July 9, 1968 A. J. GEIS ET AL 3,391,806

SEPARATOR-TRANSFER APPARATUS

Filed Dec. 19, 1966 6 Sheets-Sheet 1

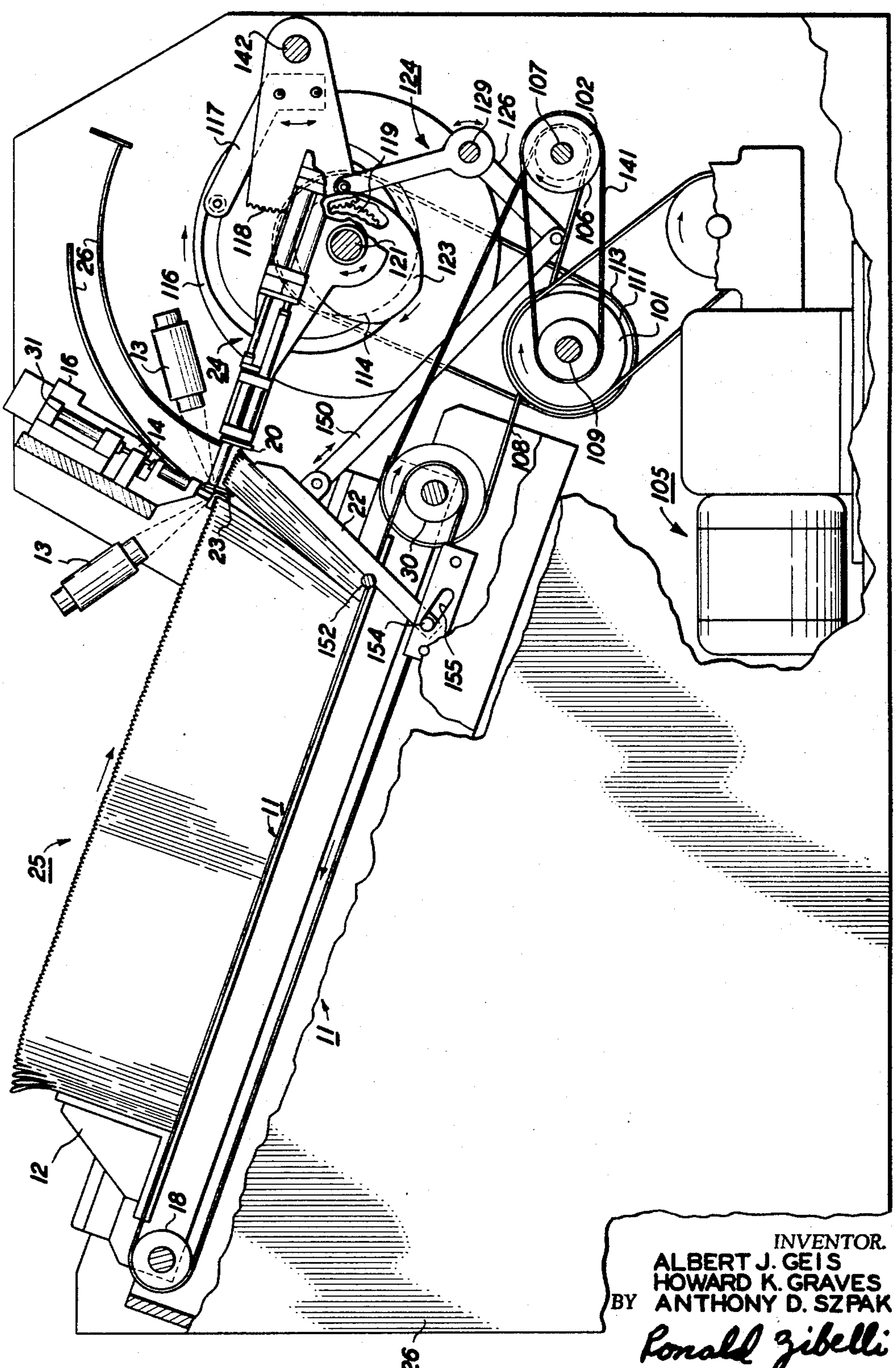

FIG. 1

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SEPARATOR-TRANSFER APPARATUS

