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(54) Apparatus and method for accumulating sheets

(57) An accumulator device with a downward angled input transport (42). Downstream, an accumulating receptacle (44,47) receives sheets. The accumulating receptacle has an upper guide (47) and a lower guide (44) forming a horizontal accumulating channel. Dump rollers (43) act as a stop during sheet accumulation, and as a transport for removing completed accumulations from the sheet accumulating device. A rear portion of sheets (1) buckle downward into a trap arrangement (45) below the input rollers (41). Preferably, the upper guide of the accumulating channel comprises a continuously rotating belt (47) to urge accumulating sheets against the dump rollers (43). Also, a positive air device (49) may be used to assist in the buckling of the rear portion of the sheets. To assist in handling large collations, when a sheet arrives at the dump rollers (43) they advance by a small predetermined incremental displacement slightly shingling the sheets (1) to maintain positive control for later reliable discharge.

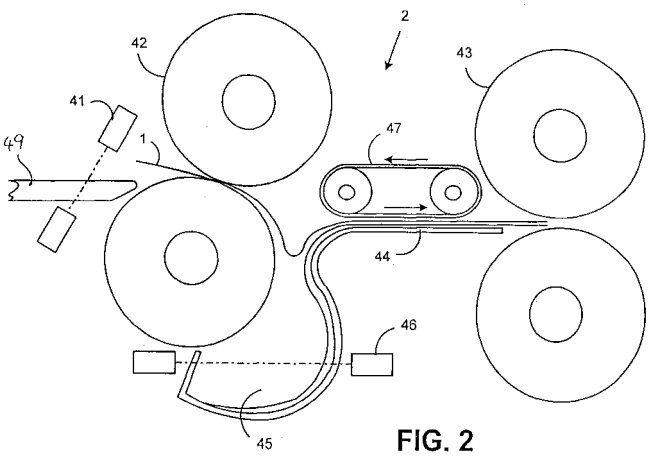

FIG. 2

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Description

[0001] The present invention relates to an inserter input system for generating accumulations of sheets of printed material to be inserted into envelopes. Such an inserter input system cuts and processes a continuous web of material into individual sheets. The individual sheets belonging to a single mail piece are accumulated together and are then further processed together downstream.

[0002] Inserter systems, such as those applicable for use with .the present invention, are typically used by organizations such as banks, insurance companies and utility companies for producing a large volume of specific mailings where the contents of each mail item are directed to a particular addressee. Also, other organizations, such as direct mailers, use inserts for producing a large volume of generic mailings where the contents of each mail item are substantially identical for each addressee. Examples of such inserter systems are the 8 series, 9 series, and APS™ inserter systems available from Pitney Bowes Inc. of Stamford, Connecticut, USA.

[0003] In many respects, the typical inserter system resembles a manufacturing assembly line. Sheets and other raw materials (other sheets, enclosures, and envelopes) enter the inserter system as inputs. Then, a plurality of different modules or workstations in the inserter system work cooperatively to process the sheets until a finished mail piece is produced. The exact configuration of each inserter system depends upon the needs of each particular customer or installation.

[0004] Typically, inserter systems prepare mail pieces by gathering collations of documents on a conveyor. The collations are then transported on the conveyor to an insertion station where they are automatically stuffed into envelopes. After being stuffed with the collations, the envelopes are removed from the insertion station for further processing. Such further processing may include automated closing and sealing the envelope flap, weighing the envelope, applying postage to the envelope, and finally sorting and stacking the envelopes.

[0005] The input stages of a typical inserter system are depicted in Fig. 1. At the input end of the inserter system, rolls or stacks of continuous printed documents, called a "web," are fed into the inserter system by a web feeder **10.** The continuous web must be separated into individual document pages. This separation is typically carried out by a web cutter **20** that cuts the continuous web into individual document pages. Downstream of the web cutter **20,** a right angle turn **30** may be used to reorient the documents, and/or to meet the inserter user's floor space requirements.

[0006] The separated documents must subsequently be grouped into collations corresponding to the multi-page documents to be included in individual mail pieces. This gathering of related document pages occurs in the accumulator module **40** where individual pages are stacked on top of one another.

[0007] The control system for the inserter senses markings on the individual pages to determine what pages are to be collated together in the accumulator module **40.** In a typical inserter application, mail pieces may include varying numbers of pages to be accumulated. For example, the phone bill for a person who lives by himself may be much shorter than another phone bill representing calls made by a large family. Thus, the accumulator **40** is capable of generating accumulations having varying numbers of sheets in accordance with data for the particular mail piece.

[0008] Downstream of the accumulator **40,** a folder **50** typically folds the accumulation of documents so that they will fit in the desired envelopes. To allow the same inserter system to be used with different sized mailings, the folder **50** can typically be adjusted to make different sized folds on different sized paper. As a result, an inserter system must be capable of handling different lengths of accumulated and folded documents.

