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(54) Document collating apparatus

(57) An apparatus for collating sheets, the apparatus comprising: a collating station having a collating position limited at its downstream end by a stop member against which the sheets abut whilst they are being collated; means for conveying sheets to the collating position so as to form a collated sheet set comprising a predetermined number of stacked sheets; a collating station eject device for moving the collated sheet set away from the collating position to an exit position; and means for conveying the collated sheet set from the exit position out of the apparatus to a downstream sheet handling device; wherein the collating station eject device comprises at least one movable pawl arranged to push each collated sheet set away from the collating position to the exit position and wherein the apparatus is adapted to collate a second sheet set at least partially overlying the first sheet set.

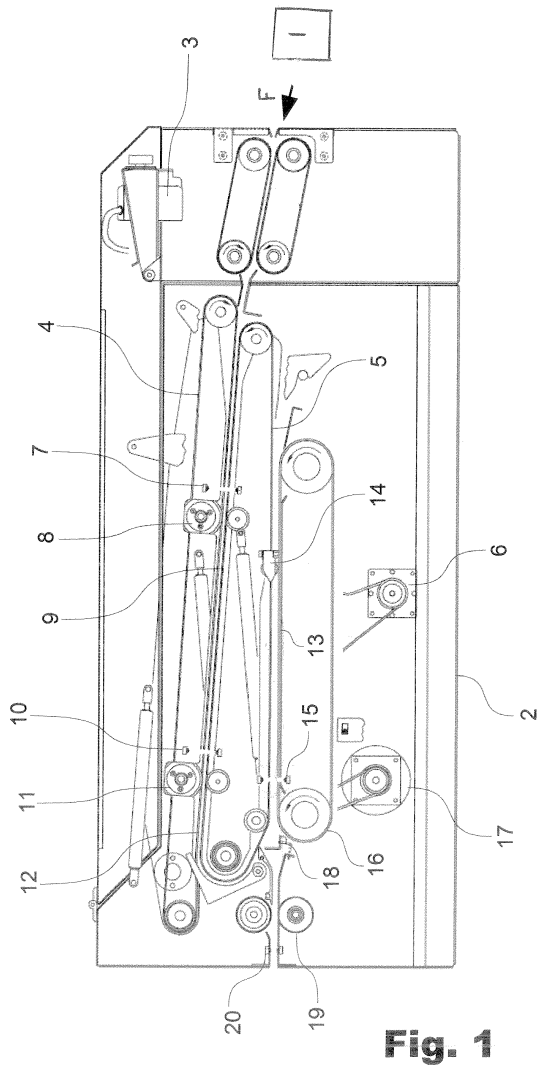

Fig. 1

EP 2 108 607 A2

Description

[0001] The present invention relates to apparatus and a method for collating documents, for example for accumulating documents or sheets of paper for bulk mailings, such as when more than one sheet of paper is to be mailed in the same envelope.

[0002] In recent years there has been a trend to design systems, particularly larger systems, as a set of modules which can be linked together to perform a complex process. There are several advantages to designing systems in a modular form, for example it provides the ability to customise the system for the users' requirements by adding or removing features, and permits the changing of individual modules for repair or upgrade.

[0003] A typical mailing system, such as the Automailer 5 Plus™ manufactured by PFE International Limited, comprises multiple modules including a module for inserting paper into the system, a printing module, a cutting module, a collate module, a folding module, and a module for inserting the documents into envelopes.

[0004] In an optimal modular mailing system each module would be able to receive the output from the upstream module as soon as it is made available, and provide input to the downstream module as soon as the downstream module is ready to receive. In reality however optimal performance is rarely possible due to a number of factors including the varying complexity of each module, the physical limitations of the technology used, and bottlenecks, delays or blockages in a module.

[0005] A simple collate module receives individual sheets of paper and stacks the sheets one by one in a collate pocket until a sheet set is complete. However, the collate module cannot transport the set from the collate pocket to the module output, until a downstream module, such as a folder module, is ready to accept the set.

[0006] Thus an inherent problem of a simple collator is that it is not possible to start collating a second set until the first set is transported out of the collate pocket to a downstream module. This can cause a delay in the system when the downstream module is not able to receive the sheet set as soon as it completed, for example if there is a blockage downstream. When this occurs the completed sheet set must wait in the collate pocket until the downstream module is able to accept the set, and in the meantime the collate module is unable to begin collation of a second sheet set. Further delay occurs if the downstream device is ready to accept the second sheet set before the collate module has finished collating the second set.