Filed Dec. 19, 1966 6 Sheets-Sheet 2

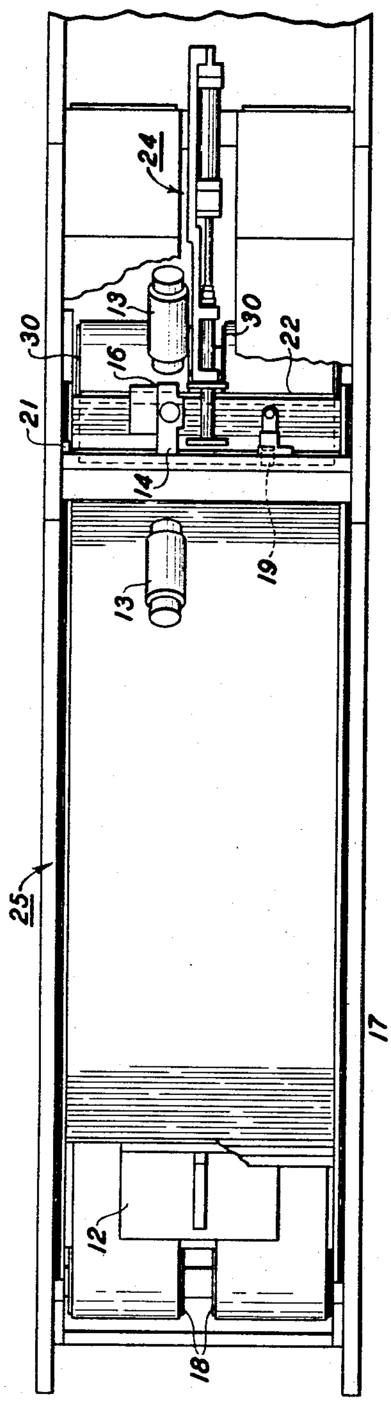

FIG. 2

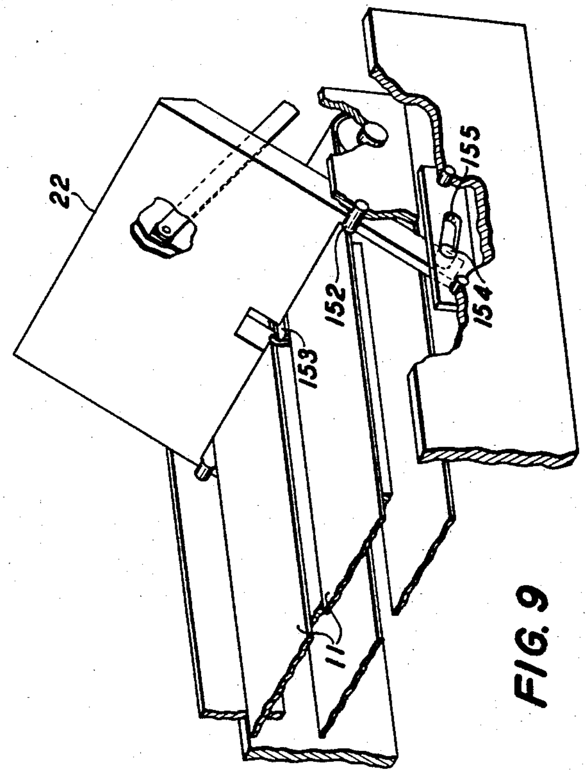

FIG. 9