[0009] Downstream of the folder **50,** a buffer transport **60** transports and stores accumulated and folded documents in series in preparation for transferring the documents to the synchronous inserter chassis **70.**

[0010] Various solutions have been proposed for accumulation of sheets in accumulator **40.** An accumulator using two accumulator bins is described in U.S. Patent 5,083,769 to Young, assigned to the assignee of the present invention. A buckling accumulator is described in U.S. Patent 5,356,263 to Miller, also assigned to the assignee of the present invention. A multi-path sheet collation device is described in U.S. Patent 6,273,419, to Allen, also assigned to the assignee of the present invention. Finally a collator capable of handling thick accumulations of sheets is depicted in U.S. Patent 5,178,379 to Edwards, assigned to the assignee of the present invention. However, a need exists for a fast, reliable, and inexpensive system to meet the needs of current inserter machines.

[0011] The present invention overcomes disadvantages of the prior art by providing an inexpensive and reliable means for accumulating sheets. An accumulator device in accordance with the present invention has a downward angled input transport. This downward angle, in connection with the further elements, helps to ensure proper overlapping of sheets. Downstream of the input transport an accumulating receptacle receives sheets. The accumulating receptacle has an upper guide and a lower guide forming a horizontal accumulating channel.

[0012] At the end of the accumulating channel, accumulation dump rollers act as a stop during sheet accumulation, and as a transport for removing completed accumulations from the sheet accumulating device. The dump rollers are positioned downstream from the input transport a distance less than the length of sheets to be accumulated. Because of this short distance and because of the angle of the input rollers, the rear portion of the sheet will tend to buckle downward.

[0013] A trap arrangement below the input rollers re-

ceives the downward buckled rear portion of the sheet. The downward positioning of the rear portion helps to ensure that subsequent sheets will lay on top of the previous sheet. In the preferred embodiment, the upper guide of the accumulating channel comprises a continuously rotating belt to urge accumulating sheets against the dump rollers.

[0014] Also, a positive air device may be used to assist in the buckling of the rear portion of the sheets. The positive air device may also be used as a substitute for the angled orientation of the input transport is assisting the buckling action into the trap arrangement.

[0015] Accumulators in accordance with the present invention may be used in parallel to provide greater efficiency. The multiple accumulators allow one to be used to receive sheets while the other is busy discharging a completed accumulation.

[0016] In a further preferred embodiment, a sensor senses the arrival of sheets in the accumulating receptacle. When a sheet arrives, the dump rollers perform a small predetermined incremental displacement thereby slightly shingling the sheets. Such incrementing allows the dump rollers to continuously maintain positive control over the entire accumulation, and is useful for handling large collations. When a thick collation is complete, dump rollers can discharge the slightly shingled accumulation without uncontrolled slippage that might otherwise result from a thick stack.

[0017] Further details of the present invention are provided in the accompanying drawings, detailed description, and claims.

[0018] Figure 1 is a diagram of the input stages of an inserter system for use with the present invention.

[0019] Figure 2 depicts a preferred embodiment of an accumulator in accordance with the present invention.

[0020] Figure 3 depicts a preferred implementation of the present invention using parallel accumulators.

[0021] Figure 4 depicts an exaggerated embodiment of shingling of sheets in an accumulator in accordance with the present invention.

[0022] Figure 5 depicts an implementation of the present invention utilizing parallel shingling accumulators.

[0023] A preferred embodiment for an accumulator **2** in accordance with the present invention is depicted in Fig. 2. A sheet **1** is transported into the accumulator **2** between input rollers **42.** At, or just upstream, of input rollers **42** sensor **41** detects the position of sheet **1** as it enters the accumulator **2.** Sensor **41** is preferably an optical sensor that detects the lead and trail edges of sheets **1.** Sensor **41** may also be used to scan a code on sheet **1** in order to obtain information about the mail piece to which the sheet belongs. Based on information in a scanned code, the system may determine how many sheets to accumulate in accumulator **2** to form a collation belonging to a single mail piece.

[0024] As can be seen in Fig. 2, input rollers **42** are positioned to deliver the sheet **1** at a downward angle. As the sheet **1** is passed through rollers **42,** its leading edge will come into contact with lower guide **44** and be guided in a horizontal direction. A horizontal accumulating channel is formed between guides **44** and **47.** At the end of the horizontal accumulating channel, a lead edge of the sheet encounters accumulation dump rollers **43.** In a first embodiment, when the lead edge of a sheet arrives at dump rollers **43,** the rollers are stopped. In this embodiment, the dump rollers **43** remain at a stopped position until a complete collation is formed, and then the complete collation is transported by dump rollers **43** to a next downstream location.

[0025] Dump rollers **43** are preferably driven from both sides. The upper and lower shafts are geared together to provide a positive drive to accumulated sheets. This preferred embodiment assists in transport of thicker sheet collations. The diameter of the rollers for dump rollers **43** is preferably about two inches. This diameter is sufficient to assist in the transport of thicker packets of sheets.