[0007] US-A-5083769A addresses this problem using a dual collating machine having two separate collate pockets for collating sheet sets. Once a sheet set is completed in the first pocket, the apparatus diverts the incoming sheets belonging to the next set to a second pocket, allowing the second set to be collated before and/or during the transportation of the first set to the downstream device. Whilst such a machine reduces the delay in collating sets, the hardware required is in effect two separate collate modules in parallel, with additional hardware for diverting the incoming sheets and outgoing sets. Not only is such a machine more expensive to produce, but it is also a physically larger machine than a single collator. The dimensions, and in particular the footprint of the machine is important, especially in modular systems where it is usually a requirement that the module fits into the predetermined space available for the module.

[0008] According to a first aspect of the present invention there is provided an apparatus for collating sheets, the apparatus comprising: a collating station having a collating position limited at its downstream end by a stop member against which the sheets abut whilst they are being collated, means for conveying sheets to the collating position so as to form a collated sheet set comprising a predetermined number of stacked sheets; a collating station eject device for moving the collated sheet set away from the collating position to an exit position; means for conveying the collated sheet set from the exit position out of the apparatus to a downstream sheet handling device; wherein the collating station eject device comprises at least one movable pawl arranged to push each collated sheet set away from the collating position to the exit position and wherein the apparatus is adapted to collate a second sheet set at least partially overlying the first sheet set.

[0009] Thus the present invention allows for the collation of a second sheet set to begin before the first sheet set has left the collator, without increasing the footprint of the collator.

[0010] The invention allows the transportation out of the collating module of a first sheet set to be delayed without slowing or interrupting the accumulation of a second sheet set. Thus downstream delays or blockages can be accommodated without slowing down the overall processing speed.

[0011] According to a preferred embodiment of the invention the collating station eject device and the exit conveying means are operable independently of each other. The exit conveying means preferably comprises a pair of holding rollers.

[0012] The pawl may be mounted on an outer surface of a belt which may be an endless belt driven cyclically.

[0013] The apparatus preferably comprises two pawls mounted at generally equidistantly spaced intervals on the belt.

[0014] The stop member is preferably spring loaded and the location of the stop member and the collating station eject device is advantageously adjustable depending on the length of the sheets to be collated.

[0015] In a preferred embodiment sensors may be arranged to detect the presence of a sheet at the collating position and / or at the holding rollers.

[0016] A scanner may be arranged to read machine control data printed on sheets entering the apparatus. This may be a bar code scanner, and OCR reader, a magnetic reader or any other reading device, e.g. for 2D

data matrix marks, a camera and computer may be used to read marks. Alternatively data may be input directly to the system.

[0017] One or more hold points may be provided upstream of the collating station.

[0018] According to a second aspect of the present invention there is provided a method for collating sheets comprising:

> conveying sheets to a collating position in a collating station so as to form a collated sheet set comprising a predetermined number of stacked sheets; ejecting the collated sheet set from the collating position by using a pawl to push it away from the collating position to an exit position; at least beginning to form a second collated sheet set in the collating position partially overlapping the first sheet set in the exit position; and subsequently conveying the first collated sheet set out of the exit position to a sheet handling device downstream of the apparatus when the downstream device is ready.

[0019] Preferably the movement of sheet sets from the collating position to the exit position is independent of the movement of sheet sets from the exit position.

[0020] The method may also comprise sensing when a sheet is present at the collating position.

[0021] To accommodate different sizes of sheets, the collating position is movable relative to the exit position which may be defined by a pair of holding rollers.

[0022] Sensors are advantageously provided to detect the presence or absence of sheets at various positions in the path of the apparatus and if delays occur then the sheets will be held at suitable hold points. The sheets may also be scanned for machine control data prior to transportation to the collating station.

[0023] For a better understanding of the present invention, and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:

> Figure 1 is a cross-sectional view of a known apparatus for collating sheets;
>
> Figure 2 is a cross-sectional view of an apparatus according to the present invention;
>
> Figure 3 is a cross-sectional view of part of the apparatus of Figure 2.