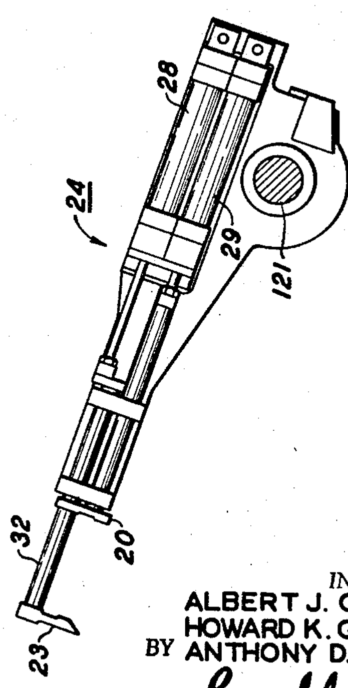

FIG. 8

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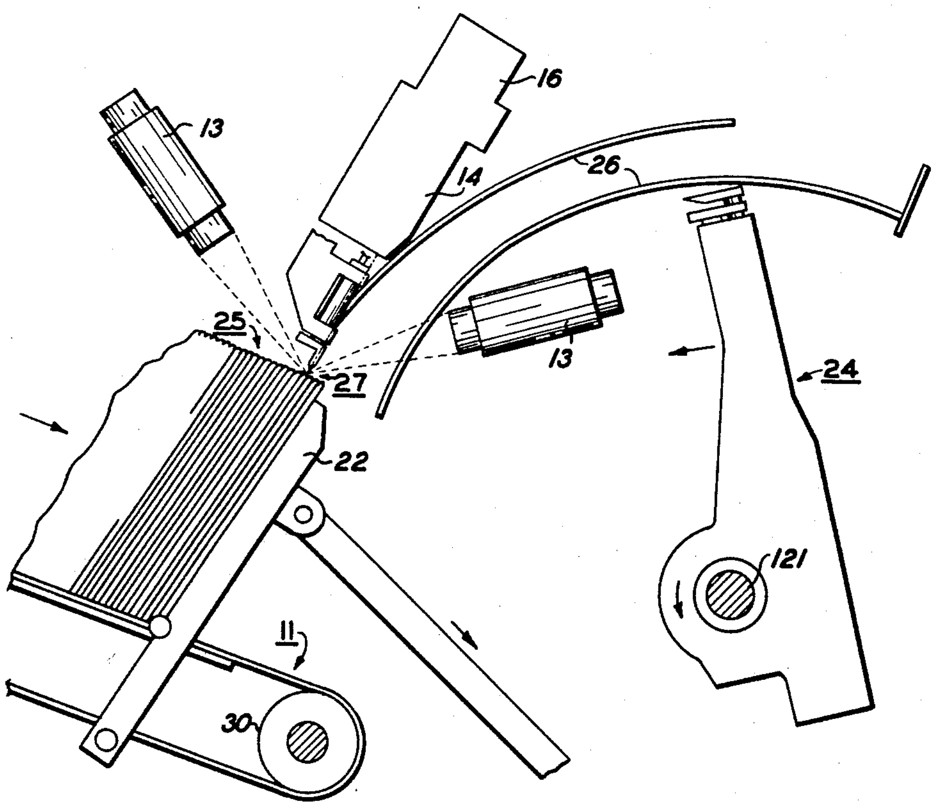

