECTOR INFL. PATT.
142
PROGRAM INSTRUCTIONS
106
HOPPER
FEED COM.
JAMS
MISSES
DOUBLES
SYNC.
1
2
3
32
108
110
112
114
116
MEMORY UNIT
100

FIG. 5

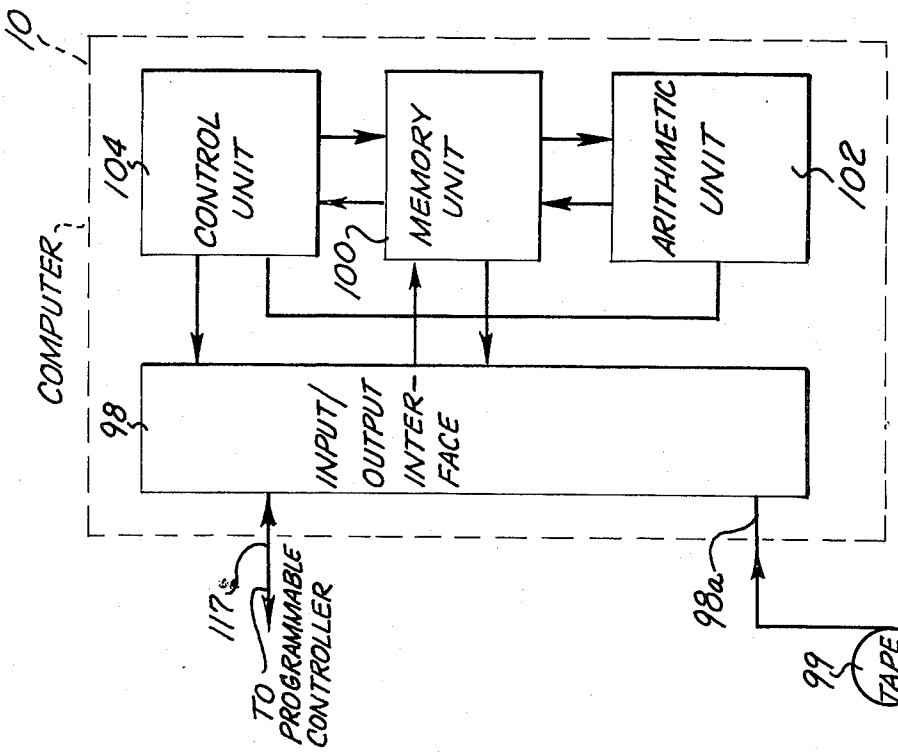

10
COMPUTER
CONTROL UNIT
104
MEMORY UNIT
100
ARITHMETIC UNIT
102
INPUT/ OUTPUT INTER-FACE
98
117
TO PROGRAMMABLE CONTROLLER
98a
99
TAPE
PROGAM AND DATA INPUTS

FIG. 4

COLLATING METHOD AND APPARATUS

BACKGROUND OF THE INVENTION

The present invention relates to a collating method and apparatus wherein a plurality of hoppers or feed stations are provided at which signatures are fed to a conveyor. The invention is an improvement in collating systems, being for example, an improvement in a collating system disclosed in U.S. patent application Ser. No. 141,331, filed May 7, 1971. In that system various magazines or books composed of various predetermined combinations of signatures are made in accordance with various subscriber information under the control of a computer. On the basis of information read from a magnetic tape the computer instructs different ones of the feed stations to feed or not to feed to provide differently constituted magazines for different subscribers. Patent application Ser. No. 141,331 also discloses feeder malfunction sensing devices at each feeder station which produce malfunction status signals. These feeder malfunction status signals are associated with the magazines which are defective because of the feeding malfunction. In that prior patent application, the malfunction status signals track the defective magazines through the stations of the gatherer to a reject station where the defective magazines are rejected.

Some collating systems of the prior art have raceway jam detectors which detect improper arrangement of a signature in a raceway of the conveyor. When a jam occurs, one of the jam detectors produces a shutdown signal to stop the collator. The operator thereupon clears the jam manually, and, with the collating machine still stopped, he inspects the magazine at the jam and several magazines upstream and downstream therefrom which may be defective because of the jam. The operator may either repair or discard the defective magazines, after which he restarts the collator. The collator is therefore stopped a relatively long time in consequence of each jam. The one magazine that was at the jam may be automatically rejected later when it arrives downstream at a reject station.

SUMMARY OF THE INVENTION

The present invention relates to a collating method and apparatus wherein a plurality of feed stations are provided at which signatures are added to a conveyor to form magazines or books. Raceway jam detection devices are provided at intervals along the path of the conveyor which are capable of detecting a jam of the signatures as they move along the raceway. When a raceway jam is detected by one of the detection devices, the apparatus is stopped until the jam is cleared. On restarting, the chain space of the conveyor that is located nearest the jam detector, is identified as containing a faulty magazine. By means of a shift register of a computer or other data storing and tracking means, the apparatus tracks the progress of that particular chain space through the collating machine to a rejection station where a reject gate removes the defective magazine from the conveyor in consequence of the stored jam status signal. Not only is a magazine rejected from the conveyor chain space which was nearest the jam detector when the jam detector produced the jam status signal, but one or more magazines in chain spaces upstream and/or downstream from that nearest chain space are also rejected. The number of additional magazines upstream, if any, which are to be rejected in consequence of the same jam status signal may be varied, as may be the number, if any, of downstream magazines which are to be rejected. This apparatus speeds up the clearing of jams, because it is no longer necessary for the operator upon a jam to inspect magazines upstream and downstream from the chain space at which the jam occurred, nor to repair or manually discard magazines before restarting the collating apparatus. As a result, the collating apparatus is stopped for a minimum of time on a raceway jam.