[0026] Dump rollers **43** are preferably comprised of a urethane material, soft enough to prevent damage to the lead edge of sheet **1** and to prevent significant bounce-back upon impact of the lead edge. Dump rollers **43** are also designed to be soft enough to absorb the impact of sheets traveling at high velocities, without damaging them. While softness is preferred for minimizing impact, the dump rollers **43** should also be durable enough that the parts do not wear out too quickly. Accordingly, a preferred urethane surface having a hardness of approximately 35-45 on an A-scale durometer should be used on the surface of dump rollers **43.** A hardness of 40 on an A-scale durometer is most preferred.

[0027] Dump rollers **43** are positioned downstream of input rollers **42** by a distance less than the length of sheet **1** to be accumulated. Therefore, when the lead edge of sheet **1** is stopped by the dump roller **43,** input rollers **42** are still transporting the tail end of the sheet **1.** Since sheet **1** cannot move forward in the accumulating channel, the downward angle of rollers **42** causes the sheet to buckle into a trap arrangement **45.** The trap arrangement **45** assists in the dissipation of the energy of the sheets traveling at high velocities. When a leading portion of the sheets hits the dump rollers **43** energy from the rear portion of the sheet can be dissipated in the trap **45.**

[0028] Trap arrangement **45** is preferably an upstream extension of lower guide **44.** The trap arrangement **45** is substantially below the input rollers **42,** and below the plane of the accumulating channel. As the trail end of sheet **1** passes through the input rollers **42** it is guided down into the trap arrangement **45.** Thus, when the sheet **1** is at rest in the accumulator **2** a leading portion is supported in the accumulating channel, and a trailing portion is supported in the trap arrangement **45.** A sensor **46** detects the successful arrival of a trail portion of a document into the trap arrangement. Sensor **46** may also detect when a sheet is not laying flat in the trap arrangement **45.**

[0029] In current inserter machines, it is often necessary for sheets to travel at speeds in the range of 300 inches per second. Accordingly, a problem arises in bringing the accumulated sheets to a sudden halt at dump rollers **43.** At such high speeds, sheets may bounce or to become skewed in the accumulating channel. Accordingly, in the preferred embodiment of the present invention the upper guide **47** is a continuously rotating belt that urges accumulated sheets in a downstream direction. A rotating belt helps to guarantee that the sheet reaches the dump rollers **43.** As sheet collations get larger in the accumulating channel, the guide belt provides drive for the incoming sheets that might otherwise be pinched between the upper guide **47** and the collation.

[0030] The belt of upper guide **47** provides a transporting force while the sheet is moving the same speed as the belt. However, because the static friction is greater than the dynamic friction, as soon as the sheet is stopped by the dump rollers, the belt **47** will slip over the surface of the paper. For these purposes, the belt (or belts) may be comprised of plastic o-rings mounted on moving rollers or, preferably, a flat belt. With the belts used in upper guide **47,** the use of the dump rollers **43** as a stopping arrangement is made feasible where high sheet speeds may have previously prevented that arrangement from being used.

[0031] In a further preferred embodiment, a positive air source **49** can be used to blow air on the sheet 1 to assist in the buckling action of the sheet into the trap **45.** Preferably, air is blown onto a trailing portion of sheet **1** after the leading portion of the sheet has passed. As such, sensor **41** may be used to detect the passage of the trail edge of sheet **1,** and may be used to trigger the positive air pressure from air source **49** when the trail edge passes through sensor **41.** It will also be understood that some form of negative air pressure from below the sheet may also be used to assist in buckling.

[0032] The preferred embodiment using air source **49** may allow the downward angle of input rollers **42** to be eliminated altogether. Thus the input rollers **42,** the accumulation channel, and the dump rollers **43** may all be in the same transport plane, and avoid inaccuracies that may result from redirecting the transport path of the sheets.

[0033] An accumulator device using two accumulating stations is depicted in Fig. 3. To provide greater speed and efficiency, accumulator **2** and accumulator **3** may be used in a parallel arrangement. Thus while accumulator **3** is in the process of discharging a completed accumulation **5,** sheets may be fed into the parallel accumulator **2.** A diverter mechanism **4** will direct sheets belonging to the same mail piece to one of the two parallel accumulators **2** or **3.** When one accumulation is complete, there is a delay while the dump rollers **43** eject the completed accumulation. Rather than wait for the dump rollers **43** to finish the transfer, the diverter **4** changes the paper path to begin the next accumulation in the alternate accumulator. The diverter **4** receives sheets serially from upstream transport rollers **7.** Diverter **4** is preferably a flipper gate that alternates between paper paths leading to accumulators **2** and **3.**

[0034] A further preferred embodiment of the present invention is depicted in Fig. 4. This embodiment addresses a problem resulting from the sudden acceleration of the dump rollers **43** to remove completed accumulations from the accumulator **2.** Execution of the aggressive acceleration on thick collations, typically of ten sheets or more, may cause the sheets to become unaligned and not reliably translate together as a uniform packet. Such failure to reliably translate together may result in jams, poor fold quality, and mail piece integrity problems. For thicker collations, dump rollers **43** may not be large enough that the lead edge of the stack is sufficiently positioned between the rollers such that it can be reliably accelerated. Also, dump rollers **43** may be driven on only one side. As a result, being driven on one side, excessive slippage may result, as one side of the collation is translated more quickly than the other.

