United States Patent [19]

Yanagawa

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[54] **COLLATOR**

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[30] **Foreign Application Priority Data**

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July 22, 1970	Japan	45/72690 (utility model)
July 29, 1970	Japan	45/65802

[52] **U.S. Cl.** **270/58,** 209/74, 271/64

[51] **Int. Cl.** **B65h 39/02**

[58] **Field of Search** 270/58, 51; 271/64; 209/74

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[57] **ABSTRACT**

A collating device having an array of shelves for receiving sheets to be collated, a belt for conveying the sheets along a path traversing the array of shelves, and a set of feed rollers associated with each shelf. All the sets of rollers are arranged to rotate normally in one direction and disposed to cooperate with the belt, when rotating in that direction, to feed successive sheets past the shelves. Means are provided for selectively rotating a particular set of feed rollers in reverse direction for feeding a sheet to a particular selected shelf. The sets of rollers respectively associated with successive shelves may be subjected in succession to the reverse rotation so that successive sheets are respectively delivered to the successive shelves.

12 Claims, 12 Drawing Figures

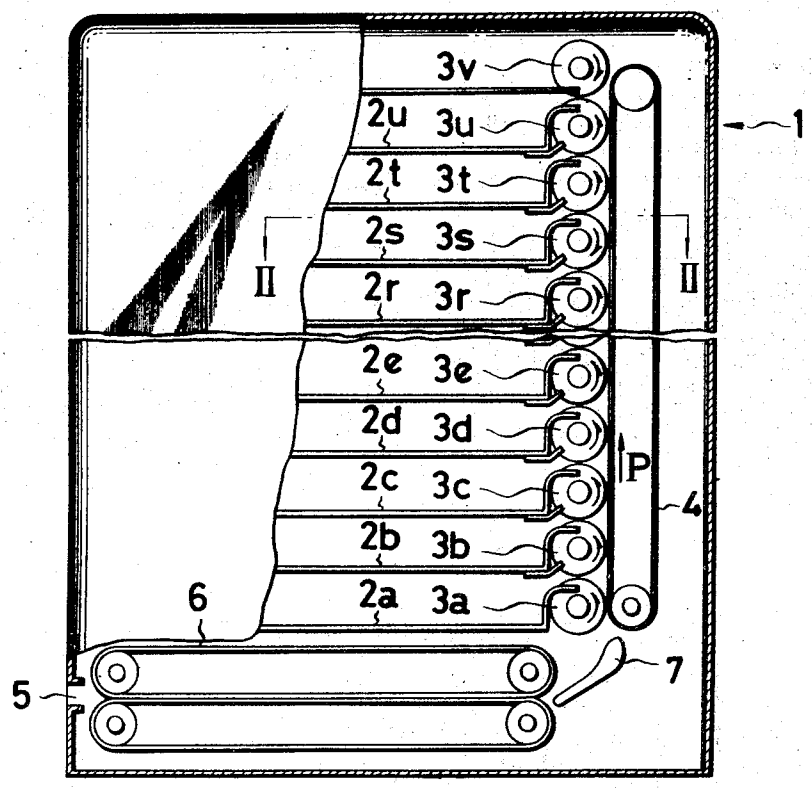
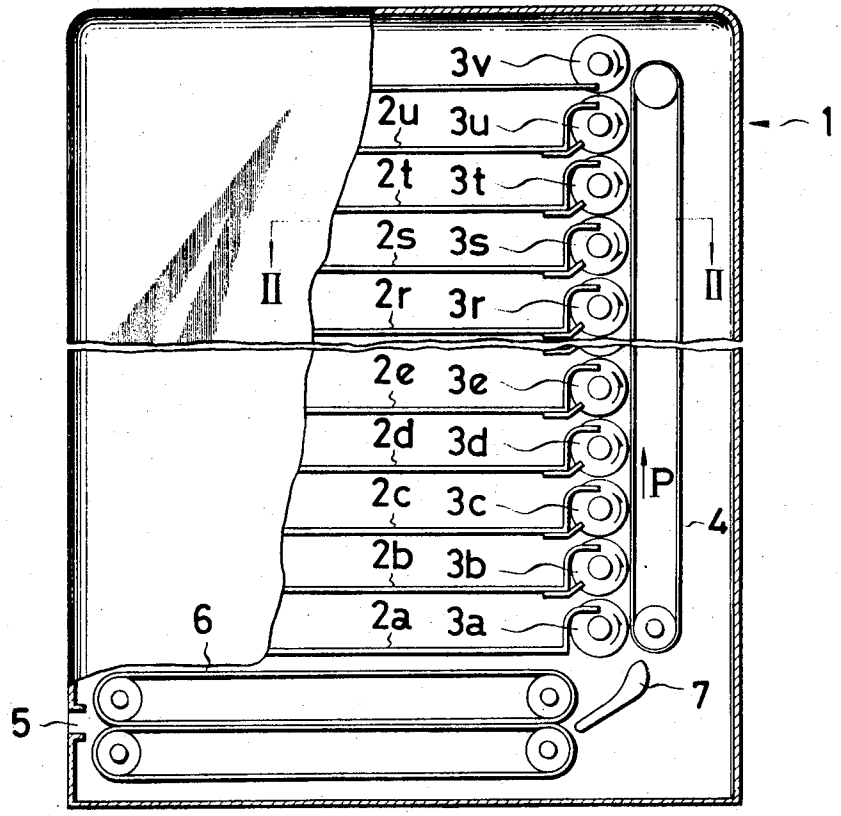
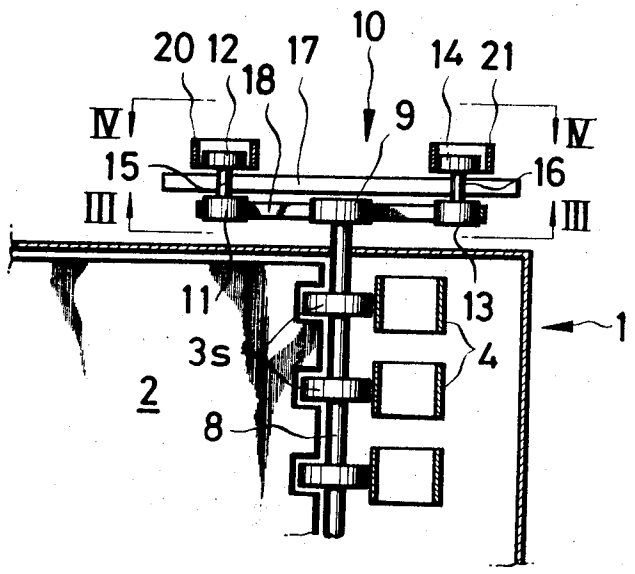