[0024] Figure 1 shows a known apparatus for collating sheets. A sheet feeder 1 is arranged to deliver sheets of paper one by one, in the direction of arrow F, to a collator 2. A barcode scanner 3 is positioned to scan each sheet as they travel from the feeder 1 to the collator 2. This reads a barcode on each sheet which determines the number of sheets to be collated together, for example the number of sheets in a bank statement for a particular recipient. Each sheet is transported along the collator 2 by frictional contact between an upper conveyor transport belt 4 and a lower conveyor transport belt 5 which are driven by an input conveyor drive 6. Downstream of the feeder 1 a first hold point sensor 7 is arranged to identify the presence and/or absence of a sheet at a point on the conveyor 5 and a first hold point drive 8 controls the transportation of sheets to a first hold point 9 downstream of the first hold point sensor 7. Similarly, there is a second hold point sensor 10, a second hold point drive 11 and a second hold point 12 downstream of the first hold point 9. A collate pocket 13 is provided downstream of the second hold point 12 which comprises a collate pocket stop 14 against which sheets can be collated one on top of each other, and a collate pocket sensor 15 for detecting the presence and/or absence of sheets in the collate pocket 13. An output conveyor transport belt 16 driven by an output conveyor drive 17 is arranged to transport the collated sheet set passed a movable bounce stop 18 to a pair of output rollers 19, which are in turn arranged to deliver each collated sheet set to a downstream device for further processing, for example for folding and/or insertion into an envelope. An output sensor 20 is provided to identify the presence and/or absence of a sheet set at the output of the collator 2.

[0025] A sheet set can comprise any number of sheets and each consecutive sheet set can comprise the same or a different number of sheets. To aid understanding, the operation of the apparatus will now be described using the example of collating two 3-sheet sets, the sheets being labelled sheet A1, A2, A3 and B1, B2, B3.

[0026] Sheet A1 is held at the output of the feeder 1 until the first hold point sensor 7 indicates that there is no earlier sheet blocking the downstream path. Sheet A1 is then transported by the conveyor transport belts 4, 5 to the first hold point 9. Prior to arriving at the first hold point 9, sheet A1 is scanned for machine control data by the barcode reader 3. This scanning process identifies which sheet set sheet A1 belongs to, and in particular is used to identify the first and/or last sheet in a sheet set.

[0027] The second hold point sensor 10 is then checked and if there is no earlier sheet blocking the downstream path sheet A1 is transported to the second hold point 12. At substantially the same time the first hold point sensor 9 is also checked and if the path is clear sheet A2 is scanned by the barcode reader 3 and transported from the feeder 1 to the first hold point 9. The purpose of the two hold points 9, 12 is to maintain only a minimal distance between the consecutive sheets in the collator 2 thus speeding up the sheet flow.

[0028] Since sheet A1 has been identified by the barcode reader 3 as the first sheet in a set, the collate pocket sensor 15 is checked to ensure that no earlier sheets are present in the collate pocket 13. If an earlier sheet set is still located in the collate pocket 13 then the collator 1 must wait until the earlier sheet set has been moved out of the collate pocket 13 before advancing sheet A1. When the collate pocket 13 is clear sheet A1 is fed into the

collate pocket 13 and forms the first sheet in sheet set A. The collate pocket stop 14 acts as a paperweight to retain the sheets and the bounce stop 18 further assists in preventing the sheets from bouncing out of the collate pocket 13.

[0029] As described above, substantially simultaneously to the advancing of sheet A1, the second hold point sensor 10 is checked and if the path is clear sheet A2 is transported to the second hold point 12, and likewise the first hold point sensor 7 is checked and if clear sheet A3 is scanned and transported from the feeder 1 to the first hold point 9. This cycle continues, one step at a time, for each of sheets B1, B2 and B3 until they reach the collate pocket 13. For ease of understanding, the further description only refers to the steps from the second hold point 12 for each sheet.

[0030] From the barcode reading, the collator 2 knows that sheet A2 is part of sheet set A and so in the next cycle sheet A2 is transported from the second hold point 12 to the collate pocket 13, on top of Sheet A1. Likewise, in the following cycle, Sheet A3 is fed from the second hold point 12 to the collate pocket 13, on top of Sheet A2, thereby completing sheet set A.

[0031] Since the collator 2 knows that the next sheet held at the second hold point 12, sheet B1, is the first sheet in a new sheet set, the collator 2 must wait until sheet set A is transported to a downstream device by the output conveyor transport belt 16 and through the output rollers 19 before allowing sheet B1 to be fed into the collate pocket 13. Since the collator 2 will only begin transportation of sheet set A when confirmation is received that the receiving downstream device is clear, the collator 2 is forced to stop collating sheets until the downstream device accepts sheet set A.

[0032] Once sheet set A has been transported to the downstream device, sheet B1 is transported to the collate pocket 13, and in subsequent cycles sheets B2 and B3 are stacked in top of sheet B1 to complete sheet set B, which is then ready for transportation to the downstream device.