[0035] In the past, one method of addressing the problem of discharging thick collations has been to use "pinch rollers" that movably close upon a completed collation and then provide a motive force to discharge the collation from the accumulator. As seen in U.S. Patent 5,178,379, pinch rollers remain out of the way when the collation is being formed, and are not used for stopping or registering the collation.

[0036] The preferred embodiment of the present invention utilizes a technique that eliminates the need for additional moving parts to handle thicker collations. In this preferred embodiment, each time a lead edge of a sheet **1** reaches the dump rollers **43,** the dump roller **43** rotates by a small increment to ingest a portion of the newly arrived sheet between the rollers **43.** The incremental rotation of the dump rollers **43** may be triggered by sensing of the lead edge arriving at the dump rollers. In a preferred embodiment, however, sensor **41** may be used to trigger the incrementing of the dump rollers **43** when the tail edge of sheet **1** is entering rollers **42.** When a trail edge is detected by sensor **41,** the lead edge will have arrived at the dump rollers **43.** Fig. 4 provides an exaggerated depiction of the shingling effect created by the incrementing of each sheet arriving at the dump rollers **43.** In practice, the displacement for ingesting each sheet is on the order of .010 inches for dump rollers **43** having a diameter of 1.25 to 1.5 inches. The larger the diameter of dump rollers **43** the less incremental displacement that will be required for achieving positive control. By slightly shingling the sheets in this manner dump rollers **43** maintain a positive grip on the entire collation and the problem of gaining control of a thick collation is avoided.

[0037] Some slightly shingled accumulations will not require folding. However, for other accumulations the slight shingling may be a consideration with respect to a folder 50. In a conventional folder **50,** if a shingled collation is input, the edges of the resulting folded documents

will not be aligned with one another. Given the relatively small amount of shingling displacement needed to implement the preferred embodiment, the slightly shingled documents may be folded and further processed without concern. However, if the specifications for fitting a folded collation into an envelope are so tight that the slightly shingled folded collations will not fit, then an intermediary mechanism for registering the collations is needed.

[0038] As seen in Fig. 5, upstream of folder **50,** registration mechanisms **12** and **13** have been added downstream of accumulators **2** and **3.** Registration mechanisms **12** and **13** may be of any conventional registration/accumulation technology. In this preferred embodiment of Fig. 5, the registration mechanisms are comprised of transport belts **14,** with a reciprocating stop device **15.** A slightly shingled collation **5** enters the registration mechanism **12,** transported between belts **14.** The collation **5** then is registered against a stopping surface of the stop device **15.** After the collation **5** has been registered it, the stopping surface is lowered and the collation may be transported on to the next processing station.

[0039] The present invention may also be useful for providing "reverse accumulation" of sheets. In the conventional accumulation described above, a first sheet to arrive in the accumulator becomes the bottom sheet in the collation as consecutive sheets are stacked on top. However, for some collating tasks, it is desirable that the first sheet be the top sheet and that subsequent sheets be added to the bottom of a collation. This adding of sheets to the bottom of an accumulation is referred to as "reverse accumulation."

[0040] Reverse accumulation is achieved by flipping the accumulator described above around its horizontal axis so that it is oriented up-side down. In this way, a first sheet will remain on top in the accumulating channel, as subsequent sheets are added underneath.

[0041] Although the invention has been described with respect to preferred embodiments thereof, it will be understood by those skilled in the art that the foregoing and various other changes, omissions and deviations in the form and detail thereof may be made without departing from the spirit and scope of this invention.

Claims

1. A sheet accumulating device comprising a first accumulator (2) including:

an accumulating receptacle (44,47; 44,48) receiving a series of sheets

(1) to be accumulated;

accumulation dump rollers (43) at a downstream end of the accumulating receptacle, the dump rollers controlled to act as a stop during sheet accumulation, and to transport completed accumulations from the sheet accumulating device;

a sensor (41) sensing the arrival of sheets in the accumulating receptacle (44,47; 44,48);

a controller controlling the dump rollers (43) to perform a small predetermined incremental displacement upon a sensed arrival of a sheet at the dump rollers, thereby slightly shingling the sheets, the controller further causing the dump rollers (43) to completely discharge the slightly shingled accumulation upon completion of the accumulation.

2. The device of Claim 1 further comprising a second accumulator in parallel with the first accumulator and whereby a diverter mechanism upstream of the first and second accumulators alternately diverts sets of sheets to the second accumulator while the first accumulator is discharging a first completed accumulation, and to the first accumulator while the second accumulator is discharging a second completed accumulation.

3. The device of Claim 2 further including an output transport downstream of the first and second accumulators whereby the output of the parallel first and second accumulators are merged back into a single transport path.

4. The sheet accumulating device of Claim 1, wherein the predetermined incremental displacement is less than 0.010 inches.