FIG. 3

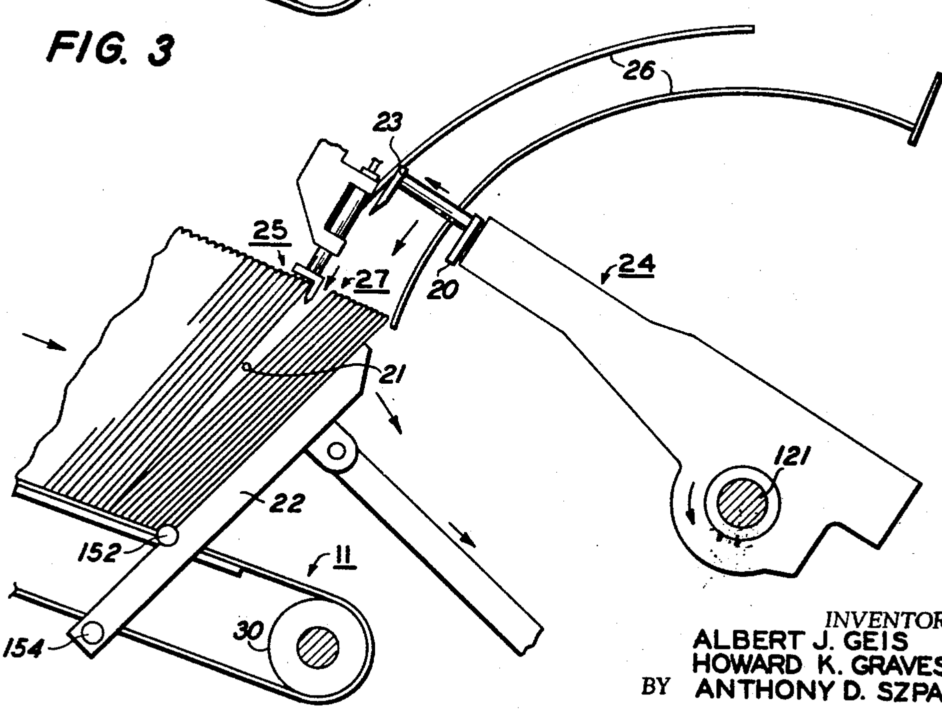

FIG. 4

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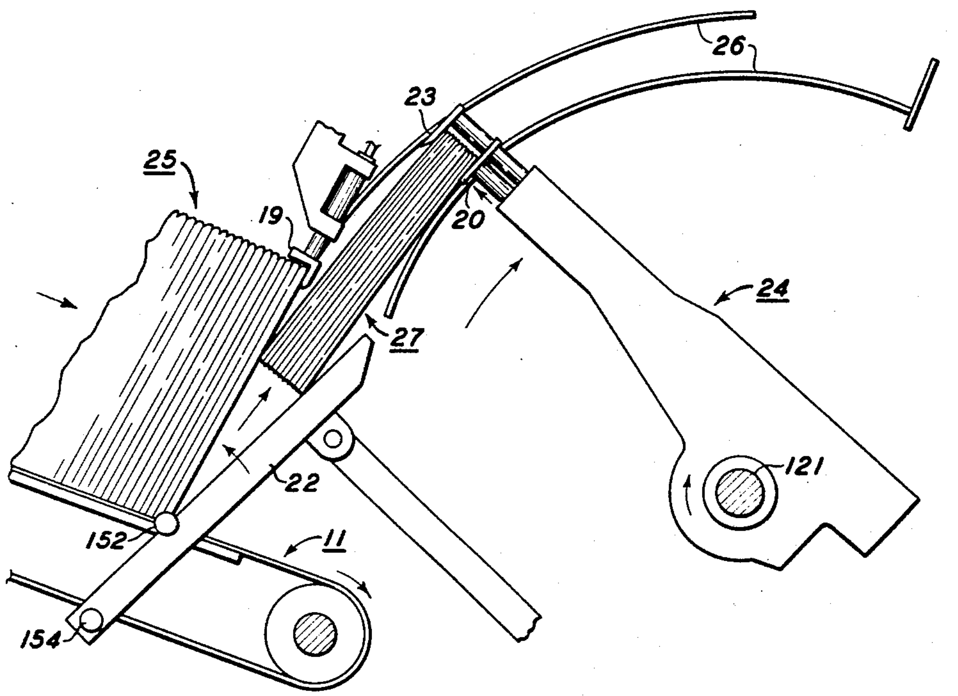