In the present invention, feeding malfunction detectors are also provided on the individual feeders and they also produce fault status signals, which may be combined with the jam fault status signals if desired, in tracking storage means that are used in common for both types of fault status signals. Moreover, the present invention provides for preventing each downstream signature feeder from feeding a signature to any chain space from which a magazine is later to be rejected, irrespective of whether the chain space is itself one for which a jam detection was sensed or was merely one of the neighboring magazines upstream or downstream from the place of jam. Thus, irrespective of whether a particular magazine is to be rejected because a jam was sensed at its own station or merely because of its proximity on the conveyor to such a magazine, the downstream hoppers are inhibited from feeding signatures to its chain space.

Two embodiments of the invention are described, the first involving only hardware, and the second involving a computer which is programmed by software to perform the same functions as were performed by the hardware of the first embodiment, and some further functions.

Accordingly, one object of the present invention is to provide a collating apparatus which is stopped for a minimum amount of time when a jam is sensed and which has a conveyor which moves past a plurality of signature feeding stations from which it receives signatures to form a book or magazine in each space of the conveyor, and in which the collating apparatus has a jam detector for sensing imperfections in arrangement of signatures on the conveyor, a reject device for rejecting defective books, and equipment controlled by a fault status signal produced by the jam detector for actuating the reject device to reject books from two or more consecutive conveyor spaces which were at and near the jam detector when the jam detector produced the fault status signal.

Another object is to provide a collating apparatus as above and in which the reject device is downstream from a signature feeding station and in which the status signal produced by the jam detector, is stored until the successive conveyor spaces at and near the jam arrived at the reject device, whereupon the reject device operates two or more times in time succession to reject books located in those successive conveyor spaces.

Another object is to provide a collating system as above in which, following the production of the fault status signal by a jam detector, books are rejected from the conveyor space which, at the time of the signal, was nearest the jam detector and from at least one conveyor space upstream and at least one conveyor space downstream from that nearest space.

Another object is to provide a collating system as above and in which the extent of the upstream and downstream influence of a jam detector for rejecting book from various conveyor spaces is programmable,

so that a selectable pattern of contiguous conveyor spaces have their books rejected in response to the sensing of a jam.

Another object is to provide a collating apparatus as above in which a status signal produced by a jam detector is stored in a data storage means which tracks the particular identified conveyor space that was nearest the jam detector as that space moves through the collating apparatus to the reject means. For example, the storage means for tracking the particular identified conveyor space can be a shift register having data stages representing stations of the collating machine and capable of shifting the stored status signal through the shift register to simulate the progress of the particular identified conveyor space through the collating apparatus. Alternatively, a computer or other apparatus instead of a shift register can be employed for the tracking.

A further object is to provide a collating apparatus as above and in which the tracking storage means simultaneously tracks all of the identified conveyor spaces from which books are to be rejected in response to a single jam signal from the jam detector.

DESCRIPTION OF THE FIGURES

Other objects and features of the invention will become apparent upon consideration of the following description taken in conjunction with the accompanying drawings wherein:

FIG. **1** shows a collating machine including a conveyor, a plurality of signature feeding stations, and a reject station and also showing a portion of a programmable controller;

FIG. **2** is a block diagram of another portion of the programmable controller, for controlling the collating machine of FIG. **1** in accordance with a first embodiment of the invention;

FIG. **3** is a block diagram of a second type of programmable controller for use in conjunction with a computer, for controlling the collating machine shown at the top of FIG. **1** in accordance with a second embodiment of the invention;

FIG. **4** is a simplified block diagram of the computer which cooperates with the programmable controller of FIG. **3** to control the collating machine; and

FIG. **5** is a symbolic block diagram showing a portion of a memory unit of the computer of FIG. **4.**

DESCRIPTION OF PREFERRED EMBODIMENTS

Two preferred embodiments of the invention are described herein. In the first preferred embodiment, a collating machine for assembling magazines and books from a plurality of signatures is arranged to be controlled by a programmable controller without the aid of a computer to feed signatures to a conveyor, to detect raceway jams and to reject the magazine at which a raceway jam occurred and other magazines near it on the conveyor.

The collating machine **14** has a conveyor chain **16** onto which different signatures are fed from hoppers **18***a*, **18***b*, **18***c*, etc. to form a desired magazine, after which any defectively formed magazines are rejected at a rejection station. As shown in FIG. **1,** the conveyor chain **16** is divided longitudinally into chain spaces or conveyor spaces each of which is large enough to accommodate a magazine to be assembled on the chain space. The conveyor **16** moves through a plurality of feeding stations or hoppers; a signature feed device is located at each feeding station. The number and construction of the feeders may vary, but preferably the feeders are as shown in U.S. application Ser. No. 339,144 assigned to the assignee of the present invention. That disclosure is incorporated herein by reference.

In general, each feeder includes, as is well known, a hopper which contains a supply of signatures. The signatures are removed from the hopper by a suitable mechanism which includes a suction device which withdraws an edge of a signature downwardly into a position where it can be gripped by a gripper which is carried on a rotatable drum. The gripper, once it grips the signature, carries the signature with the drum to a release location where the signature is released for deposit into a chain space of the conveyor.

In the preferred embodiment there are 32 hoppers, **18***a*, **18***b*, **18***c*, etc. for feeding signatures onto the chain. Each of the hoppers **18** has a supply of signatures which differ among hoppers, and each hopper is capable of feeding one signature at a time onto the chain **16** when a respective feed device **20***a*, **20***b*, etc. of the hopper is actuated.