5. The sheet accumulating device of Claim 1 further comprising:

an input transport upstream of the accumulating receptacle;

the accumulating receptacle being positioned downstream of the input transport and receiving sheets from the input transport, the' accumulating receptacle having an upper guide and a lower guide forming an accumulating channel, the accumulating channel being substantially horizontal;

the accumulation dump rollers being positioned at a downstream end of the accumulating receptacle and positioned downstream from the input transport a distance less than the length of sheets to be accumulated; and

a trap arrangement at an upstream end of the accumulating receptacle positioned beneath the input transport and below a level of the accumulating channel for receiving trailing portions of accumulated sheets stopped at the dump rollers and caused to buckle into the trap arrangement from the input transport.

6. The sheet accumulating device of Claim 5, wherein

the input transport has a downward angle relative to the accumulating receptacle thereby assisting in the buckling of the sheets into the trap arrangement.

7. The accumulating device of Claim 5, wherein at least one of the lower or the upper guides comprises a continuously rotating belt to urge accumulating sheets against the dump rollers.

8. A sheet accumulating device comprising a first accumulator (2) including:

an input transport (42);
an accumulating receptacle (44,47; 44,48) downstream of the input transport (42) and receiving sheets from the input transport, the accumulating receptacle (44,47; 44,48) having an upper guide (47;48) and a lower guide (44) forming an accumulating channel, the accumulating channel being substantially horizontal;
accumulation dump rollers (43) at a downstream end of the accumulating receptacle, the dump rollers (43) controlled to act as a stop during sheet accumulation, and to transport completed accumulations from the sheet accumulating device, the dump rollers (43) positioned downstream from the input transport a distance less than the length of sheets to be accumulated;
a trap arrangement (45) at an upstream end of the accumulating receptacle (44,47; 44,48) positioned beneath the input transport and below a level of the accumulating channel for receiving trailing portions of accumulated sheets stopped at the dump rollers and caused to buckle into the trap arrangement (45) from the input transport (42); and
an air pressure source (49) positioned proximal to the trap arrangement (45) for assisting tail portions of sheets into the trap arrangement.

9. The sheet accumulating device of Claim 8 further comprising a sensor detecting a position of a sheet and the air pressure source being activated based on the sensed position of a sheet.

10. The sheet accumulating device of Claim 5 or 8, wherein the orientation of the device is turned upside-down thereby creating a reverse accumulating device.

11. A method for accumulating and transporting sheets, the method comprising:

transporting a sheet to an accumulation receptacle (44,47; 44,48);
stopping the sheet in the accumulation receptacle (44,47; 44,48) with accumulation dump rollers (43) in a stopped condition;
sensing an arrival of the sheet in the accumulation receptacle (44,47; 44,48);
displacing the dump rollers (43) by a small predetermined incremental displacement upon sensing the arrival of the sheet, thereby slightly shingling the sheets;
repeating the foregoing steps for a series of sheets comprising a complete accumulation; and
discharging a completed accumulation of slightly shingled sheets from the dump rollers (43).

12. The method of Claim 11, wherein the predetermined incremental displacement is less than 0.010 inches.

13. The method of Claim 12, wherein the step of buckling further includes blowing air in a downward direction to assist the rear portion of the sheet into the trap arrangement.

14. The method of Claim 13, wherein the step of transporting the sheet to the accumulating receptacle includes transporting the sheet in an input transport plane with a downward angle, the method further comprising the steps of:

buckling a rear portion of transported sheets into a trap arrangement when a lead edge of the sheet stops at the dump rollers; and
urging accumulating sheets in the accumulating receptacle against the dump rollers with an urging arrangement that provides a continuous urging force while slipping over the surface of transported sheets.

15. The method of Claim 11, wherein prior to the accumulation of documents sheets, diverting sheets to one of at least two parallel accumulation paths, whereby sets of sheets are diverted to a second accumulator while a first accumulator is discharging a first completed accumulation, and sheets are diverted to the first accumulator while the second accumulator is discharging a second completed accumulation.

16. The method of Claim 15 further including the step of merging completed accumulations from the parallel accumulation paths into a single transport path.