Fig. 1



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Fig. 2



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Fig. 3

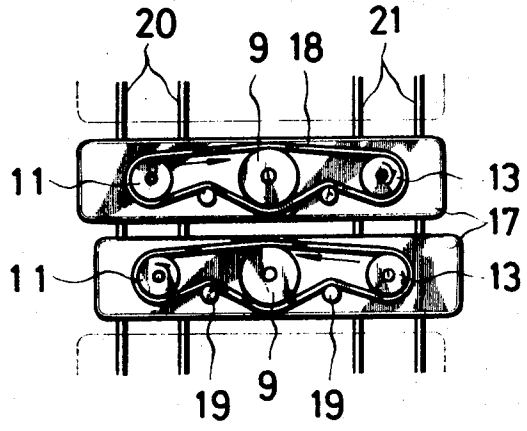
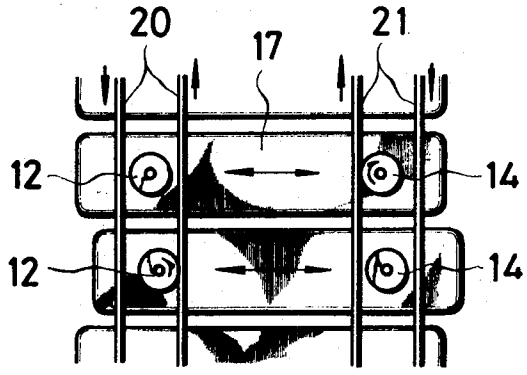
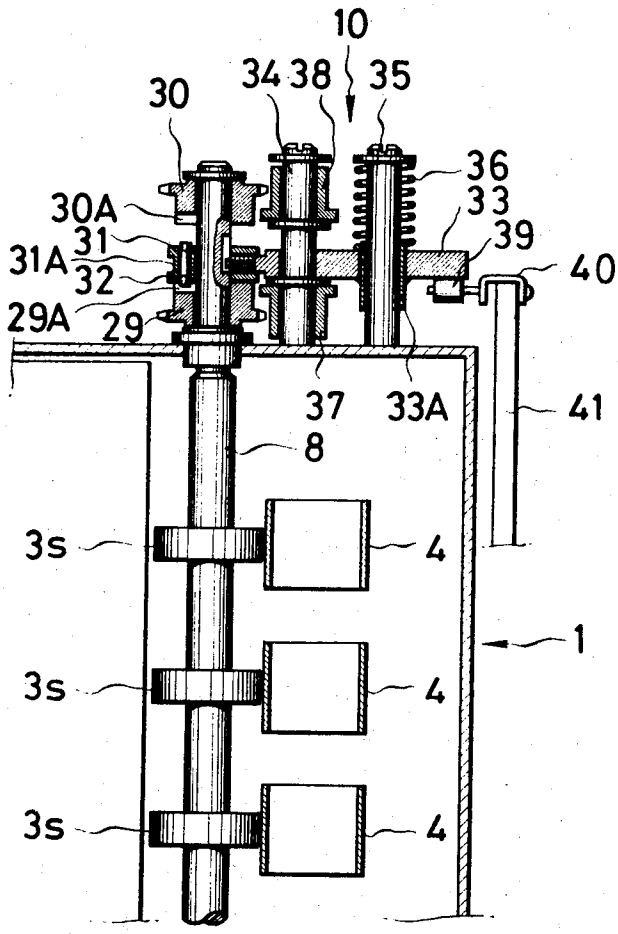


Fig. 4



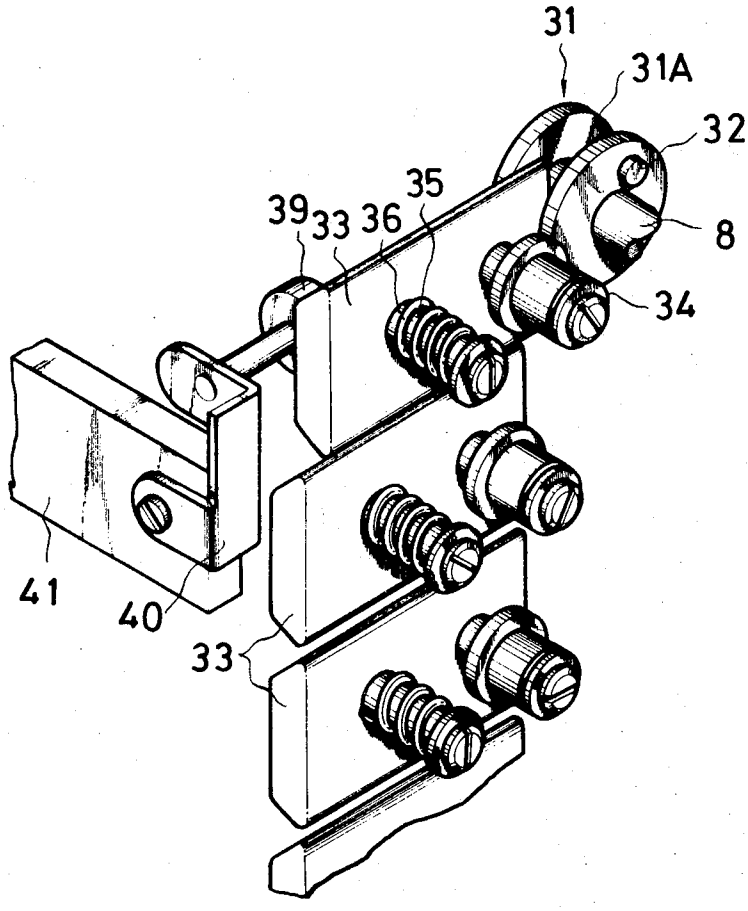
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Fig.5



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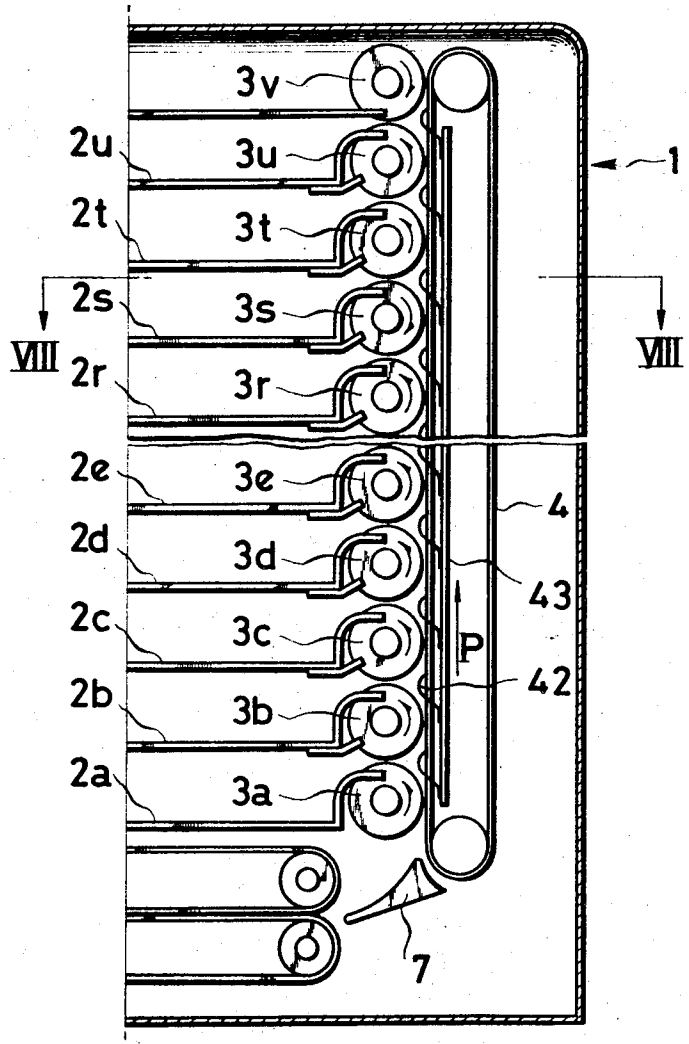
Fig.6