Each hopper has a respective caliper means **22***a*, **22***b*, etc. for measuring the thickness of a signature which is fed during each machine cycle. The caliper device actuates a first switch called a miss switch **24***a*, **24***b*, etc., if no signature is fed, and it actuates a second switch **26***a*, **26***b*, etc., if two or more signatures are fed. Under some circumstances, but not all, an abstention from feeding represents a malfunction so that actuation of the miss switch **24** may indicate a malfunction. Actuation of a doubles switch **26** always indicates a malfunction of a signature feeder.

In addition to the switches just described for sensing feeder malfunctions, raceway jam detector switches are provided along the path of the conveyor, preferably near alternate ones of the hoppers **18.** For example, **16** raceway jam detector switches **27***b*, **27***d*, **27***f* . . . **27***p*, are preferably provided at the second, fourth, sixth and other even-numbered hopper stations of the collating apparatus, FIG. **1.** Raceway jam detector switches of various types are well known in the prior art of collators, and it is immaterial to the invention which of the various available types are employed for sensing jams in the raceway of the conveyor **16.** One raceway jam detector is a lightly spring-biased electrical switch whose actuating lever is a feeler with a small roller on an extending end for contacting papers on the conveyor.

When one of the jam detector switches encounters a paper which is incorrectly positioned on the moving conveyor **16,** the switch contacts close to produce an electrical signal indicating a raceway jam. Thereupon the collating machine is immediately stopped to enable an operator to clear the jam. In the present invention, the operator need not examine upstream or downstream magazines in the neighborhood of the jam to verify their correct composition before restarting the collating machine, because the magazine at the jam and one or more magazines upstream and/or downstream from the jam will subsequently be rejected automatically at a rejection station beyond the last signature feeding hopper.

Each chain space, as it comes out of the last stage in the gatherer **18,** carries a magazine. Some of the magazines are defective, as indicated by information obtained from the miss switches **24,** the doubles switches

26, or the jam detector switches 27. When a defective magazine or one in the immediate neighborhood of a jam reaches a reject station 28, it is removed from the conveyor chain 16 by the operation of a reject actuator 30, which is under the control of a programmable controller 12.

In this way, the collating machine 14 feeds signatures at a plurality of hoppers onto a conveyor chain 16, with the misses and double feedings and jams detected by various devices, and defective finished magazines are rejected at a rejection station 28. The reject actuator 30 at the rejection station 28 can be any means suitable for rejecting defective magazines. Details of the mechanism will not be described since any known reject structure can be utilized.

The programmable controller 12 of the first preferred embodiment performs many functions. It stores instructions, in the form of selected switch positions, specifying which hoppers are to feed signatures for the magazine currently being made, in situations in which not all of the feeders are required to feed. It also receives malfunction data from the caliper switches 24 and 26, and jam data from the jam detector switches 27, and it shifts the data through shift registers to simulate movement of the books through the collating machine 14. Also, the controller 12 issues reject signals to the reject station 28.

If, for example, a signature is to feed at hopper 18*b*, a switch 44*b*, FIG. 2, is manually placed in a closed position prior to starting the magazine run. The switch 44*b* connects a voltage from a dc voltage supply bus 46 to the feeder actuator 20*b* of the hopper 18*b* by way of a series connection of relay contacts 50*b* and 52*b*, whose individual functions are to be described later. If all of the contacts 44*b*, 50*b*, and 52*b* are closed, the actuator 20*b* causes a signature to feed at the station 18*b* onto the conveyor chain 16.

If the signature feeds properly, the caliper 22*b* does not actuate either the miss switch 24*b* or the doubles switch 26*b*. If the signature does not feed at all, however, the caliper 22*b* closes the contacts of the miss switch 24*b*. This connects an electrical signal, which was received from the switch 52*b* on a cable 54, through the miss switch 24*b*, and from there through a phase delay device 56*b* and an OR gate 58*b* into a second stage 60*b* of a shift register 60.

Voltages applied to the various conductors of a multiple conductor cable 54 on the line *a*2 of FIGS. 1 and 2 serve to enable and disable the miss switches 24 and the doubles switches of FIG. 1. In this way the miss switches and doubles switches are selectively controlled to prevent them from generating a reject status signal if a hopper is intentionally inhibited from feeding a signature. The hoppers are intentionally inhibited when a corresponding stage of a shift register contains a fault status signal because of a jam, a miss, or a double feed.

The shift register 60 keeps track of both the miss signals and the jam signals. The miss signal which is thus stored in stage 60*b* is later transmitted to the next succeeding stage 60*c*, upon the next machine cycle, the machine cycle being indicated by a pulse produced by a synchronizer 62 and a polyphase slaved clock 64, which shifts the shift register 60. The synchronizer 62 is a sensing device which produces one output pulse signal for each machine cycle of the collating machine 14.

When feed malfunction data is being shifted, the signal in the stage 60*b* passes through an OR gate 58*c* into the stage 60*c* of the shift register 60. The shifting is repeated cyclically to advance the fault status signal. All strobe signals are omitted from the diagrams.

When the jam is detected by one of the jam detector switches 27*b*, 27*d*, 27*f* . . . 27*p*, a dc signal from a supply terminal 29, FIG. 1, is connected through the jam switch and through a plurality of two-input AND gates to a plurality of OR gates and thence into a plurality of stages of the jams and misses shift register 60, FIG. 2. For example, when the jam switch 27*d* of hopper No. 4 closes to indicate a jam, a voltage signal on a line m is connected to one input of each of four AND gates 31, 33, 35, 37.