17. A sheet accumulating device comprising a first accumulator (2) including:

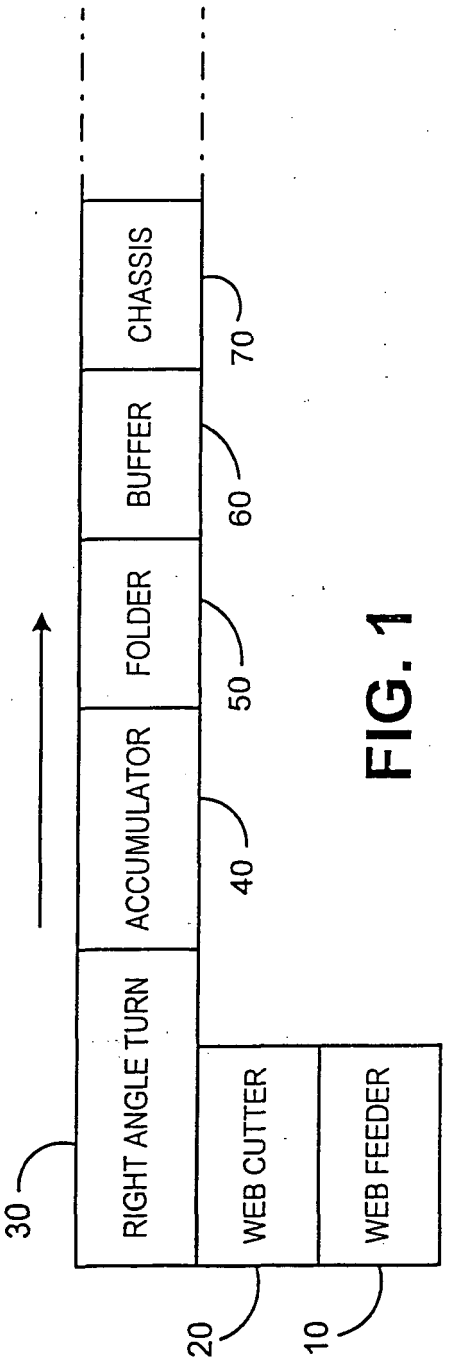
an input transport (42);
an accumulating receptacle (44,47;44,48) downstream of the input transport (42) and receiving sheets (1) from the input transport, the accumulating receptacle having an upper guide (47) and a lower guide (44) forming an accumu-

lating channel, the accumulating channel being substantially horizontal;
accumulation dump rollers (43) at a downstream end of the accumulating receptacle, the dump rollers controlled to act as a stop during sheet accumulation, and to transport completed accumulations from the sheet accumulating device (44,47; 44,48), the dump rollers (43) positioned downstream from the input transport a distance less than the length of sheets to be accumulated;
a trap arrangement (45) at an upstream end of the accumulating receptacle positioned beneath the input transport (42) and below a level of the accumulating channel for receiving trailing portions of accumulated sheets stopped at the dump rollers and that buckle into the trap arrangement from the input transport;

wherein at least one of the lower (44) or the upper guide (47;48) comprises a continuously rotating belt to urge accumulating sheets against the dump rollers (43).

18. The device of Claim 17, wherein the accumulation dump rollers (43) are comprised of urethane material with a hardness in the range of 35-45 on an A-scale durometer.

19. The device of Claim 17 further comprising an air pressure source positioned proximal to the trap arrangement for assisting tail portions of sheets into the trap arrangement.


WEB FEEDER
WEB CUTTER
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ACCUMULATOR
FOLDER
BUFFER
CHASSIS
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20
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40
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60
70