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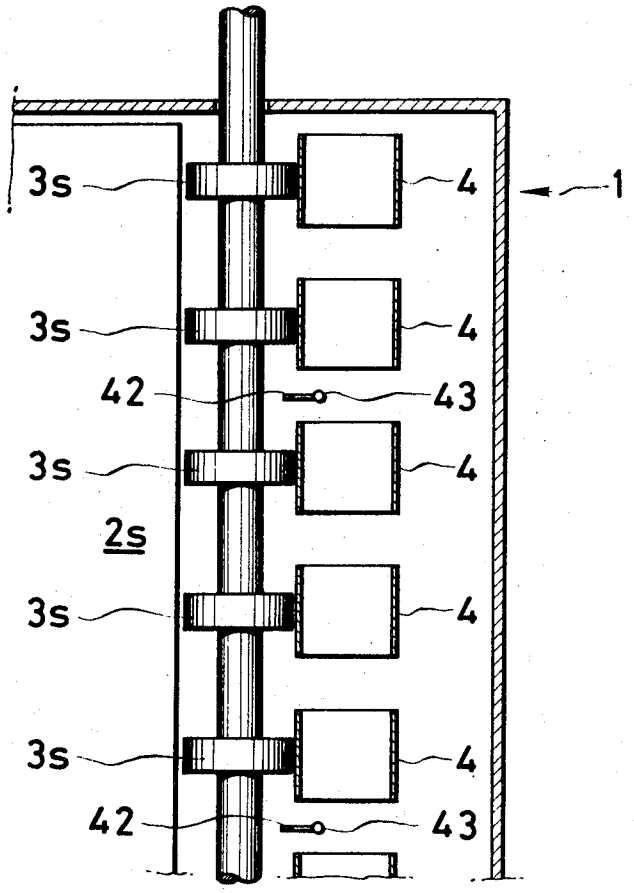
Fig. 7



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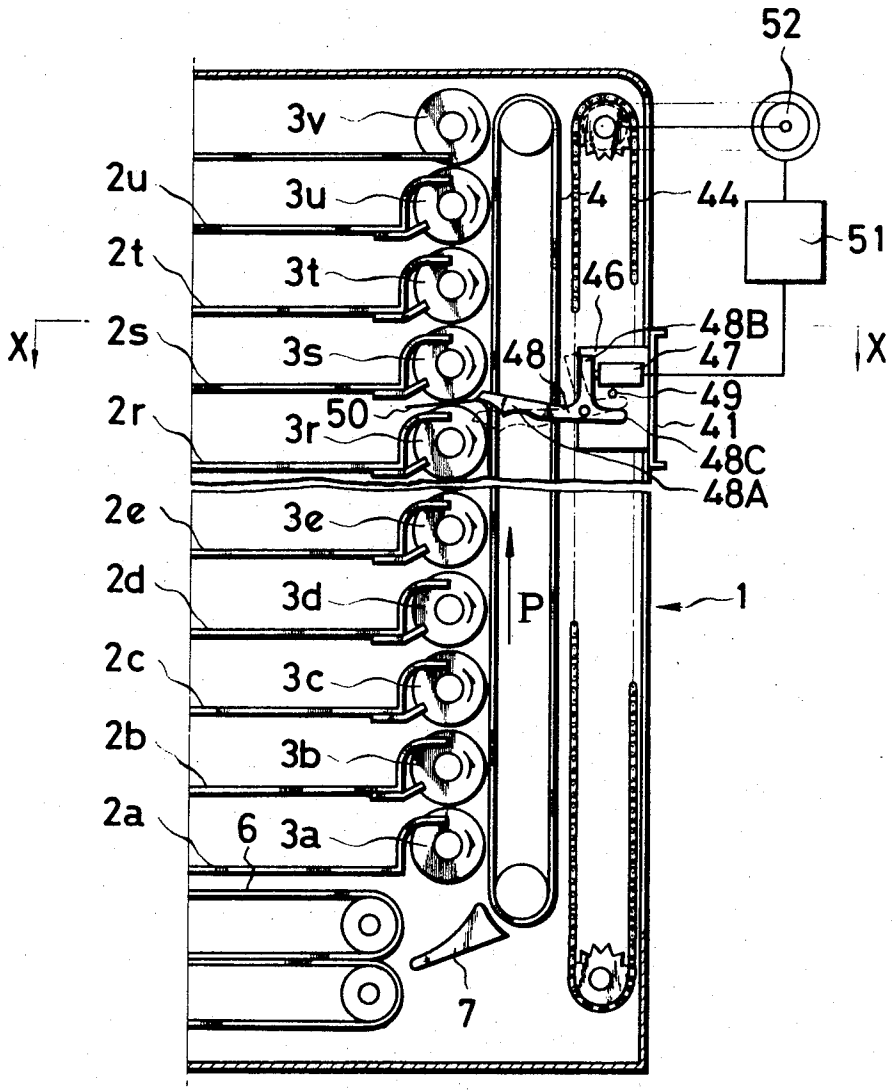
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Fig.8



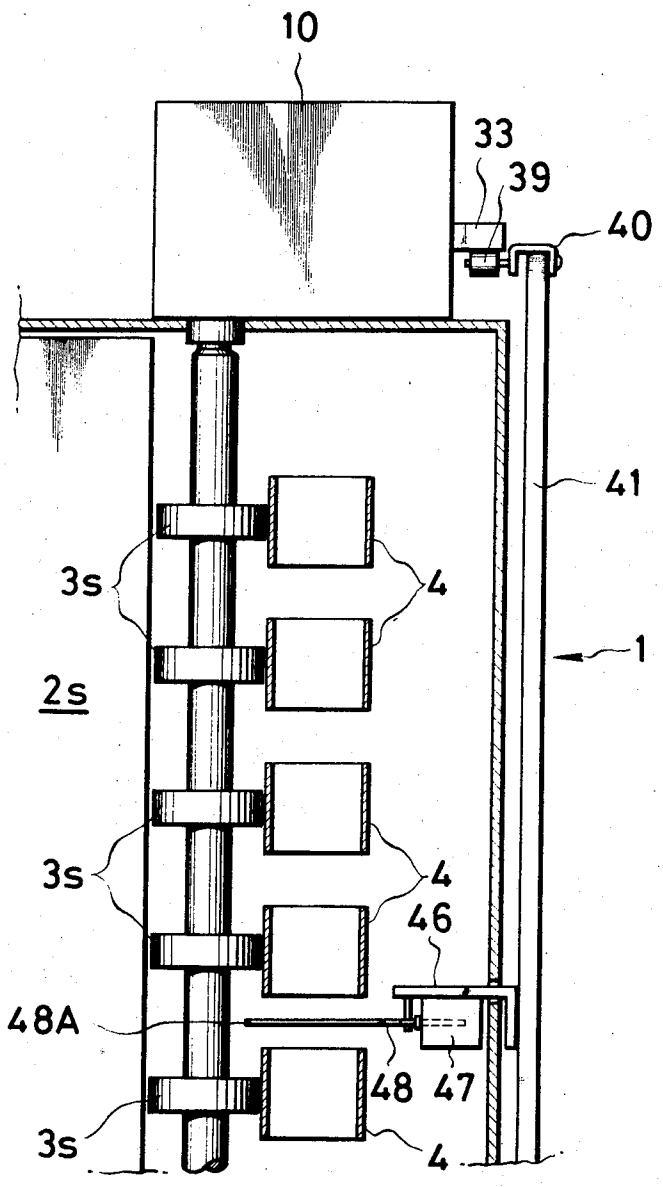
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Fig. 9