Some or all of these AND gates may be conditioned by the presence of an enabling signal on a second one of their input terminals to pass signals to the output of the AND gate. The AND gate 31 can be thus enabled by manually closing, in advance of starting the magazine run, a switch 39 which applies a dc voltage from a bus 49 to the AND gate 31 and to other AND gates representing chain spaces two positions upstream from any jam detector 27 producing a signal. Another switch 41 is manually operable to enable a second group of AND gates including the AND gate 33, which correspond to conveyor spaces one space upstream from whatever jam detector 27 may operate, and similar switches 43, 45 may be preset in the same way. For example, if it were desired subsequently to reject magazines that are one space upstream from the jam detector at the time of occurrence of the jam signal, and also the magazine that was right on or nearest to the jam detector, and also the magazine one space downstream from the jam detector, then only the switches 41, 43 and 45 would be closed in advance, to program that particular desired pattern of influence of the jam detectors upon the reject actuator 30. Switch 39 would be left open. Of course, additional similar switches may be provided for extending the influence of a jam fault to reject magazines farther upstream than two spaces and farther downstream than one space if desired.

Assuming that all of the switches 39, 41, 43 and 45 are in a closed position when the switch 27*d* of the present example closes to indicate a jam, then output signals are transmitted from all of the AND gates 31, 33, 35 and 37 to phase-delay devices 51, 53, 55 and 57 of FIG. 1, these being part of the programmable controller 12. The phase-delay devices 51, 53, 55, and 57 store the signals received from the AND gates 31, 33, 35, and 37 respectively, until a later phase of the present machine cycle at which it is appropriate to enter data into the shift register 60. After that phase delay, signals appear at the terminals J_2, K_3, L_4, and M_5 in the present example, and are entered into OR gates 58*b*, 58*c*, 58*d* and another OR gate, not shown, provided for the fifth stage of the jams and misses shift register 60. From the respective OR gate, each signal enters the corresponding stage 60*b*, 60*c*, 60*d*, 60*e* of the shift register 60 to represent a jam status of a particular chain position of the conveyor 16.

When a malfunction signal such as a jam status signal arrives at a later station 60R of the shift register 60, a defectively produced or possibly defectively produced magazine which resulted from the jam detected at the station 18*b* is then located at the reject station 28. Thereupon, the reject actuator 30 is actuated by the jam status signal in the stage 60R, which is communicated to the reject actuator 30 through an OR gate 62, and the defective or suspectedly defective magazine is

removed from the conveyor chain **16** by the reject actuator **30.**

In a similar manner, when a feeder malfunctions by failing to feed, or malfunctions by feeding two signatures instead of one, the malfunction is detected by a caliper switch **24, 26,** and is entered as a code signal or status signal into either the jams and misses shift register **60** or the doubles shift register **64,** respectively, which thereafter shifts the malfunction status signal progressively to successive stages of the shift registers **60, 64** upon successive machine cycles. As described above, when the malfunction signals subsequently arrive at respective stages **60R, 64R,** they actuate the reject actuator **30** through the OR gate **62.**

When either a jam or a feeder malfunction occurs, the downstream hoppers are prevented from feeding signatures onto the particular chain space which carries the resulting defective or suspectedly defective magazines. This downstream shut-off of the feeder **18***b*, for example, is accomplished by the switches **50***b* and **52***b*, FIG. **2.** The switch **52***b* is actuated to an open position by a register read device **66***b* when the respective shift register stage **60***b* contains a logic 1 signal, which indicates that a defective book or a suspectedly defective book is then present at the hopper **18***b*. The open contacts of the switch **52***b* prevent the actuator **20***b* from operating in a machine cycle in which hopper **18***b* is at a defective magazine because hopper **18***b* is downstream from a hopper **18***a* where a malfunction occurred. The switch **50***b* performs a similar inhibit function of hopper **18***b* for double-feed malfunctions of an upstream hopper, by opening its switch contacts in response to the presence of a malfunction status signal in the stage **64***b* of the doubles shift register **64.**

Output signals from the jam switches **27***b*, **27***d*, **27***f* . . . **27***p* are transmitted not only to the AND gates **51,** etc., for purposes of inhibiting downstream feed and operating the reject actuator as described above, but are also transmitted on a cable *g* to the inputs of an OR gate **76,** FIG. **2,** to stop the collating machine immediately. The OR gate **76,** upon receiving such a jam signal, transmits a stop signal to a stop relay **78** whose resulting output signal on a line *j* operates to trip a latching run contactor **80,** FIG. **1,** to stop the collating machine **14.** This occurs immediately upon detection of a jam; the operator is then able to remove the misaligned papers from the raceway and start the collating machine again by pressing a start pushbutton **81,** FIG. **1.** The operator need not inspect the signatures constituting upstream and downstream magazines, as was necessary in the prior art, because he knows that the reject station **28** will eliminate not only the magazine currently at the jam, but also a number of magazines upstream and downstream from the jam within the influence pattern established by settings of the switches **39, 41, 43** and **45.** The extent of influence is set so as to include all conveyor spaces whose magazines have a significant probability of having been affected by the jam and therefore of being defective.

In a similar manner, actuation of any feeder miss detector switch **24** or feeder doubles detector switch **26** acts, by way of lines **59,** FIG. **2,** to operate the OR gate **76** to stop the collating machine **14** immediately. Other embodiments of the switch circuits for immediately stopping the collating apparatus are readily achievable and have been used in the prior art. For example, only the occurrence of two successive faults at a particular hopper feed switch or a particular jam detector can stop the collating machine **14,** if desired.

In a first portion of each machine cycle, the data contents of both the jams and misses shift register **60** and the doubles shift register **64** are read, and their corresponding switches **52, 50** are set in positions in accordance with the data in the shift registers. Also the feeder hoppers **18***a*, **18***b*, etc., are actuated in that first portion of each machine cycle, and the misses and double switches **24, 26** are electrically enabled to be ready to produce new fault data if a malfunction should occur. The jamm detector switches **27** are preferably always able to produce signals, because the dc bus **29** energizes them.