FIG. 1

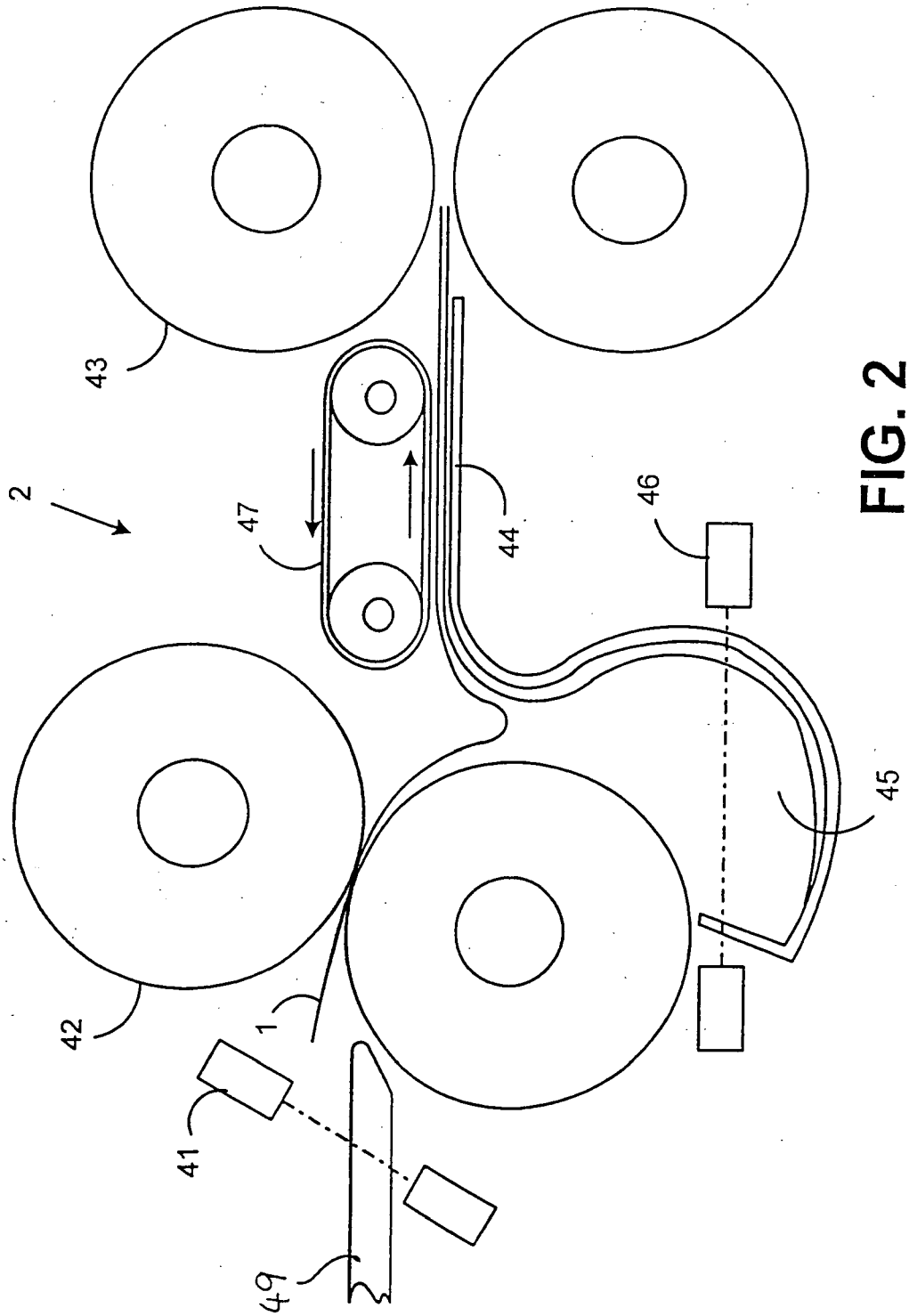

FIG. 2

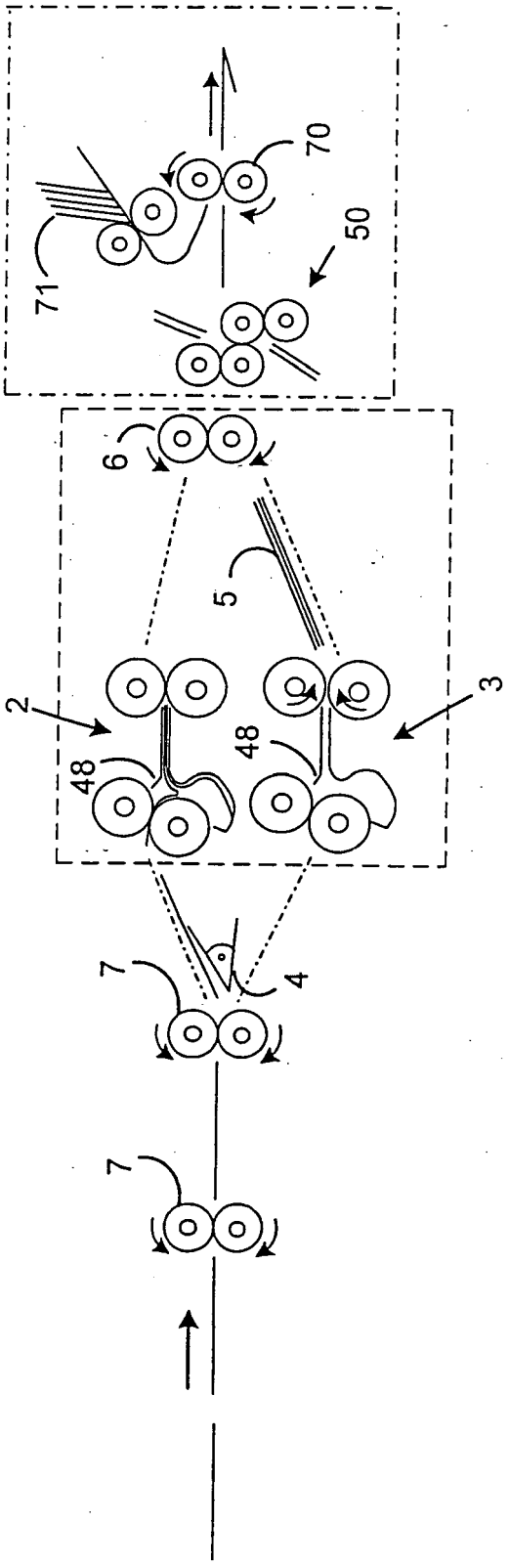