FIG. 5

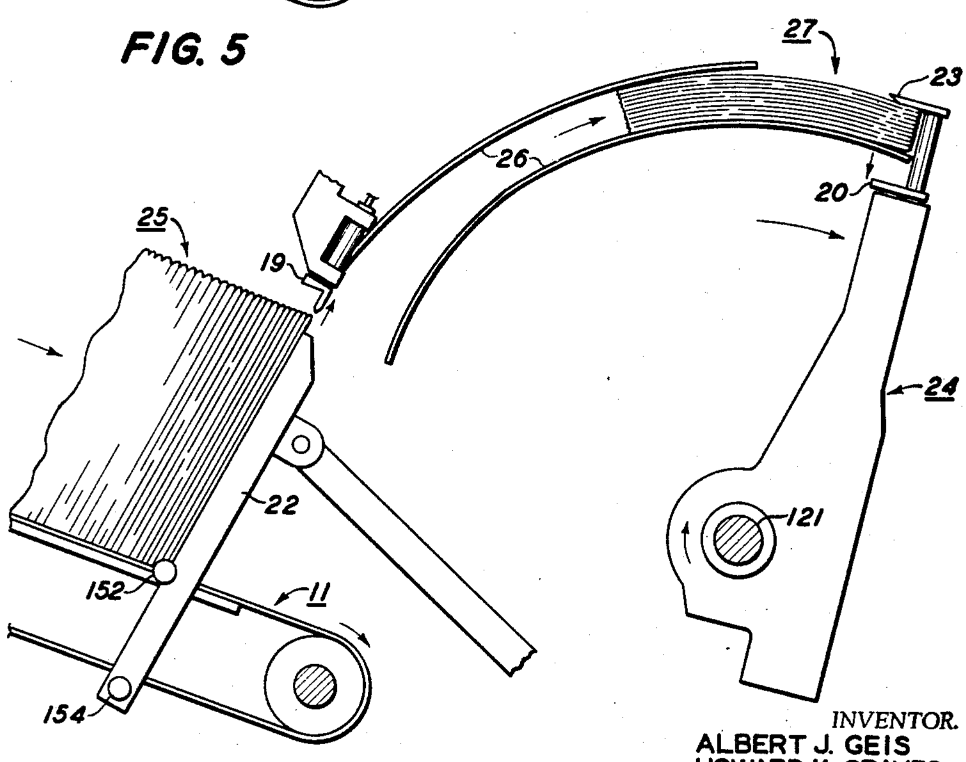

FIG. 6

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SEPARATOR-TRANSFER APPARATUS

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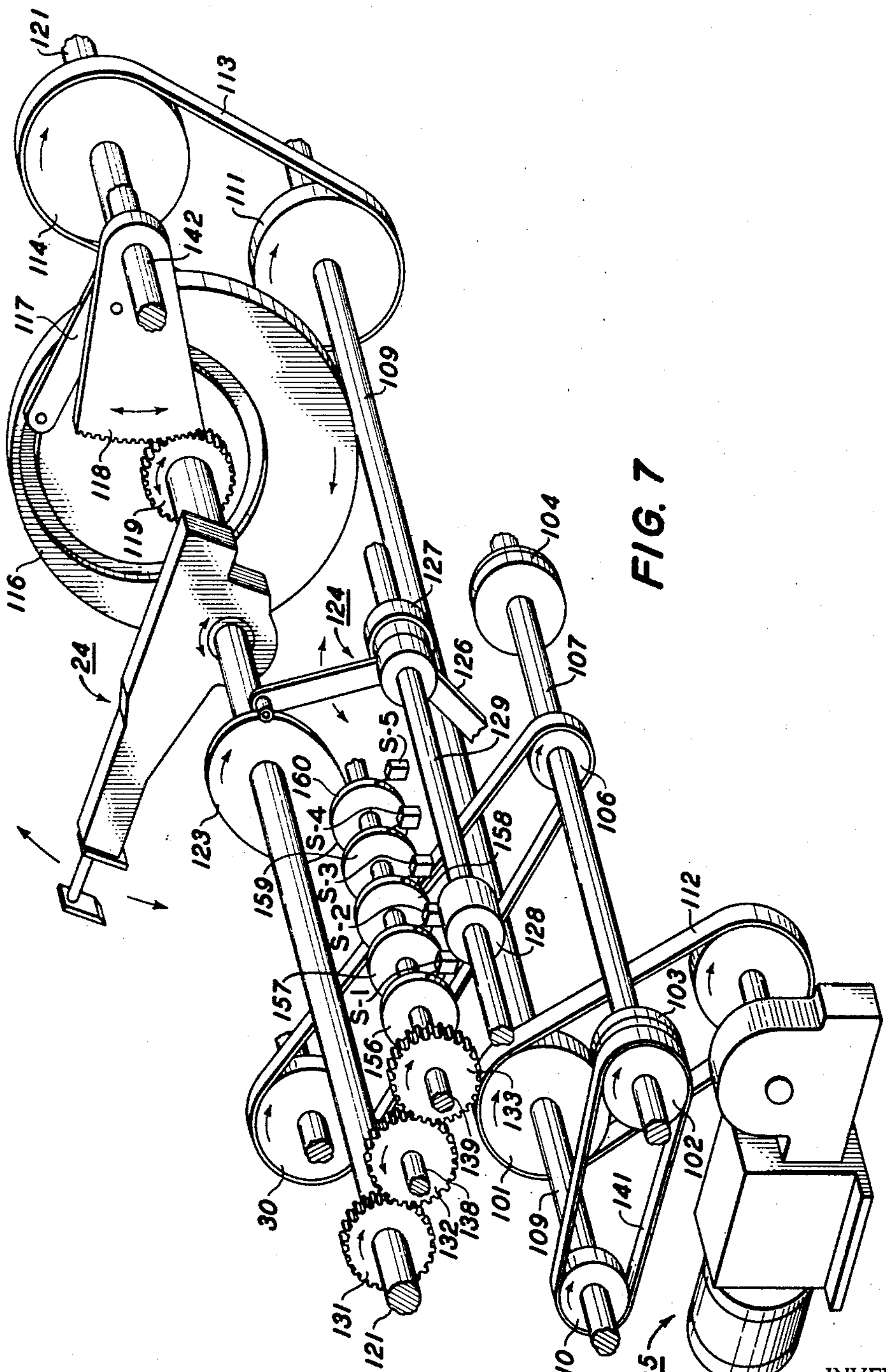