[0033] Only being able to collate one sheet set at a time can cause a delay in the overall system, particularly when there are a large number of sheets in each set, because once a blockage or bottleneck in the downstream device is cleared and the sheet set is transported from the collate pocket 13, the collator 2 then must collate a whole new sheet set before the next sheet set is ready.

[0034] Figure 2 shows an apparatus adapted according to the present invention which reduces the problem described above by providing a buffer for completed sheet sets in the collator without increasing the footprint of the apparatus. Similar features are labelled with like-numbered reference numerals.

[0035] A sheet feeder 1 delivers consecutive sheets of paper to the collator 21 and a barcode scanner 3 is positioned to scan each sheet as it travels from the feeder to the collator 21. An upper conveyor transport belt 4 and a lower conveyor transport belt 5 are arranged to transport the sheets to a first hold point 9, having an associated first hold point sensor 7 and first hold point drive 8, and a second hold point 12, having an associated second hold point sensor 10 and second hold point drive 11 as described with reference to Figure 1. A collate pocket 13, a spring loaded collate pocket stop 14 and a collate pocket sensor 15 are located downstream of the second hold point 12. A pair of output rollers 19 and an output sensor 20 are located downstream of the collate pocket 13. A first collate pocket eject pawl 22a is positioned at one end of the collate pocket 13. The leading edge of each sheet fed into the collate pocket 13 is stopped against a spring stop 14.

[0036] The first collate pocket eject pawl 22a is part of a movable collate pocket eject device 23 which also comprises a second collate pocket eject pawl 22b spaced equidistant from the first eject pawl 22a on an outer surface of a collate pocket conveyor belt 24, which is driven by a collate pocket drive 25. When cycled, the collate pocket conveyor belt 24 performs a half revolution which causes the first collate pocket eject pawl 22a to travel substantially in the direction of the output rollers 19, thereby pushing the collated sheet set towards the output. Because the two pawls 22a, 22b are spaced equidistant from each other, after the collate pocket conveyor belt 24 has performed a half revolution, the second pawl 22b will be located in the same position as the first pawl 22a prior to the cycle, ready to drive out the next document sheet set.

[0037] The collator 21 is designed to accept sheets of different lengths. Typically, the minimum document length accepted is approximately 89mm and the maximum is approximately 406mm. In order to ensure that the leading edge of the sheet stack, which is equivalent to the trailing edge of the individual sheets, always reaches the output rollers 19 after the collate pocket conveyor belt 24 has been cycled. The collate pocket eject device 23 is adjustable along the plane of the conveyor belts to accommodate different paper lengths. The eject stroke of the collate pocket pawl belt 24 always moves the same amount to drive the sheet set to the output rollers 19. As little as 20-30mm clearance between the sets of documents is necessary.

[0038] Provided the collator output is clear the collation will be continuous: there is no need to stop the apparatus unless a blockage occurs downstream.

[0039] The use of a stepper motor allows more accurate positioning of the pawls and of conveyor belts and more accurate prediction of the position of trailing and leading edges of sheets.

[0040] The operation of the apparatus according to the present invention will now be described using the same example of collating two 3-sheet sets as used with reference to Figure 1.

[0041] The operation of the collator 21 up to the point where the sheets are held at the second hold point 12 is substantially identical to that described with reference to the collator 2 of Figure 1, therefore the following is a de-

scription of the stages after this point only.

Sheet A1 is held at the second hold point 12. Since sheet A1 has been identified by the barcode reader 3 as the first sheet in a set, the collate pocket sensor 15 is checked to ensure that no earlier sheet set is located above the collate pocket conveyor belt 24 in the collate pocket 13. When the collate pocket sensor 15 indicates that the downstream path is clear sheet A1 is fed into the collate pocket 13 and is stacked against the first collate pocket eject pawl 22a to form the first sheet in sheet set A. In the next cycle sheet A2 is transported from the second hold point 12 to sheet set A and in the following cycle sheet A3 is transported to the collate pocket 13, thereby completing sheet set A.

[0042] Once sheet set A is complete then collator 21 checks the status of the output sensor 20 to ensure that no earlier sheet set is waiting at the output. If the output is clear the collate pocket eject device 23 performs one cycle. During the cycle, the first collate pocket eject pawl 22a pushes sheet set A downstream a distance less than the length of a sheet in the set, but far enough so that the leading edge of the sheet set engages the output rollers 19. Then a check is made to determine if the receiving device downstream of the collator 21 is ready to accept sheet set A, and if so the apparatus activates the output rollers 19 to transport sheet set A to the downstream device. If the downstream device is not ready to accept sheet set A then the set is held in position by the output rollers 19 until the downstream device is ready, at which time sheet set A is transported to the downstream device by the output rollers 19.