FIG. 3

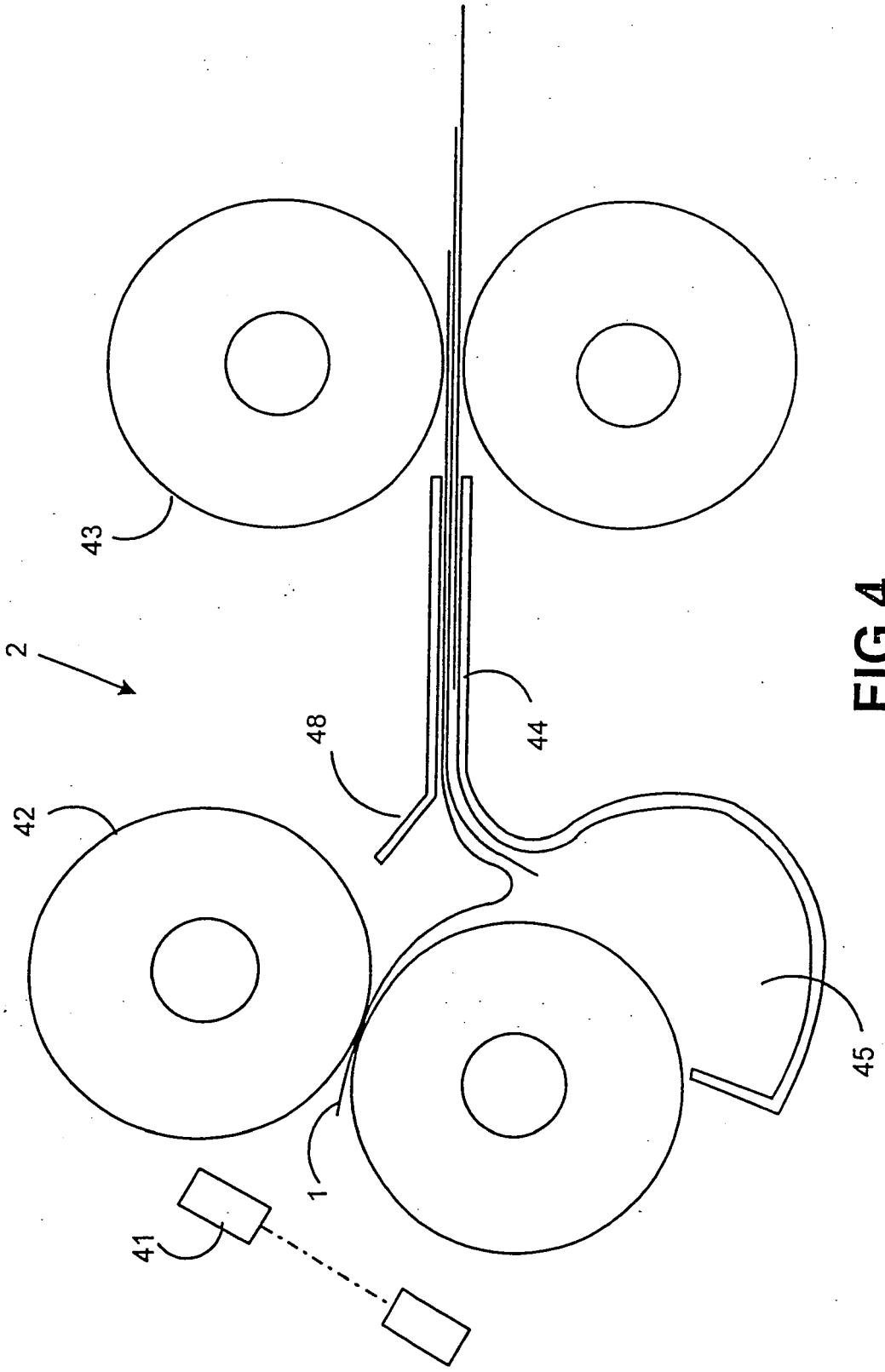

FIG.4

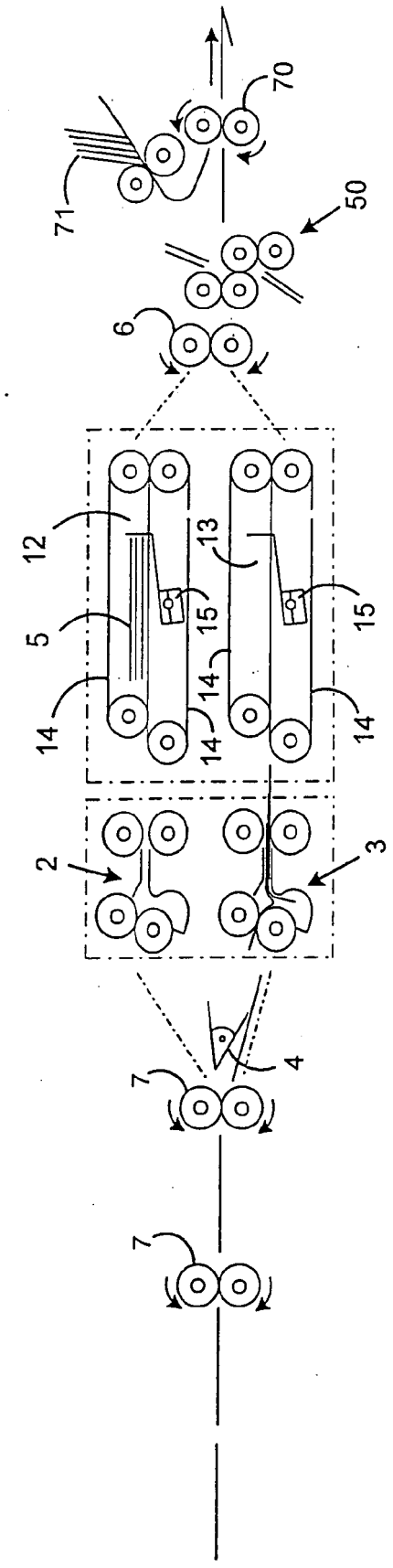

FIG.5