FIG. 7

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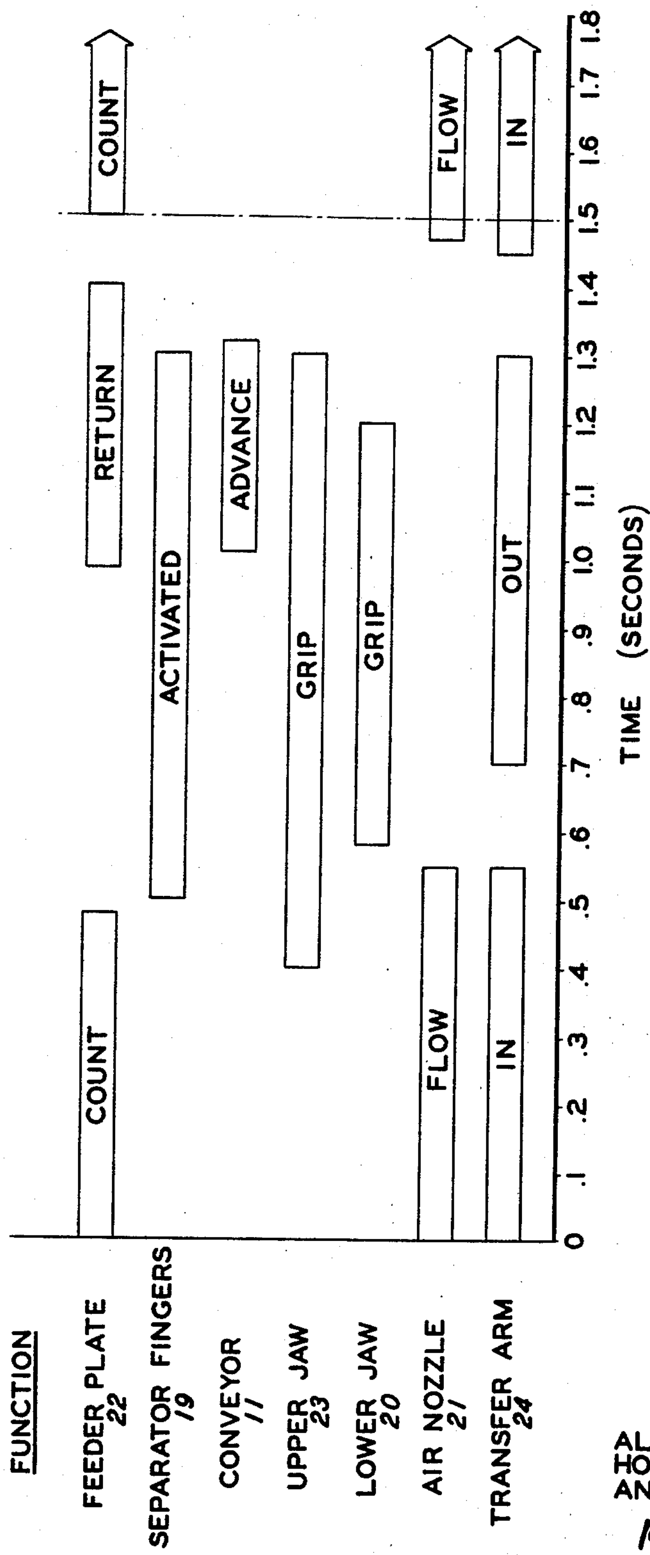