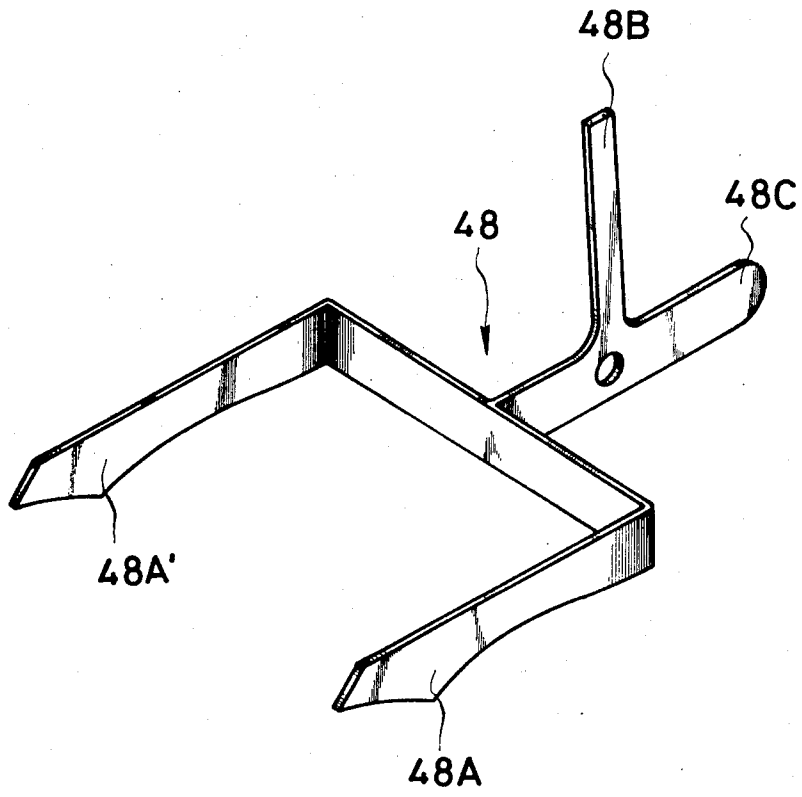
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Fig.10



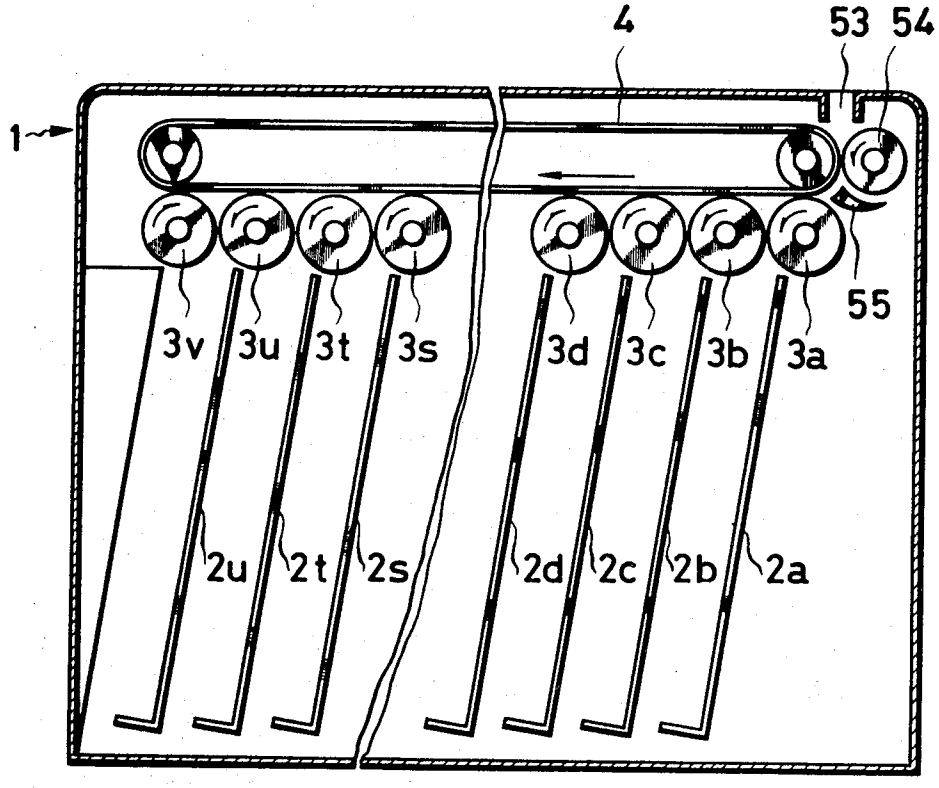
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Fig. 11



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Fig.12



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COLLATOR

BACKGROUND OF THE INVENTION

This invention relates to a collator provided with a number of sheet-receiving shelves arranged in side-by-side relationship for successively receiving therein copied sheets or printed sheets which are delivered to the collator. More particularly, the invention is directed to a collating device having an array of sheet-receiving shelves and incorporating new and improved means for delivering successive sheets to successive shelves in the array.

Mechanical collating devices are widely used to assemble plural copies of multipage or multisheet documents or other records, i.e. printed or otherwise reproduced on a suitable recording medium in sheet form such as paper or the like. Such devices may be used, for instance, in association with printing presses or copying machines on which the individual sheets to be collated are printed or otherwise reproduced. In an illustrative example, for production of a selected number of copies of a multipage report or other document on a copying machine, the copying machine produces in succession the desired number of copies of the first page of the report, then an equal number of copies of the second page, continuing until the requisite number of copies of the requisite number of pages have been completed. A collator as contemplated herein may be arranged to receive the successive sheets or pages as they are produced by the copying machine and to assemble them into copies of the complete multipage report.

For purposes such as the foregoing, a typical collating device is provided with an array of sheet-receiving shelves, at least equal in number to the number of copies to be collated, and typically arranged in a more or less vertical or horizontal stack. Means are provided for distributing to these shelves in succession the successively produced copies of each page. Thus, as the desired number of copies of the first page to be collated are received from the copying machine in succession, they are delivered in succession to successive shelves of the array. The same number of copies of the next page of the report, again delivered in succession to the collator from the copying machine, are likewise distributed in succession to the same successive shelves. While various arrangements are known for accomplishing the function of delivering or distributing successively received sheets to different shelves in a mechanical collating device, these known arrangements have in general presented difficulties, for example with respect to cost, structural complexity, and operating convenience or assured effectiveness.

In one type of collator known in the art, two sets of rollers are provided for each sheet-receiving shelf and the sheets, conveyed by belts, are successively guided to the successive paired sets of rollers to deliver the sheets to each shelf. This collating device has a disadvantage in that it is high in cost because of the provision of two sets of rollers for each shelf. Another disadvantage is that the diameter of each roller must be less than one half the spacing between the adjacent shelves and rollers of such small diameter are commonly found to be too small in size to firmly catch the sheet therebetween.

In another type of the collator known in the art, sheet distributor means provided with a pair of rollers are adapted to move along the sheet-receiving shelves and stop at each shelf in succession. This collator device has the disadvantage of being complex in construction because the sheet distributor means must be precise and positive in moving from one shelf to another step by step and, at the same time, the sheets must be conveyed to the sheet distributor means, for example, under suction.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a collating device, of the type having an array of sheet-receiving shelves, incorporating new and improved means for distributing successively received sheets to successive shelves of the array, obviating the aforementioned and other disadvantages of conventional collator devices as described above, and providing a collator of a relatively simple construction.

To this and other ends, the invention broadly contemplates collating apparatus including, in combination with a plurality of sheet-receiving shelves disposed in succession along a path of advance for the sheets, and conveyor means for advancing successive sheets to be collated along that path, a plurality of rotatably mounted roller structures for feeding the sheets, respectively associated with successive shelves of the array, and means hereinafter further described for effecting and controlling rotation of the roller structures in a particular manner.

In accordance with the invention, the roller structures are normally rotated in one given direction and are so disposed as to cooperate (when rotating in that direction) with the conveyor means in feeding the sheets along the path of sheet advance. However, each roller structure is further adapted to be rotated in a direction reverse to the aforementioned given direction and is disposed to cooperate (when rotating in such reverse direction) with the roller structure associated with an adjacent shelf (the latter roller structure rotating in the normal direction) to feed a sheet from the path to the adjacent shelf.

Further in accordance with the invention, means are provided for selectively effecting rotation of a particular roller structure in reverse direction. Also, means are provided for successively actuating the roller-reversing means so that as successive sheets are fed along the path, the roller structures are successively reversed to feed the successive sheets to successive shelves in the array. Guide means for assisting the feeding of successive sheets to successive shelves by the roller structures may also be incorporated in the apparatus in accordance with the invention.