In a later portion of the same machine cycle, following a phase delay introduced by the phase-delay devices **51, 56***a*, etc., new fault data from the switches **24, 26,** and **27** are entered into the appropriate shift registers **60, 64,** following which the data in those shift registers are shifted to the next succeeding stage in response to a pulse on a line **84** from the synchronized polyphase clock **64.**

If desired, the gatherer **18** may be divided into sections having, for example, four hoppers per section, with a different synchronizer *s'* like the synchronizer **62** for each section, and with the various sections mechanically driven out of phase with each other to distribute the torque load on a driving motor more uniformly throughout a machine cycle. Techniques involved in using more than one synchronizer are known in the prior art.

A second preferred embodiment of the invention is shown in FIGS. **1, 3, 4** and **5,** in which many functions of the collating apparatus are controlled by a software-entered program in a computer **10.** The programmable controller **12'** of FIG. **3,** which replaces the programmable controller **12** of the first preferred embodiment, is drawn so as to receive correspondingly labeled cables and lines *a***1**, *a***2**, *b*, *c*, *d*, *e*, *f*, *k*, *m*, *n* . . . *p*, *h*, and *j* from the collating machine **14** which is shown in the upper portion of FIG. **1.** Thus, FIG. **1** is applicable to both the first and second embodiments, and in the second embodiment FIGS. **3, 4,** and **5** have replaced FIG. **2.**

In the second preferred embodiment, the programmable controller **12'** receives signals from the collating machine **14** and stores them in storage registers from which they are read out periodically by a scanning unit and transmitted to the computer **10,** which then determines control signals and transmits the control signals back to the programmable controller **12'**, which in turn sends them to the collating machine **14.** The programmable controller **12'** receives input signals from the jam detector switches **27,** the miss switches **24,** the doubles switches **26,** and the synchronizing devices **62.** For example, signals indicating the actuation of a jam detector switch **27***b*, **27***d*, **27***f* . . . **27***p* are transmitted along lines *k*, *m*, *n* . . . *p* to separate stages of a jams storage register **160** in the programmable controller of FIG. **3.**

In a similar manner, signals from the miss switch **24***a* of the first hopper are transmitted on the line *c* to a first stage **148***a* of a storage register **148** in the programmable controller **12'**, and signals from the miss switch **24***b* of the second hopper are connected by way of a line *e* to a second stage **148***b* to the misses storage register **148,** FIG. **3.** The construction and operation of a doubles storage register **156** is similar to that of the misses storage register **148** just described. Signals produced by

the doubles switches 26*a*, 26*b*, etc., are entered into respective stages 156*a*, 156*b*, etc., of the doubles storage register 156.

Synchronizing signals produced by periodic closures of the synchronizing switch or switches 62 are stored in a sectional sync storage register 158 of the programmable controller 12'. This register periodically receives one or more synchronizing signals along a cable *b*. If only one synchronizing device 62 is employed to serve all 32 hoppers of the collating machine, only the first stage 158*a* of the storage register 158 receives signals upon each cycle of the collating machine 14. If instead, as is preferred, a separate synchronizing device, such as device *s'* of hopper No. 5, is provided for each four-hopper section of the collating machine 14, then signals are periodically provided by these additional synchronizing devices also, and are stored in additional stages such as stage 158*e* of the sectional sync storage register 158. The separate synchronizing devices are necessary when each four-hopper section is out of phase with the other four-hopper sections, as is the case in the preferred embodiment.

A read-only memory scan unit 150 scans the jams storage register 160 periodically to read the data sequentially from the stages of that register. The same scan unit 150 also frequently and periodically scans the data stored in the stages 148*a*, 148*b*, etc., of the misses storage register 148, as well as the data in the doubles storage register 156 and in the sectional sync signal storage register 158.

The scan unit 150 is a read-only memory unit having very high noise immunity and is capable, because of semipermanent internal programming, of performing sequential operations under its own control. It is paced by the sync signals from device 62. The read-only memory scan unit 150 and other devices of the programmable controller 12' are known in the prior art. For example, a typical commercial programmable controller of this type is being manufactured by The Digital Equipment Corporation of Maynard, Massachusetts, and is known as Model PDP-14. Methods for programming the read-only memory unit of the programmable controller 12' are well known and easy, and include programming from English statements, from ladder diagrams and from Boolean algebra equations.

The array of jams data, misses data, doubles data and synchronizing signals data that are stored in the respective storage registers 160, 148, 156, and 158 is periodically transmitted through the read-only memory scan unit 150 and from there through an input/output register 152 to the computer 10. In the computer 10, FIG. 4, these data are utilized under the control of programming instructions which were previously entered into a memory unit 100 of the computer 10 by a software program. The computer 10 determines the proper behavior of the feed devices 20*a*, 20*b*, 20*c*, and also determines whether or not to enable each of the miss switches 24 and doubles switches 26 upon each machine cycle so as to be capable of producing a signal if a fault should occur. The computer further determines whether or not to actuate the run contactor 80 in dependence upon the jam switches 27 and the switches 24, 26, and whether or not to actuate the reject actuator 30 in accordance with prior upstream behavior of the switches 27, 24 and 26. Instructions for these purposes that are generated by the computer 10 are transmitted to the input/output register 152 of the programmable controller 12', and under the control of the read-only scan unit 150, they are then transmitted to an output register 154 of the programmable controller 12'. The output register 154 applies control signals to the lines *a*1, *a*2, *h* and *j*, FIG. 1 and FIG. 3, to control the feed devices 20, to enable the malfunction swtiches 24, 26, to operate the reject actuator 30, and to trip the run contactor 80, respectively,

The computer 10 in the embodiment being described is a model PDP8 manufactured by the Digital Equipment Corporation of Maynard, Massachusetts; other computers could be employed instead. It includes an input/output interface unit 98, a memory unit 100, an arithmetic unit 102, and a control unit 104. Major communication routes between the units of the computer are shown in the greatly simplified block diagram of FIG. 4. The input/output interface unit 98 accommodates inputs and outputs of the computer 10 from any of a variety of sources and destinations. Program instructions are entered into the computer at a terminal 98*a* of the unit 98. Also, certain parameter values are entered at the terminal 98*a* and stored in the computer memory unit 100 before the collating machine 14 is started. Also entered at the terminal 98*a* are data representing the desired jam detector influence pattern, that is, information specifying whether or not a magazine that is two chain spaces upstream from a jam is to be rejected, one chain space upstream, right on the jam, one chain space downstream, etc.