FIG. 10

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United States Patent Office

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SEPARATOR-TRANSFER APPARATUS

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Filed Dec. 19, 1966, Ser. No. 602,840
12 Claims. (Cl. 214—8.5)

This system relates, in general, to a separator-transfer system, and, more specifically, to a device which separates and transfers articles such as magazines, newspapers and similar printed publications from a stack to a remote location.

Devices for separating and transferring articles in the prior art have many disadvantages, the most noticeable inadequacies being slowness, inaccuracy, inflexibility and unreliability.

One prior art apparatus utilizes a moving platform to push a predetermined number of articles from the stack. Such an apparatus can separate only an approximate number of articles since the number of articles actually removed from the stack is a direct function of the compactness of the stack, and in separating relatively thin, folded publications known in the art as signatures, uniformity of compactness is difficult to control. This type of system also has the disadvantage of being necessarily limited to a slow speed of operation due to the involvement of bulky, heavy elements in the platform and supporting mechanisms.

In another type of prior art device signatures in an imbricated position on a conveyor are fed to the end of the conveyor where they drop into a supporting member thereby becoming superimposed one upon another. When the supporting member contains the desired number of signatures, the conveyor is stopped and the supporting member pivots about one of its ends through stripper bars which strip the signatures from the supporting member causing them to drop into a cavity below. A drawback to this transfer system is that the articles must be delivered by a relatively slow moving conveyor in an overlapped, substantially flat manner in order to be received properly by the supporting member, and increasing the speed of operation of the system would undoubtedly cause maldelivery to the supporting member.

Other types of separator-transfer apparatus which operate on one article at a time are more precise, but also have major drawbacks, generally using a complex combination of suction cups, drums and grippers which separate an article from the stack, grasp it at its edges, and transfer it away from the conveyor on a drum.

The present invention is intended to improve upon prior art by counting, separating and transferring articles at a much more rapid pace with greater accuracy, flexibility and reliability than was previously possible. Accordingly, it is an object of this invention to provide a novel separator-transfer system which overcomes the deficiencies of the prior art devices as described above.

It is a further object of the present invention to provide a separator-transfer system that rapidly and efficiently separates a group of articles from a continuous stack and transfers them away from the separation area.

A still further object is to provide a transfer system utilizing guides which compress the group of separated articles into a compact unit in preparation for bundling as they are being transferred away from the separation area.

A still further object of this invention is to provide a photosenstive counting device in combination with the separator-transfer apparatus.

A still further object is to provide a combination counter-separator-transfer apparatus which is capable of counting, separating and transferring consecutive groups of articles where each group may vary in size.

The objects of this invention are accomplished, generally speaking, by placing a stack of articles on a conveyor and moving their uppermost edges past a counting device. Prior to being counted the leading articles in the stack are preferably separated from one another by a stream of air directed at them by a nozzle. The first article in the stack is supported by a feeder plate which rotates away from the stack causing the folded edge of the articles to pass under the counter mechanism and be counted.

After a predetermined number of articles have been counted, the feeder plate stops rotating and a separator finger drops in front of the stack from an overhead position holding back the uncounted articles while, simultaneously, a rotary transfer arm swings over the counted articles and the group is gripped tightly by jaws located at the extremity of the transfer arm.

The articles are subsequently transferred by the arm to a delivery area through cam-like transfer guides located between the conveyor and delivery area. As they proceed toward the delivery area the separator finger automatically is raised to its initial overhead position, the feeder plate assumes its initial upright position, the conveyor is restarted, and the entire sequence is repeated.

Any one of a number of photosensitive counting systems can be used in conjunction with the separator-transfer apparatus. One such device is a photosensitive counting system which relies on pulsations of high intensity light to intermittently activate a photosensitive cell.