The roller structure associated with each shelf may be a single roller or a single set of rollers spaced along a common shaft for rotation about a common axis.

The described apparatus enables positive distribution of successive sheets to the successive sheet-receiving shelves and is additionally advantageous in that only one set of feed rollers is associated with each of the sheet-receiving shelves; the belt or conveyor means cooperate with the sets of feed rollers rotating in normal direction so as to convey sheets, one set of feed rollers being selectively rotated in reverse direction so as to feed a sheet to a predetermined sheet-receiving shelf by cooperation of the set of feed rollers rotating in reverse direction with an adjacent set of feed rollers rotating in normal direction.

Since, as stated, according to this invention each shelf for receiving sheets therein is provided with only one set of rollers, such rollers can have a relatively large diameter. These feed rollers cooperate with belt means for conveying sheets and introduce the sheets into each shelf, affording an advantageously simplified collator construction.

Additional features and advantages of the invention will become evident from the description set forth hereinafter when considered in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic sectional view of a collator embodying the present invention in a particular form;

FIG. 2 is a sectional view taken along the line II—II of FIG. 1, showing the feed roller reverse means;

FIG. 3 is a view taken along the line III—III of FIG. 2;

FIG. 4 is a view taken along the line IV—IV of FIG. 2;

FIG. 5 is a sectional view similar to FIG. 2 showing another form of feed roller reverse means;

FIG. 6 is a fragmentary perspective view of the feed roller reverse means of FIG. 5;

FIG. 7 is a schematic sectional view similar to FIG. 1 of a collator embodying the present invention, showing sheet-leading end deflector means provided in the collator;

FIG. 8 is a sectional view taken along the line VIII—VIII of FIG. 7;

FIG. 9 is a schematic sectional view of a collator embodying the invention and provided with vertically movable detector switch means constructed according to the invention;

FIG. 10 is a sectional view taken along the line X—X of FIG. 9;

FIG. 11 is a perspective view of the actuator of the detector switch means of FIG. 9; and

FIG. 12 shows another embodiment of the collator according to this invention.

DETAILED DESCRIPTION

In FIG. 1, there is a collator generally designated 1 which comprises a number of sheet-receiving shelves 2*a*, 2*b*, 2*c* . . . 2*u*, arranged horizontally in side-by-side relationship (i.e. vertically spaced parallel relationship) and spaced from one another equidistantly. With each of the shelves there is associated a roller structure comprising a set of feed rollers (respectively designated 3*a*, 3*b*, 3*c* . . . 3*u*) disposed at the inlet end of the shelf. As shown, each set of feed rollers is constituted of a plurality of short rollers mounted in spaced relation to each other along a common shaft for rotation therewith about a common axis. Another similar set of rollers designated 3*v* may be mounted beyond the last set of feed rollers 3*u* (associated with shelf 2u); in the form shown, the axes of rotation of all the sets of feed rollers, including set 3v, are horizontal and lie in a common vertical plane.

Endless belt means 4 comprising a plurality of belts (corresponding in number and spacing to, and respectively in register with, the plural individual rollers of each of the aforementioned sets of feed rollers) is mounted adjacent the feed rollers 3*a*, 3*b*, 3*c* . . . 3*u*, for unidirectional movement (i.e. in the direction shown by arrow P) at all times. The feed rollers are disposed in close proximity to, but are prevented from coming into contact with, one another and the endless belt means 4.

Successive copied sheets of paper or other sheet-form recording medium delivered from a copying machine (or printed sheets from a printing press) are supplied to an inlet opening 5 of the collator and are conveyed in succession by a further endless belt means 6 and a guide 7 to the aforementioned endless belt means 4, to be held between the belt means 4 and the set of feed rollers 3a so that they may be moved upwardly.

Each of the sets of feed rollers 3*a* . . . 3*u* associated with the respective shelves is normally rotated in counter-clockwise direction as seen in FIG. 1 for cooperation with the belts 4 in advancing the successively supplied sheets (i.e. sheet copies of a given page) upwardly in the direction P, the successive sheets being gripped as described between the feed rollers and the belts 4 for such upward movement. The last set of feed rollers in the array (rollers 3*v*) may be rotated at all times in clockwise direction as seen in FIG. 1, i.e. in a direction reverse to the normal direction of rotation of the rollers 3*a* . . . 3*u*. Furthermore, at least each of the sets of rollers associated with the second and successive shelves of the array (i.e. rollers 3*b* . . . 3*u*) may be selectively rotated in the reverse, i.e. clockwise direction; in FIG. 1, the set of rollers 3*s* is indicated as being rotated in reverse direction.

Thus at the stage of operation shown in FIG. 1, all the feed rollers, except for the sets of feed rollers 3*s* and 3*v*, for example, rotate in the counterclockwise direction as indicated by arrows, in which direction the sheets are moved upwardly by the feed rollers cooperating with the endless belt means, while the sets of feed rollers 3*s* and 3*v* rotate in opposite direction. With this arrangement, a sheet held between the endless belt system 4 and the set of feed rollers 3*a* is moved upwardly by being successively held by the sets of feed rollers 3*b*, 3*c* . . . and endless belt means 4 till it reaches the set of feed rollers 3*s* which rotate in opposite direction. The sheet reaching the set of feed rollers 3*s* has its leading end deflected horizontally by the rollers 3*s* rotating in a direction opposite to the direction of movement of the endless belt means 4, so that the sheet is urged by the set of rollers 3*s* to change its direction of movement and move between the sets of feed rollers 3*s* and 3*r* into the sheet-receiving shelf 2*r*.

The sets of feed rollers 3*a* to 3*u* normally rotate in a direction in which they cooperate with the endless belt means 4 to move the sheets upwardly, and the particular set of rollers adjacent (i.e. just above) the shelf which is to receive a particular advancing sheet is selectively rotated in a direction opposite to the direction of rotation of other sets of feed rollers. The uppermost set of feed rollers 3*v* may, as stated, be rotated in a direction opposite to the direction of rotation of other sets of rollers at all times.

In accordance with the invention, means are provided for selectively effecting reverse rotation of each set of feed rollers associated with a sheet-receiving shelf, i.e. except for the set 3*a*. It will be appreciated from the foregoing description that such reverse rotation of any particular set of rollers effects feeding of a sheet from the path defined by belts 4 into the shelf immediately preceding that set of rollers (i.e. in the direction of sheet advance), the reversely rotating rollers cooperating with the normally rotating rollers associated

with such preceding shelf to accomplish the desired feeding. Accordingly, the first set of rollers 3*a* need not be provided with means for effecting reverse rotation because feeding of sheets to the first shelf 2*a* is accomplished by reversing the rotational direction of the second set of rollers 3*b*. Also, the last set of rollers 3*v* may always rotate in reverse direction because it is used only to feed a sheet to the last shelf 2*u* in cooperation with the rollers 3*u*.

One form of means for effecting selective reverse rotation of a particular set of feed rollers in accordance with the invention is illustrated in FIGS. 2, 3 and 4. In FIG. 2, the endless belt means 4 is shown as comprising a plurality of belts respectively disposed adjacent the feed rollers of the set 3*s* (which are secured to a shaft 8), these rollers 3*s* being equal in number to the belts of belt means 4. A roller 9 is secured to an end of the shaft 8 disposed outwardly of the casing of collator 1 so that the shaft 8 may be operatively connected to rotation control means 10 through the roller 9.