After the computer has been thus programmed, subscriber data specifying the signatures to be used in forming magazines for a first group of subscribers is entered into the computer at the terminal 98*a*, preferably from a magnetic tape file 99. Other sources of input data can be employed, of course, including punched paper tape, punched cards, or a manually operated keyboard instrument. If desired, the input/output interface 98 may also transmit print-out information concerning the operation of the collating machine 14 to a teleprinter. Various other output devices may be used including paper tape, punched cards, and magnetic tape.

The memory unit 100 stores program instructions for use by the control unit 104, the jam detector influence pattern, and other instructions and data from and for use by the programmable controller 12'. Preferably, the memory unit 100 is a random access storage device such as an array of toroidal magnetic cores which store binary data by being magnetized in either a clockwise or counterclockwise direction. The memory unit 100 is preferably capable of storing more than two thousand words, each of which is 12 bits long typically. Each word space of data storage is identified by an address so that data can be written into the space or read out of it by addressing that location.

The arithmetic unit 102 performs the computations, counting, etc., that must be done by the computer. The principal component of the arithmetic unit is an accumulator which accumulates partial sums during arithmetical computations. The accumulator is surrounded by ancillary logic devices for assisting it.

The control unit 104 is a switching section which manages the operations of the computer 10. The control unit 104 withdraws program instructions in an orderly manner from the computer memory unit 100, and uses those instructions to control the arithmetic unit 102, the memory unit 100, and the input/output interface 98. The control unit 104 issues commands to the arithmetic unit 102 to tell it what to do, and to tell it

from what address in the memory unit it should obtain the data upon which it is to operate. When the arithmetic unit **102** has completed a task, the control unit **104** instructs the arithmetic unit as to what to do with the results, for example, to store the results in a particular address of the memory unit **100** for subsequent use.

Some of the contents of the memory unit **100** are indicated symbolically in FIG. **5.** The contents include program instructions stored in a group of storage locations **106,** each of which accommodates one word. Also stored in the memory unit is the jam detector influence pattern, in a memory location **142.** Hopper data or chain space data that are stored in the memory **100** include feed commands stored in a group of memory locations **108.** The core addresses **108** contain instructions to the hoppers **18** for controlling whether or not each of the feed devices **20***a*, **20***b*, **20***c*, etc., should feed a signature. Hence, the feed commands in the storage locations **108** specify the make-up of a particular type of magazine for a subscriber whose magazines are currently being assembled by the collating machine **14.**

The stored data in the memory unit **100** also include jams fault data in storage locations **110,** misses fault data in the storage locations **112,** doubles fault data in the storage registers **114,** and synchroninizing signal data in the storage registers **116,** the synchronizing data being relatively frequently updated by the scan unit **150** of the programmable controller **12'**.

Only a few interconnecting lines **117** are required between the input/output interface module **98** of the computer **10** and the programmable controller **12'**, because the scanning unit **150** multiplexes the signals passing between these two units.

Software is required for programming the computer **10,** including software to perform those functions of the second embodiment that were performed by the programmable controller **12** alone in the first embodiment. The preparation of the software for performing these clearly defined functions is well within the knowledge of those skilled in the art of programming process control computers and general purpose computers, and will not, therefore, be further elaborated here.

From the above, it should be clear that the present invention provides a substantial improvement over the art. Moreover, it should be apparent that the invention is applicable to collating equipment for assembling hard or soft cover books, magazines, pamphlets, etc., and the word "book" or "magazine" as used in the claims is intended to cover the assemblage of all such publications.

What is claimed is:

1. A collating apparatus for forming a book from a plurality of signatures, said apparatus comprising a gatherer conveyor having a plurality of conveyor spaces movable in a path successively past a plurality of signature feeding stations and adapted to receive signatures at said feeding stations to form an assembly of different signatures contributing toward a book in each conveyor space, at least one jam detector located on said path of said conveyor spaces for sensing a jam of said assemblies of different signatures as they are moved by said conveyor and for producing a code signal thereupon, means responsive to a code signal from said jam detector to stop said conveyor immediately upon a jam, manually operable means for restarting said conveyor, and reject means along said conveyor path following said plurality of feeding stations for rejecting signature assemblies from said conveyor and controlled by said code signal to reject books from successive conveyor spaces including the conveyor space nearest said jam detector as well as at least one conveyor space upstream from said nearest space and at least one conveyor space downstream from said nearest space when said jam detector produced said reject code signal.