[0043] As soon as the collate pocket conveyor belt 24 is free to eject the set being collated in the pocket and even while the last sheet of the set is arriving in the pocket, the collate pocket 13 is ready to accept the first sheet of sheet set B, even though sheet set A may still be partially or completely located in the collate pocket 13. Sheet B1 is transported from the second hold point 12 to the collate pocket 13 and arrives at the spring stop 14 just after the trailing edge of sheet set A has moved forward under the action of the pawl..

[0044] If sheet set A is still located at the output of the collator when sheet B1 arrives at the collate pocket 13 then it is possible that sheet B1 will partially overlay sheet set A. This does not cause a problem because the movement of sheet set A is controlled by the output rollers 19 and the resistive force exerted by the collate pocket stop 14 prevents sheet set B from moving out of the collate pocket 13 when sheet set A is transported downstream. The collate pocket stop 14 may comprise a spring loaded ball as shown more clearly in Figure 3. This holds sheets in the collating position even when a previous sheet set is moving out of the collating position and might tend to displace the subsequent sheets by friction and allows closer tolerances and more overlap thus reducing the time intervals occurring between sheet sets being collated. It also prevents bounce back of sheets.

[0045] Sheets B2 and B3 are sequentially stacked in the collate pocket 13, thereby completing sheet set B. If, in the time it takes to collate sheet set B, the downstream device has accepted sheet set A, then the output sensor 20 will indicate that the output is empty and sheet set B will be advanced to the output rollers 19 by cycling the collate pocket eject device 23. Alternatively, if the downstream device has not accepted sheet set A by the time sheet set B is complete then the collator 21 will wait until sheet set A is accepted and transported out of the collator 21, after which sheet set B will be advanced to the output rollers 19 ready for transporting to the downstream device.

[0046] Figure 3 shows an enlarged view of the collate pocket eject device 23 and shows a top sheet A3 of a first sheet set partially overlaid with the first sheet B of a second sheet set just after the first sheet A has been moved out of the collating position by the first eject pawl 22b. The sheet A1 is held in the collating position by the stop 14 which comprises a spring loaded ball 32 biasing the sheets toward the conveyor belt 24 of the eject device 23. At this stage the second eject pawl 22a is located behind the stop unit 14.

[0047] Whilst a document set is being collated the pawls (and belt 24) are generally stationary but when the last sheet of the second sheet set B is being fed into the collating position the eject device begins to move conveyor belt 24 and thus move pawl 22a toward the stop unit 14 and subsequently past the back stop to push sheet set B away from the collating position. This timing can be controlled by a collating position sensor 15 detecting the presence or absence of sheets at the collating position.

[0048] Alternatively or in addition the timing of the movement of the pawl 22a can be controlled predictively by calculating when the last sheet will hit the back stop of stop unit 14 using information from the sheet scanner 3 about the number of sheets to be collated in each set and the speed of the collator at any time. This allows the pawl to be accelerated to reach full speed earlier and to eject the sheet sets more quickly than otherwise. The exit holding rollers will accelerate the sheet set away to allow the pawl to turn the corner as the eject device cycles.

[0049] The eject device belt is driven by stepper motor 43 via drive belt 44.

[0050] The first sheet of any sheet set can be allowed to enter the collating position as soon as the pawl (22a or b) moving the previous sheet set out of the collating position has cleared the horizontal position, i.e. gone below the level of the belt. This reduces the delay between each collation and speeds up the process.

[0051] Sensors and detectors can be arranged along the belts or in relevant positions to determine the length of the sheet, and a control system can be incorporated, for example to control the position of the collate pocket eject device in relation to the output rollers. Alternatively, the document length information may be incorporated into the machine control data on each sheet which is read

by the barcode scanner.

Claims

1. An apparatus for collating sheets, the apparatus comprising:

   a collating station having a collating position limited at its downstream end by a stop member against which the sheets abut whilst they are being collated;
   means for conveying sheets to the collating position so as to form a collated sheet set comprising a predetermined number of stacked sheets;
   a collating station eject device for moving the collated sheet set away from the collating position to an exit position; and
   means for conveying the collated sheet set from the exit position out of the apparatus to a downstream sheet handling device;
   wherein the collating station eject device comprises at least one movable pawl arranged to push each collated sheet set away from the collating position to the exit position and wherein the apparatus is adapted to collate a second sheet set at least partially overlying the first sheet set.

2. An apparatus according to claim 1 wherein the collating station eject device and the exit conveying means are operable independently of each other.