The rotation control means 10 associated with the set of rollers 3*s* comprises a sliding plate 17 (i.e. slidably mounted on suitable support structure, not shown for simplicity of illustration) and rotatably supporting roller shafts 15 and 16 having rollers 11, 12 and 13, 14 attached to the opposite ends thereof respectively, and an endless belt 18 mounted on the rollers 11, 9 and 13. Preferably, tension wheels 19 shown in FIG. 3 are provided for the endless belt 18 to increase the length of the portion of belt 18 brought into contact with the periphery of the roller 9. Endless drive belts 20 and 21 are provided and so mounted that the rollers 12 and 14 of the rotation control means 10 for all the sets of feed rollers 3*a* to 3*v* may be disposed between the right and left runs of the endless belts 20 and 21 respectively. As will be understood, each of the sets of rollers is provided with a rotation control means as just described.

The sliding plate 17 of each rotation control means 10 is slidable to right and left, i.e. horizontally, in relation to shaft 8. As shown in FIG. 4, the roller 14 is brought into contact with the left or upwardly moving run of the belt 21 and rotated thereby when the sliding plate 17 is in its farthest left position, while the roller 12 is disposed intermediate between the right and left runs of the belt 20 and kept from contacting either of them. When the sliding plate 17 is in this position, the endless belt 18 moves in the direction indicated by the arrow in the upper one of the sliding plates 17 shown in FIG. 3. When the sliding plate 17 is in its farthest right position as shown in the lower sliding plate 17 of FIG. 4, the roller 12 is brought into contact with the right or upwardly moving run of the belt 20 and rotated thereby while the roller 14 is disposed intermediate between the right and left runs of the belt 21 and kept from coming into contact therewith. When the sliding plate 17 is in this position, the endless belt 18 moves in a direction indicated by the arrow in the lower sliding plate in FIG. 3. By moving the sliding plate 17 to either the rightmost or leftmost position, it is possible to select as desired the direction of rotation of the endless belt 18 and hence the direction of rotation of the roller 9 and the associated set of feed rollers 3*a* . . . 3*u*. Thus, when a sheet is to be fed to the sheet-receiving shelf 2*r*, for example, the set of feed rollers 3*s* for the sheet-receiving shelf 2*s* disposed immediately above the shelf 2*r* is rotated in a direction opposite to the direction of all other sets of feed rollers as described with reference to FIG. 1. This causes the sheet to advance upwardly along the path defined by belts 4 until it reaches the pair of sets of feed rollers 3*r*, 3*s*, and the sheet is then diverted out of the path of advance and fed to the shelf 2*r*. For successive feeding of sheets to successive shelves, the sliding plates 17 respectively associated with successive sets of rollers are moved in turn from their normal positions wherein the rollers are driven counterclockwise as seen in FIG. 1, to positions in which the rollers are driven clockwise as seen in FIG. 1, and after a sheet has been fed to a particular shelf by virtue of such clockwise rotation, the sliding plate associated with the clockwise-rotating set of rollers is returned to its normal position to change the direction of rotation back to counter-clockwise direction, while the next higher sliding plate is moved in the manner described to reverse the direction of rotation of its associated set of rollers, for feeding a sheet to the next higher shelf.

Instead of the arrangement shown in FIG. 1, the sheet inlet 5 and belt conveyor means 6 may be provided in the upper portion of the collator 1 so as to move the sheets downwardly along the inlets of the sheet-receiving shelves. When this is the case, the sets of feed rollers 3*a*, 3*b*, 3*c* . . . 3*u* and endless belt means 4 are rotated and moved respectively in directions opposite to the directions in which they are shown to rotate and move respectively in FIG. 1, while the lowermost set of feed rollers are rotated in a direction opposite to the direction of rotation of other sets of feed rollers at all times.

In FIG. 5, there is shown an alternative form of rotation control means in accordance with the invention for each of the sets of feed rollers in the collating device of FIG. 1. The form of rotation control means shown in FIG. 5 includes two sprockets 29 and 30 mounted on an extension of the shaft 8 of each set of feed rollers such that they are rotatable relative to the shaft 8 but immovable axially thereof. A control wheel 31 is mounted on the extension of the shaft 8 in a position intermediate between the two sprockets 29 and 30 such that it is not rotatable relative to the shaft 8 but slidably movable axially thereof. Provided in the control wheel 31 and disposed to extend through the wheel 31 axially thereof is a pin 32 which, when the control wheel 31 moves in sliding motion on the shaft 8 axially thereof, is adapted to be received in an engaging recess 29A formed at one side of the sprocket 29 or an engaging recess 30A formed at one side of the sprocket 30. The sprockets 29 and 30 are rotated in opposite directions by chains (not shown) at all times. It will be understood that the chains interconnect the respective sprockets of the rotation control means of all the sets of feed rollers, and that the chains are further engaged by appropriate drive means (also not shown) for effecting their respectively oppositely directed continuous advance for rotating the sprockets in the manner just described.

The control wheel 31 is formed on its peripheral surface with an annular groove 31A which receives therein a complementary engaging portion of a control plate 33. The control plate 33 is slidably supported by bars 34 and 35 attached to the casing at one end. The control plate 33 is supported by the bar 35 through a relatively elongated sleeve 33A so as to ensure that the control plate 33 is maintained in the desired disposition normal to the bar 35 during its sliding motion. The control plate 33 is normally urged by a compression spring

36 mounted on the bar 35 to move toward the casing, so that the control wheel 31 is brought into engagement through the pin 32 with the sprocket 29 normally rotating in normal direction. Stoppers 37 and 38 are fixedly mounted on the bar 34 for defining two control end positions of the control plate 33.

As shown in FIG. 6, actuating means comprising a roller 39, a plate 40 for rotatably carrying the roller 39 and a sliding plate 41 is disposed for movement up and down along the casing of the collator. When this actuating mechanism is shifted, the roller 39 moves the control plate 33 against the biasing force of the spring 36, so that the control wheel 31 is also moved. As a result, the control sheel 31 is released from engagement with the sprocket 29 and brought into engagement with the sprocket 30.

The control means shown in FIG. 5 operates as follows: the actuating mechanism capable of moving up and down is successively moved, by signals produced by switch means (such as a switch 47 of FIG. 9 subsequently to be described) which detects the movement of sheets, into positions in which it actuates the control plates 33 for the respective sets of rollers 3*a*, 3*b* . . . 3*u*. When the roller 39 is disposed against the control plate 33 for one shelf and moves the same against the biasing force of the spring 36 as shown in FIG. 6, the control wheel 31 is released from engagement with the sprocket 29 and brought into engagement with the sprocket 30 as the pin 32 is received at the other end thereof in the engaging recess 30a of the sprocket 30 rotating in reverse rotation, so that the direction of rotation of the control wheel 31 is reversed. Accordingly, the shaft 8 and the set of feed rollers secured to the shaft 8 also rotate in reverse direction. After the latter rollers effect feeding of a sheet to a shelf, the actuating means is moved or indexed to its next position in which it comes into register with the control plate for another set of rollers upon receipt of a signal, so that the aforementioned cycle of operation is repeated. The control plate 33 released from engagement with the roller 39 of actuating means is restored to its original position by the biasing force of the spring 36, so that the control wheel 31 is brought into engagement with the sprocket 29. This causes the control wheel 31 to rotate the shaft 8 and the set of feed rollers secured to the shaft 8 in normal direction again.

The rotation control means 10 constructed as aforementioned is effective to positively cause the feed rollers to rotate either in normal direction or reverse direction by virtue of positive engagement between its parts and no slip is produced between its parts. The rotation control means is reliable in performance and simple in construction.

As aforementioned, the collator according to this invention operates such that, when one set of feed rollers is rotated in a direction opposite to the direction of rotation of other sets of feed rollers to deliver a sheet to a predetermined sheet-receiving shelf, the leading end of the sheet impinges on the rollers rotating in reverse direction and is guided thereby so as to be held between the set of feed rollers rotating in reverse direction and the next preceding set of rollers, which is rotating in normal direction. In order that the sheets may be positively held between the two sets of rollers and fed smoothly to the predetermined sheet-receiving shelf, this invention provides another feature which will now be described.