2. A collating apparatus for producing different books composed of different predetermined combinations of signatures for different groups of subscribers classified in accordance with predetermined subscriber information, the apparatus comprising a gathering machine having a gatherer conveyor with a plurality of conveyor spaces movable successively along a path through a plurality of signature feeding stations and adapted to receive signatures at said feeding stations to form an assembly of different signatures contributing toward a book in each conveyor space as the conveyor space moves through the feeding stations, said gathering machine comprising signature feed means at each of said stations, said gathering machine operating in cycles, each cycle of operation causing successive feeding of signatures from at least some of said signature feed means to make up each book, each of said signature feed means having instruction means for instructing the associated signature feed means to feed or not feed during each gathering machine cycle, file means for storing information in machine readable form identifying different subscribers with different predetermined combinations of at least some of said signature feed means to be instructed to feed during a machine cycle to provide the predetermined combination of signatures constituting the appropriate book for each subscriber, reading means for reading said file means and instructing feeding of said signature feed means in the predetermined combination required to provide the different books appropriate for the corresponding subscribers, a plurality of jam detectors located on said path of said conveyor spaces for sensing a jam of said assemblies of different signatures as they are moved by said conveyor and each for producing a code signal thereupon, means responsive to a code signal from each of said jam detectors to stop said conveyor immediately upon a jam, manually operable means for restarting said conveyor, reject means along said conveyor path following said plurality of feeding stations and controlled by said code signals to reject books from the conveyor space nearest the signalling jam detector as well as at least one conveyor space upstream from said nearest space and at least one conveyor space downstream from said nearest space when any of said jam detectors produced said reject code signal.

3. A method of forming a book from a plurality of signatures, said method comprising the steps of advancing a gatherer conveyor having a plurality of conveyor spaces successively past a plurality of signature feeding stations and a reject station located downstream of said feeding stations, feeding signtures to the conveyor spaces at said feeding stations to form an assembly of different signatures contributing to a book in each conveyor space, sensing a jam of said assembly of different signatures at at least one jam sensing station along said gathering conveyor as said assemblies of signatures are moved by the conveyor past the plurality of feeding stations, stopping the gatherer conveyor promptly in response to said sensing, clearing the jam manually without necessarily inspecting and removing assemblies of signatures from conveyor spaces at and near the jam,

manually restarting the gatherer conveyor, subsequently in response to said sensing rejecting assemblies of signatures at said reject station from the conveyor space that was nearest the jam detector as well as at least one conveyor space upstream therefrom and at least one conveyor space downstream therefrom when the jam detector sensed the jam, when said consecutive conveyor spaces subsequently reach the reject station, and sensing a malfunction in the feeding of signatures at each feeding station and rejecting at the reject station the book in the chain space affected by said malfunction.

4. A collating apparatus for forming a book from a plurality of signatures, said apparatus comprising a gatherer conveyor having a plurality of conveyor spaces movable in a path successively past a plurality of signature feeding stations and adapted to receive signatures at said feeding stations to form an assembly of different signatures contributing toward a book in each conveyor space, at least one jam detector located on said path of said conveyor spaces for sensing a jam of said assemblies of different signatures as they are moved by said conveyor and for producing a code signal thereupon, means responsive to a code signal from said jam detector to stop said conveyor immediately upon a jam, manually operable means for restarting said conveyor, reject means along said conveyor path following said plurality of feeding stations for rejecting signature assemblies from said conveyor, and means controlled by said signal for actuating said reject means after manual operation of said means for restarting said conveyor to reject signature assemblies from at least three consecutive conveyor spaces including the conveyor space at which the jam occurred.

5. A collating apparatus as defined in claim **4** and further comprising storage means for storing said signal in response to the sensing of said jam, and wherein said means controlled by said signal for actuating said reject means comprises means responsive to the stored signal for actuating said reject device in time succession once for each conveyor space when said two or more successive conveyor spaces are successively at said reject device.

6. A collating apparatus as defined in claim **5** and wherein said storage means for storing said signal comprises means for tracking the particular identified conveyor space that was nearest said jam detector when said jam detector produced said signal, as said particular conveyor space moves through the collating apparatus to said reject means, and wherein said means for tracking further includes means for tracking all of the identified conveyor spaces from which books are to be rejected as said spaces move through the collating apparatus.

7. A collating apparatus as defined in claim **6** and further comprising signature feed means located at each of said signature feeding stations and selectively controllable to feed or to not feed a signature, and downstream shutoff means responsive to said means for tracking the conveyor spaces to control each of said signature feed means downstream from the most upstream of said identified conveyor spaces to not feed a signature when said identified conveyor spaces are at the respective feeding stations.

8. A collating apparatus as defined in claim **7** and wherein said means for tracking all of the identified conveyor spaces from which books are to be rejected comprises a shift register having data stages representing stations including signature feeding stations and the reject station, and further comprises means for simultaneously storing replications of said signal in a plurality of contiguous ones of said data stages representing locations of said identified conveyor spaces, and wherein said shift register comprises means for shifting all of said replications, and wherein said means for actuating said reject device in time succession comprises means responsive to the arrival successively of each of said replications of said signal at said data stage representing said reject station.

9. A collating apparatus as defined in claim **4** and wherein said means for actuating said reject means comprises means for selectively programming a jam detector influence pattern to specify which conveyor spaces are to have their books rejected in response to the sensing of a jam by said jam detector, and means for storing the selective program for actuating said reject means in response to said reject code signal.

10. A collating apparatus for producing different books composed of different predetermined combinations of signatures for different groups of subscribers classified in accordance with predetermined subscriber information, the apparatus comprising a gathering machine having a gatherer conveyor with a plurality of conveyor spaces movable successively along a path through a plurality of signature feeding stations and adapted to receive signatures at said feeding stations to form an assembly of different signatures contributing toward a book in each conveyor space as the conveyor space moves through the feeding stations, said gathering machine comprising signature feed means at each of said stations, said gathering machine operating in cylces, each cycle of operation causing successive feeding of signatures from at least some of said signature feed means to make up each book, each of said signature feed means having instruction means for instructing the associated signature feed means to feed or not feed during each gathering machine cycle, file means for storing information in machine readable form identifying different subscribers with different predetermined combinations of at least some of said signature feed means to be instructed to feed during a machine cycle to provide the predetermined combination of signatures constituting the appropriate book for each subscriber, reading means for reading said file means and instructing feeding of said signature feed means in the predetermined combination required to provide the different books appropriate for the corresponding subscribers, at least one jam detector located on said path of said conveyor spaces for sensing a jam of said assemblies of different signatures as they are moved by said conveyor and for producing a code signal thereupon, means responsive to a code signal from said jam detector to stop said conveyor immediately upon a jam, manually operable means for restarting said conveyor, reject means along said conveyor path following said plurality of feeding stations for rejecting signature assemblies from said conveyor, and means controlled by said signal for actuating said reject means after manual operation of said means for restarting said conveyor to reject signature assemblies from at least three consecutive conveyor spaces including the conveyor space at which the jam occurred.