3. An apparatus according to claim 1 or 2 wherein the exit conveying means comprises a pair of holding rollers.

4. An apparatus according to claim 1, 2 or 3 wherein the pawl is mounted on an outer surface of a belt, and further comprising means to drive the belt.

5. An apparatus according to claim 4 wherein the belt is an endless belt.

6. An apparatus according to claim 5 comprising two pawls mounted at generally equidistantly spaced intervals on the belt.

7. An apparatus according to any one of claims 1 to 6 wherein the stop member is spring loaded.

8. An apparatus according to claim 7 wherein the stop member comprises a spring loaded ball.

9. An apparatus according to any one of claims 1 to 8 wherein the location of the stop member and the collating station eject device is adjustable depending on the length of the sheets to be collated.

10. An apparatus according to any one of claims 1 to 9 further comprising a sensor arranged to detect the presence of a sheet at the collating position.

11. An apparatus according to any one of claims 1 to 10 further comprising a sensor arranged to detect the presence of a sheet set at the exit position.

12. An apparatus according to any one of the preceding claims wherein the means for determining sheet data for each sheet comprises a scanner arranged to read machine control data printed on sheets entering the apparatus.

13. An apparatus according to any one of the preceding claims further comprising at least one hold point upstream of the collating station.

14. A method for collating sheets comprising:

   conveying sheets to a collating position in a collating station so as to form a collated sheet set comprising a predetermined number of stacked sheets;
   ejecting the collated sheet set from the collating position by using a pawl to push it away from the collating position to an exit position; at least beginning to form a second collated sheet set in the collating position partially overlapping the first sheet set in the exit position; and
   subsequently conveying the first collated sheet set out of the exit position to a sheet handling device downstream of the apparatus when the downstream device is ready.

15. A method according to claim 14 wherein the movement of sheet sets from the collating position to the exit position is independent of the movement of sheet sets from the exit position.

16. A method according to claim 14 or 15 comprising sensing when a sheet is present at the collating position.

17. A method according to any one of claims 14 to 16 wherein at least the first sheet of the second sheet set is arranged to at least partially overlap the first sheet set in the collating position.

18. A method according to any one of claims 14 to 17 wherein the collating position is movable relative to the exit position to accommodate different sizes of sheets.

19. A method according to any one of claims 14 to 18 comprising scanning the sheets for machine control data prior to transporting the sheets to the collating station.