As aforementioned, the endless belt means 4 comprises a number of belts spaced apart from one another. In accordance with the invention, there may be provided a plurality of sheet-leading end deflecting members 42, disposed betweeen adjacent feed rollers 3*a* . . . 3*v* in at least one of the spaces between the adjacent belts. The deflecting members 42 are secured to a support rod 43 which is also disposed in the space between the belts. Preferably, the deflecting members 42 are in the form of pliable piano wires or plate springs. The force with which each deflecting member 42 presses against the leading end edge of a sheet is such that the deflecting member slightly bends the leading end edge of the sheet, but when the leading end edge of the sheet reaches the adjacent set of feed rollers, then assuming that the latter rollers are rotating in normal direction (the same direction as the movement of the endless belt means 4), the deflecting member is deprived of the force with which it bends the sheet which is maintained in contact with the two adjacent feed rollers, so that the deflecting member is diverted from the path of movement of the sheet. The leading end edge of the sheet is bent by the deflecting member such that, when the adjacent set of feed rollers rotate in reverse direction (the opposite direction to the movement of the endless belt means 4), the sheet is positively guided by the deflecting member and feed roller and fed to the particular sheet-receiving shelf. One or more deflecting members 42 as shown in FIG. 8 may be provided for each sheet-receiving shelf. It will be appreciated that the deflecting members are simple in construction and low in cost, and yet afford positive introduction of the sheets into the sheet-receiving shelves.

In accordance with the invention, means may also be provided for positively introducing a sheet to one shelf and detecting the feeding of the sheet so as to permit the aforementioned feed roller reverse actuating means to be shifted or indexed into register with the rotation control means associated with a next sheet-receiving shelf upon completion of feeding of the sheet to the first-mentioned shelf.

In FIG. 9, a timing belt 44 is disposed rearwardly of the endless belt means 4, and the sliding plate 41 is secured to the timing belt 44 for movement up and down when the timing belt 44 moves. As shown in FIG. 10, the aforementioned control roller 39 is attached to one end portion of the sliding plate 41 for engagement with the control plate 33 associated with each roller rotation control means 10 for each set of feed rollers 3*a* . . . 3*u* so as to shift the same and reverse the direction of rotation of the respective set of feed rollers. Attached to the sliding plate 41 is a support plate 46 which supports switch means comprising a microswitch 47 and an actuator 48 which is in the form of a pivotally supported three-arm lever. One arm 48A of the three-arm actuator 48 extends through one of the spaces between the belts of endless belt means 4 into the path of travel of the sheets; a second arm 48B is adapted to actuate the microswitch 47; and a third arm 48C is disposed in a position in which it engages a stop 49 when the actuator 48 is in its normal position shown in broken lines.

When a sheet 50 conveyed by the feed rollers 3*a*, 3*b*, 3*c* . . . 3*r* rotating in normal direction and the endless belt means 4 reaches a position in which the arm 48A is disposed and strikes the same, the actuator 48 disposed in the normal position shown in broken lines in FIG. 9 is pivotally moved in a clockwise direction to a

position shown in solid lines in FIG. 9. The arm 48C is released from engagement with the stop 49, and the arm 48B actuates the microswitch 47. The switch 47 includes an operation member which is pushed and serves as a stop. The arm 48A is in a position in which it is effective to bend the forward end edge of the sheet 50 and guide the same to move between the set of feed rollers 3*r* rotating in normal direction and the set of feed rollers 3*s* rotating in reverse direction. Thus, the sheet 50 is smoothly fed to the sheet-receiving shelf 2*r*. During the time the sheet 50 passes by the arm 48A, the arm 48B continues to push the operation member of microswitch 47. When the sheet 50 is released from the arm 48A, the actuator 48 is restored to its normal position shown in broken lines by the action of the operation member of microswitch 47.

At this time, the microswitch 47, acting through a control circuit 51, operates a driving motor 52 to index the timing belt 44 forwardly, i.e. to advance the timing belt 44 a predetermined sitance. The sliding plate 41 attached to the timing belt 44 also moves (releasing the control means for the set of rollers 3*s*, which thereupon is again driven for rotation in the normal direction of roller rotation), so that the control roller 39 and the actuator 48 move to and stop at a position in which they are in register with a next sheet-receiving shelf. The control roller 39 actuates the rotation control means for the set of feed rollers associated with the next sheet-receiving shelf so as to cause the set of feed rollers 3*t* to rotate in reverse direction. The arm 48A of actuator 48 is disposed in a position intermediate the two sets of feed rollers 3*s* and 3*t* to be ready for introducing a next sheet into the sheet-receiving shelf 2*s*.

From the foregoing description, it will be appreciated that the actuator 48 serves not only to actuate the microswitch 47 for controlling the movement of timing belt but also to guide the incoming sheets so as to smoothly feed the same into respective sheet-receiving shelves. Preferably, the actuator 48 is constructed such that the arm 48A thereof is in the form of a fork as shown in FIG. 11 so as to ensure that the sheets are positively detected and guided thereby.

Thus in summary, it will be seen that the invention in each of its described embodiments includes an array of sheet-receiving shelves 2*a* . . . 2*u* and an array of sets of feed rollers 3*a* . . . 3*u* respectively associated with the sheet-receiving shelves, a further set of rollers 3v being provided beyond the last shelf 2*u* and associated roller set 3*u*. Each set of rollers 3*a* . . . 3*v* is mounted on a shaft 8 for rotation therewith, and means are provided for driving the shafts of the sets of rollers and for selectively controlling the direction of rotation of at least each set of rollers in the series 3*b* . . . 3*u*. The rollers 3*a* . . . 3*u* are disposed and adapted, when rotating in a first or normal direction, to cooperate with a conveyor belt system 4 to advance incoming sheets of paper or the like past the successive shelves of the array. Further, each of the sets of rollers 3*b* . . . 3*v* is disposed and adapted, when rotating in a direction opposite to the aforementioned normal direction, to cooperate with the immediately preceding set of rollers (which is rotating in the normal direction) to feed a sheet from the path of sheet advance to the shelf associated with that preceding set of rollers. The first set of rollers 3*a* needs to rotate only in the normal direction, while the last set of rollers 3*v* needs to rotate only in the opposite direction. The direction of rotation of each of the other sets of rollers (3*b* . . . 3*u*) is individually controlled by the aforementioned rotation control means which in the illustrated embodiments affords selective engagment of its associated roller shaft 8 with means for driving the shaft in either one direction or the other.

Means are also provided for effecting the successive actuation of the control means respectively associated with the successive sets of rollers 3*b* . . . 3*u* in the series of rollers shown, to cause each of these sets of rollers in succession to rotate in the reverse direction while all the other sets of rollers in the sequence are rotating in the normal direction. The actuating means, as in the embodiment of FIGS. 9 – 11, may be responsive to the introduction of successive sheets to the collator.