11. A method of forming a book from a plurality of signatures, said method comprising the steps of advancing a gatherer conveyor having a plurality of conveyor spaces successively past a plurality of signature feeding

stations and a reject station located downstream of said feeding stations, feeding signatures to the conveyor spaces at said feeding stations to form an assembly of different signatures contributing to a book in each conveyor space, sensing a jam of said assembly of different signatures at at least one jam sensing station along said gatherer conveyor as said assemblies of signatures are moved by the conveyor past the plurality of feeding stations, stopping the gatherer conveyor promptly in response to said sensing, clearing the jam manually without necessarily inspecting and removing assemblies of signatures from conveyor spaces at and near the jam, manually restarting the gatherer conveyor, and subsequently in response to said sensing rejecting assemblies of signatures at said reject station from at least three consecutive conveyor spaces including the conveyor space at which the jam occurred when the jam detector sensed the jam, when said consecutive conveyor spaces subsequently reach the reject station.

12. A method as defined in claim **11** further including sensing a malfunction in the feeding of signatures at each feeding station and at the reject station rejecting the book in the chain space affected by said malfunction.

13. A collating apparatus for forming a book from a plurality of signatures, said apparatus comprising a gatherer conveyor having a plurality of conveyor spaces movable in a path successively past a plurality of signature feeding stations and adapted to receive signatures at said feeding stations to form an assembly of different signatures contributing toward a book in each conveyor space, at least one jam detector located on said path of said conveyor spaces for sensing a jam of said assemblies of different signatures as they are moved by said conveyor and for producing a code signal thereupon, means responsive to a code signal from said jam detector to stop said conveyor immediately upon a jam, manually operable means for restarting said conveyor, reject means along said conveyor path following said plurality of feeding stations for rejecting signature assemblies from said conveyor, and means controlled by said signal for actuating said reject means after manual operation of said means for restarting said conveyor, programming means independently settable with respect to said jam detectors for providing an influence pattern, and means coupling said influence pattern to said reject means for rejecting signature assemblies from at least two consecutive conveyor spaces including the conveyor space at which the jam occurred when said jam detector produced said signal.

14. A collating apparatus for producing different books composed of different predetermined combinations of signatures for different groups of subscribers classified in accordance with predetermined subscriber information, the apparatus comprising a gathering machine having a gatherer conveyor with a plurality of conveyor spaces movable successively along a path through a plurality of signature feeding stations and adapted to receive signatures at said feeding stations to form an assembly of different signatures contributing toward a book in each conveyor space as the conveyor space moves through the feeding stations, said gathering machine comprising signature feed means at each of said stations, said gathering machine operating in cycles, each cycle of operation causing successive feeding of signatures from at least some of said signature feed means to make up each book, each of said signature feed means having instruction means for instructing the associated signature feed means to feed or not feed during each gathering machine cycle, file means for storing information in machine readable form identifying different subscribers with different predetermined combinations of at least some of said signature feed means to be instructed to feed during a machine cycle to provide the predetermined combination of signatures constituting the appropriate book for each subscriber, reading means for reading said file means and instructing feeding of said signature feed means in the predetermined combination required to provide the different books appropriate for the corresponding subscribers, at least one jam detector located on said path of said conveyor spaces for sensing a jam of said assemblies of different signatures as they are moved by said conveyor and for producing a code signal thereupon, means responsive to a code signal from said jam detector to stop said conveyor immediately upon a jam, manually operable means for restarting said conveyor, reject means along said conveyor path following said plurality of feeding stations for rejecting signature assemblies from said conveyor, and means controlled by said signal for actuating said reject means after manual operation of said means for restarting said conveyor, programming means independently settable with respect to said jam detectors for providing an influence pattern, and means coupling said influence pattern to said reject means for rejecting signature assemblies from at least two consecutive conveyor spaces including the conveyor space at which the jam occurred when said jam detector produced said signal.

15. A method of forming a book from a plurality of signatures, said method comprising the steps of advancing a gatherer conveyor having a plurality of conveyor spaces successively past a plurality of signature feeding stations and a reject station located downstream of said feeding stations, feeding signatures to the conveyor spaces at said feeding stations to form an assembly of different signatures contributing to a book in each conveyor space, sensing a jam of said assembly of different signatures at at least one jam sensing station along said gatherer conveyor as said assemblies of signatures are moved by the conveyor past the plurality of feeding stations, stopping the gatherer conveyor promptly in response to said sensing, clearing the jam manually without necessarily inspecting and removing assemblies of signatures from conveyor spaces at and near the jam, manually restarting the gatherer conveyor, programming an influence pattern independently settable with respect to jam sensing for a pattern of signatures to be rejected in response to sensing a jam and subsequently in response to said sensing rejecting assemblies of signature at said reject station in accordance with said influence pattern from at least two consecutive conveyor spaces including the conveyor space at which the jam occurred when the jam detector sensed the jam, when said consecutive conveyor spaces subsequently reach the reject station.

* * * * *