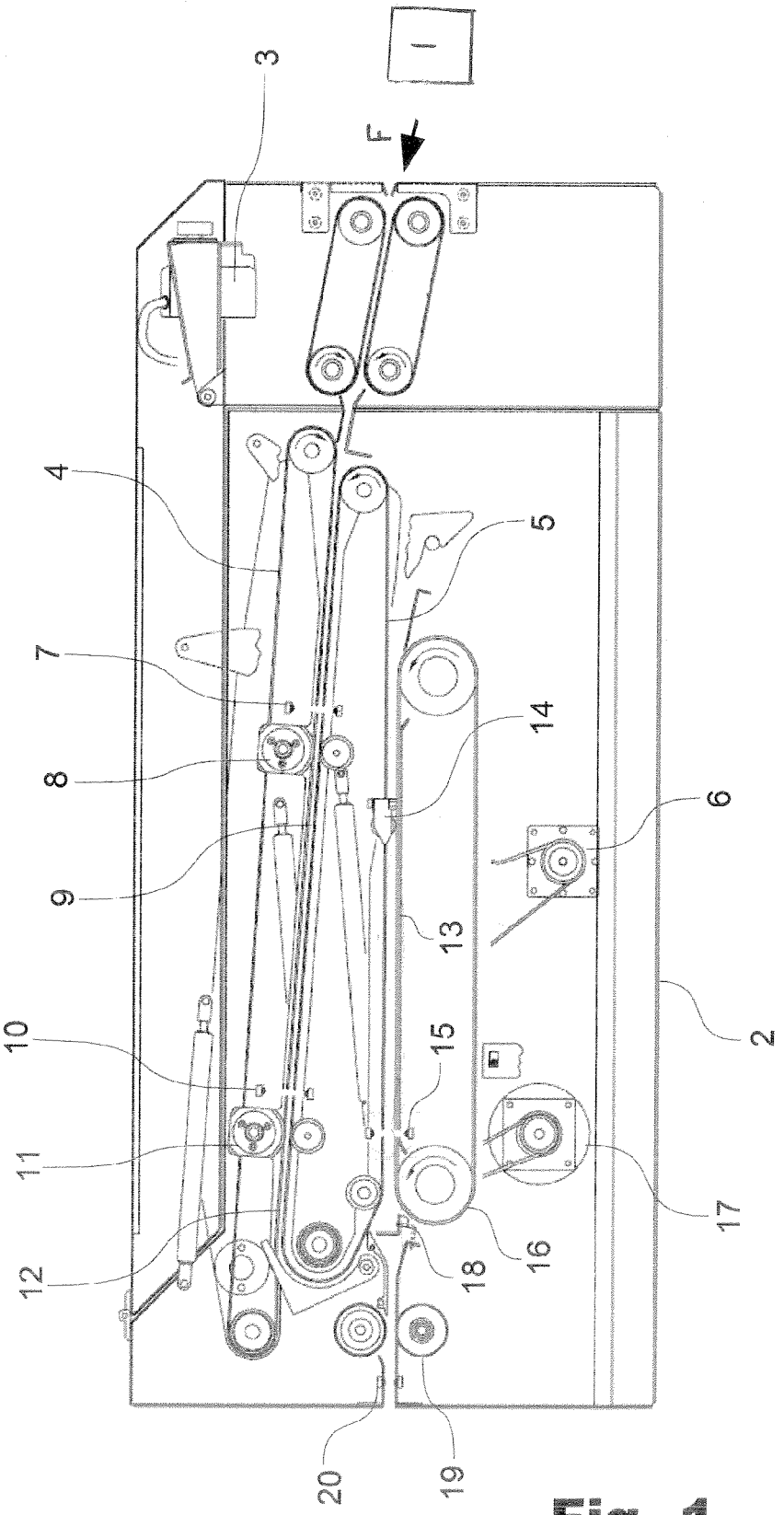

Fig. 1

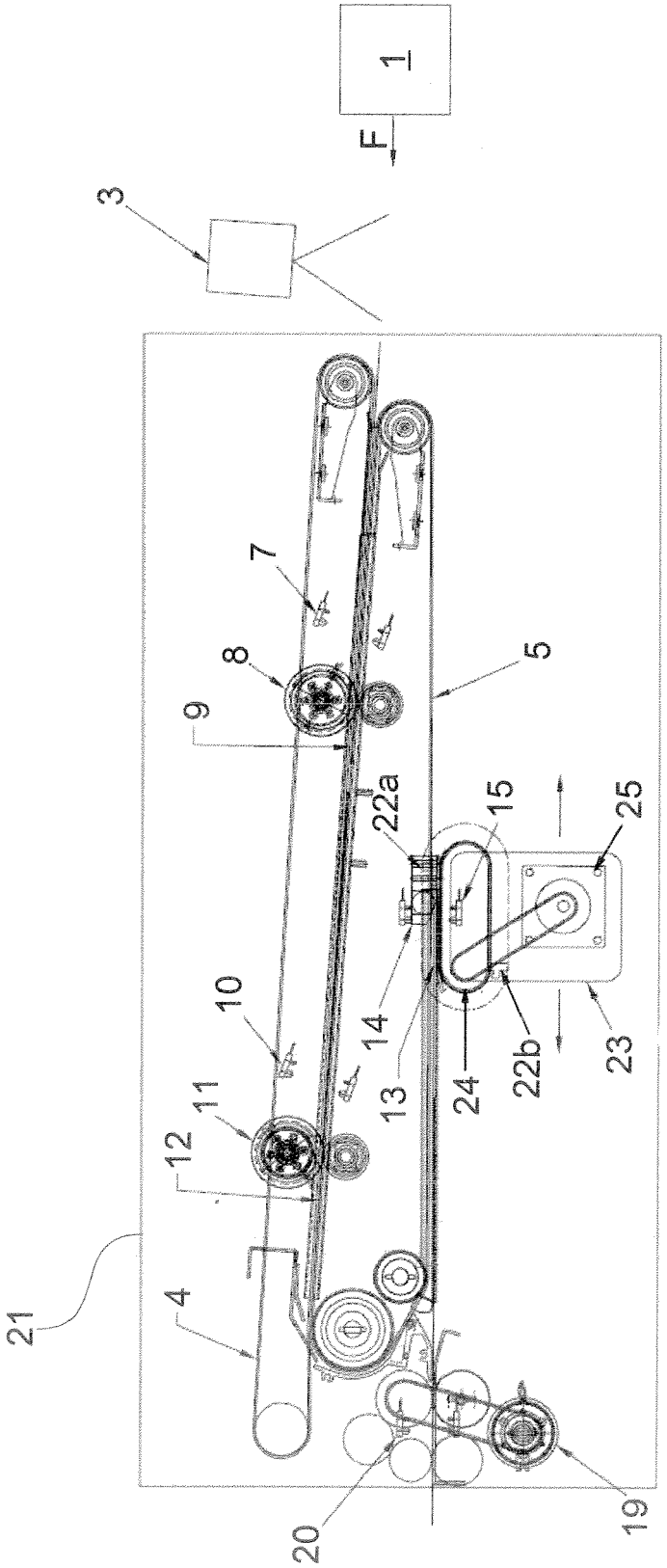

Fig. 2

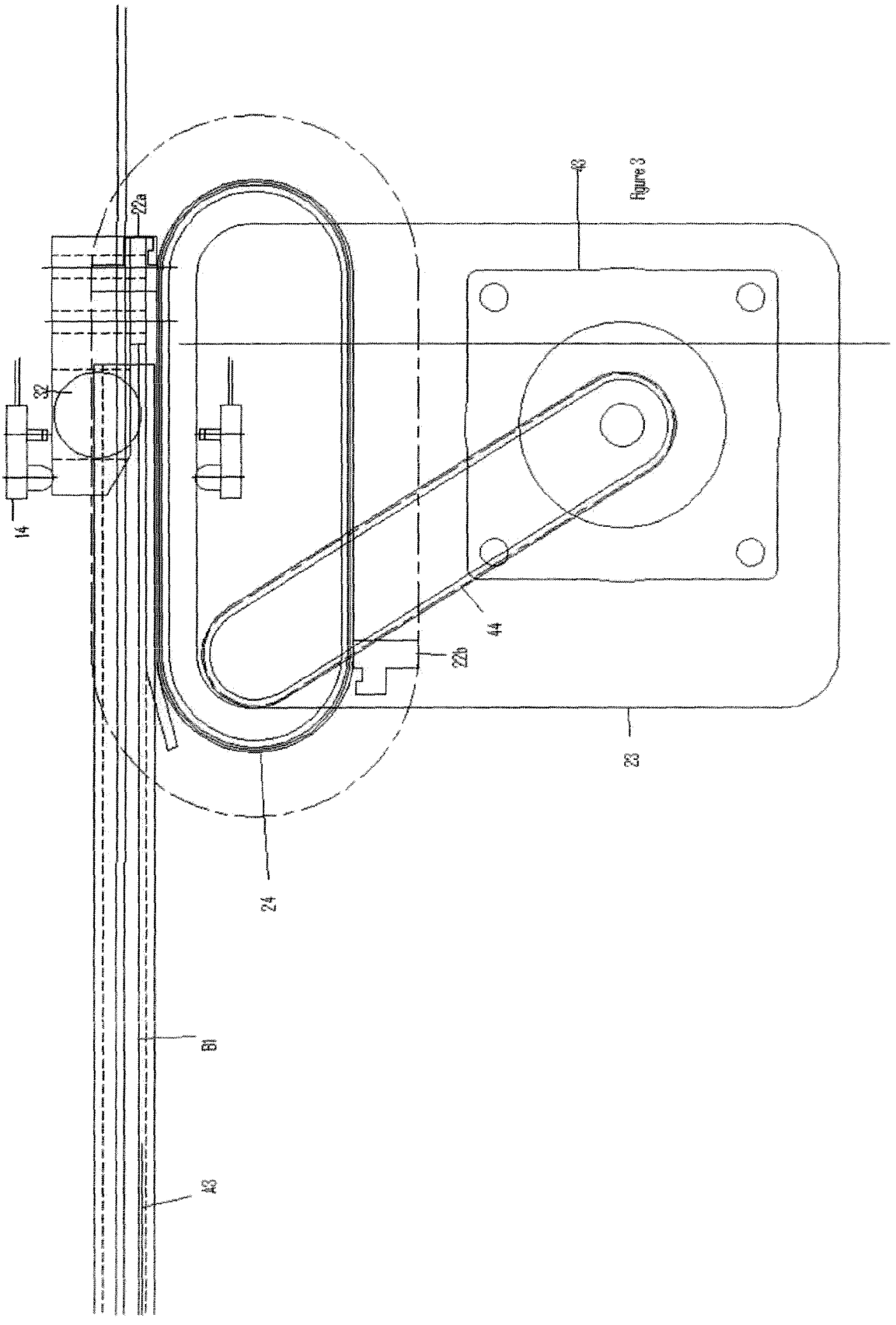
Figure 3
48
22a
32
14
44
22b
23
24
B1
A3

REFERENCES CITED IN THE DESCRIPTION

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