By way of further explanation of the invention, let it be assumed that 21 copies of a first page of a report or other document are to be respectively distributed to the shelves of the collator of the invention, these copies being fed in succession to the collator from a copying machine or the like. At the outset of the collating operation, all of the sets of rollers 3*a* . . . 3*u* are being driven in the normal direction for cooperation with the belt means 4 to advance the sheets past the successive shelves, except that the set of rollers 3*b* (associated with the second shelf 2*b*) is driven in reverse direction. As the first copy sheet is advanced through the collator, it is diverted from the path of sheet advance defined by belt means 4 and fed by and between the cooperating (and now oppositely rotating) sets of rollers 3*a* and 3*b* to the first shelf 2*a*. Upon completion of such feeding, the actuating means causes the rotation control means associated with the set of rollers 3*b* to reverse the direction of rotation of those rollers, i.e. to restore the set of rollers 3*b* to the normal direction of rotation. The actuating means also causes the rotation control means associated with the next set of rollers 3*c* to reverse the direction of roller rotation for that set, i.e. from the normal direction to the opposite direction. Thus, as the next sheet advances through the collator, the set of rollers 3*b* no longer cooperates with rollers 3*a* to feed the sheet to the first shelf 2*a*, but instead (because it is now rotating in the normal direction) cooperates with the belt means 4 to advance this second copy of the first page past the first shelf 2*a*, until the sheet encounters the oppositely rotating rollers 3*c*, which cooperate with the rollers 3*b* (rotating in normal direction) to feed the second sheet to the second shelf 2*b*. The actuating means then restores rollers 3*c* to the normal direction of rotation and reverses the rotation of the next set of rollers 3*d*, so that the next sheet advanced along the belt means 4 passes the second shelf 2*b* and is fed by and between the sets of rollers 3*c* and 3*d* to the third shelf 2*c*.

This operation is continued with successive reversal and restoration of the normal direction of rotation of each successive set of rollers by the actuating means so that each successively introduced sheet advances further along the belt means than the immediately preceding sheet and is then fed to a shelf immediately beyond the shelf that received the preceeding sheet. After all the copies of one page have been distributed to the respective shelves, the actuating means returns to its starting position or condition to effect like distribution of the copies of the second page of the report or other document, as the second page copies are fed in succession to the collator.

While this invention has been described as being incorporated in a collator comprising horizontally disposed sheet-receiving shelves (i.e. superposed vertically, one above another), it is to be understood that the invention can have application in a collator comprising sheet-receiving shelves which are disposed substantially vertically (i.e. in a horizontally extending array). FIG. 12 illustrates such application of the present invention. A copied sheet or printed sheet is introduced through an inlet 53 into the collator and held between a roller 54 and belt means 4. It is passed by a guide 55 and held between the belt means 4 and sets of feed rollers 3*a*, 3*b*, 3*c* . . . to be moved forwardly thereby. When the set of feed rollers 3*d* are rotated in reverse direction, the sheet is moved between the sets of feed rollers 3*c* and 3*d* to be fed to the sheet-receiving shelf 2*c* as aforementioned.

It is to be understood that the invention is not limited to the features and embodiments hereinabove specifically set forth but may be carried out in other ways without departure from its spirit.

I claim:

1. A collator comprising

a. a plurality of sheet-receiving shelves arranged in side-by-side relationship,

b. a plurality of sets of feed rollers respectively associated with each of said sheet-receiving shelves, each of said sets of feed rollers comprising a plurality of rollers mounted for rotation on a common axis, all the sets of feed rollers normally rotating in the same direction, and the successive sets of rollers being disposed closely enough to each other so that two adjacent sets of rollers respectively associated with two adjacent shelves cooperatively advance a sheet passing between them into one of the last-mentioned shelves when one of the two adjacent sets of rollers rotates in reverse direction,

c. belt means cooperating with said sets of feed rollers rotating in normal direction so as to convey sheets, and

d. means for causing one set of feed rollers to selectively rotate in reverse direction so that when one set of feed rollers is rotated in reverse direction a sheet can be fed to a predetermined sheet-receiving shelf by cooperation of said set of feed rollers rotating in reverse direction with an adjacent set of feed rollers rotating in normal direction.

2. A collator as defined in claim 1, wherein said means for causing one set of feed rollers to rotate in reverse direction is control means comprising two sprockets loosely mounted for rotation in opposite directions on an extension of a shaft for supporting each of said sets of feed rollers, and a control wheel mounted on said extension of said shaft in a position intermediate said two sprockets, said control wheel being unrotatable relative to said shaft but movable axially thereof, said control wheel normally engaging one of said sprockets which rotates in normal direction but being released from engagement therewith upon receipt of a signal from outside and brought into engagement with the other sprocket which rotates in reverse direction, whereby the set of feed rollers associated with said means can be rotated in reverse direction.

3. A collator as defined in claim 2, further comprising a control plate engaging said control wheel such that said control plate shifts the control wheel axially, and actuating means for moving said control plate, said actuating means being adapted to be shifted by signals from outside and indexed successively with said means for causing one set of feed rollers to selectively rotate in reverse direction so that the actuating means may move the control plate and hence the control wheel associated with each of said sheet-receiving shelves, whereby the control wheel can be released from engagement with the sprocket rotating in normal direction and brought into engagement with the sprocket rotating in reverse direction.

4. A collator as defined in claim 1, further comprising at least one pliable sheet-leading end deflecting member being disposed between the adjacent two sets of feed rollers and in the path of movement of sheets.

5. A collator as defined in claim 1, further comprising switch means adapted to be shifted and indexed successively with the sheet-receiving shelves to which sheets are fed and for detecting the introduction of the sheets to the respective sheet-receiving shelves, said switch means comprising an actuator which serves concurrently as a guide for introducing a sheet into a predetermined sheet-receiving shelf.

6. In apparatus for collating sheets of material such as paper or the like, in combination,

a. an array of spaced sheet-receiving shelves disposed in succession along a path of advance of the sheets;

b. conveyor means for advancing successive sheets along the path;

c. a plurality of roller structures for feeding the sheets, respectively associated with successive shelves of the array, the shelf roller structures being disposed closely enough to each other so that two adjacent roller structures respectively associated with two adjacent shelves cooperatively advance a sheet passing between them into one of the last-mentioned shelves when one of the two adjacent roller structures rotates in reverse direction, each roller structure of said plurality being dipsosed and adapted for cooperation,

i. when rotating in a given direction, with said conveyor means, to feed sheets along said path, and

ii. when rotating in an opposite direction, with an adjacent roller structure rotating in said given direction, to feed a sheet from said path to the shelf with which said adjacent roller structure is associated; and

d. means for selectively reversing the direction of rotation of one of said roller structures.

7. Apparatus as defined in claim 6, wherein said rotation-reversing means comprises separate means for rotatably driving said roller structures in respectively opposite directions; and motion-transmitting means associated with said one roller structure for selectively drivably engaging that roller structure with either of said separate driving means.

8. Apparatus as defined in claim 7, wherein each of said separate driving means includes a cyclically moving driven element having a direction of motion corresponding to one of said given and opposite directions of rotation of said roller structures, and wherein said motion-transmitting means comprises a cyclically movable element engaging said one roller structure for imparting rotational movement thereto and mounted for sliding movement into selective engagement with either of the cyclically moving driven elements for receiving cyclical motion therefrom and transmitting the cyclical motion to said one roller structure.

9. Apparatus as defined in claim 6, wherein each of said roller structures comprises a set of rollers mounted on a common shaft for rotation therewith and having a diameter substantially equal to the spacing between adjacent shelves of said array.

10. Apparatus as defined in claim 6, wherein said rotation-reversing means comprises separate means for rotatably driving said roller structures in respectively opposite directions and individual motion-transmitting means respectively associated with each of said roller structures for selectively drivably engaging its associated roller structure with either of said separate driving means, and further including means for successively actuating the motion-transmitting means respectively associated with adjacent roller structures to engage that one of said separate driving means which drives the roller structures in said opposite direction.

11. Apparatus as defined in claim 10, further including means for biasing each of said motion-transmitting means into engagement with that one of said separate driving means which drives said roller structures in said given direction, said actuating means overcoming said biasing means to disengage said motion-transmitting means from said last-mentioned driving means and engage the motion-transmitting means with the other of said driving means.

12. Apparatus as defined in claim 10, wherein said actuating means successively actuates the motion-transmitting means of adjacent rollers as aforesaid in correspondence with advance of successive sheets along said path.

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