In order to employ this device, the edge of an article; e.g., the folded edge of a signature, is illuminated as it passes under a photocell with a small, long light-guiding barrel which only accepts incoming light from a certain small range of angles known as a microscope. When a signature is directly under the microscope, the light cast by the illuminator is reflected from the edge of the signature and into the microscope barrel where it is of sufficient intensity to activate the photosensitive cell. However, during such time as there is not a signature located immediately under the microscope, much of the light from the illuminator is absorbed by the natural dark area in the space between the signatures, and that light which is reflected into the microscope barrel, if any, is not of sufficient intensity to activate the photosensitive cell. The resulting pulsations of light that intermittently activate the cell make it possible to accurately count the signatures as they pass by the microscope.

For a better understanding of the invention as well as other objects and further features thereof, reference is had to the following detailed description of the invention to be used in connection with the accompanying drawings, wherein:

FIGURE 1 is a partially broken away side view of the apparatus showing the arrangement of the mechanical drive elements;

FIGURE 2 is a partially broken away top view of the apparatus;

FIGURES 3–6 are side diagrammatic illustrations of the key elements of the counting, separating and transfer device as it runs through a cycle of operation;

FIGURE 7 is a perspective side view of the mechanical drive mechanism that operates the counting, separating and transfer device;

FIGURE 8 is a side view of the transfer jaws and a portion of the transfer arm;

FIGURE 9 is a partially sectioned isometric view of the feeder plate and conveyor linkage; and

FIGURE 10 is a timing chart of mechanical members in the apparatus.

Referring now to the drawings, there is shown in FIGURE 1 a machine cabinet **26** housing an incline endless belt conveyor **11** entrained on upper roller **18** and lower driven roller **30**. Roller **30** is driven through belt **108** by pulley **106** mounted on shaft **107**. Shaft **107** is driven from the main drive shaft **109** through belt **141** by pulley **103** while motor assembly **105** imparts power to the main drive shaft. Prior to the time the counting of the articles takes place, conveyor **11** moves the stack of articles, by virtue of the above-mentioned linkage, against feeder plate **22**. Conveyor **11** is inclined in order that any article **25** on the conveyor will have a tendency to fall forward toward the feeder plate. Slide plate **12**, which moves with the conveyor, is placed behind the last article in the stack to insure they remain in an upright position as they are being advanced.

The top edge of each article is counted as it passes underneath microscope **14** and photosensitive cell **16** while being illuminated by illuminators **13**. The operation of this counting system is explained in detail in conjunction with FIGURE 3. To keep the articles within the focus of microscope **14** at all times during counting, the lower end of conveyor **11** is automatically elevated as the feeder plate rotates in the clockwise direction. This is made possible through the action of cam **154** in slot **155** which is described in greater detail in conjunction with FIGURE 9.

The top edge of each article passes underneath the counting system when feeder plate **22** rotates in the clockwise direction about pin **152**. The feeder plate is driven by link **150** and arm **126** which is mounted on shaft **129**. Follower **124**, also mounted on shaft **129**, dictates the motion of arm **126** and is driven by cam **123** which is mounted on shaft **121**. Shaft **121** is also driven by the main drive shaft **109** through belt **113** and pulley **114**.

The degree to which the feeder plate rotates in the clockwise direction depends entirely upon the number of articles to be counted. When the desired number of articles has passed beneath the counting system, separator finger **19** drops into the stack from its overhead position separating the counted signatures from the stack, feeder plate **22** ceases to rotate in the clockwise direction, and transfer arm **24** arrives over the stack of articles. Arm **24**, which is mounted on shaft **121** and moves independently of it, is driven by gear **119** and gear segment **118**. Segment **118** is attached to follower **117** whose motion is defined by cam **116** mounted on shaft **121**. Jaws **20** and **23**, located on arm **24**, grip the counted articles and, by drawing them through transfer guides **26**, remove them to a remote location. While the articles are being transferred by arm **24**, feeder plate **22**, by rotating in the counterclockwise direction, returns to the position where it supports the stack before starting the next cycle.

As can best be seen in FIGURE 2, illuminators **13**, microscope **14**, photosensitive cell **16**, jaws **20** and **23** and separator finger **19** are found in approximately the same area of the conveyor, generally designated as the counter area. Each of these parts is located offset from the others within the counter area in order to avoid interference with another member during operation. Jaws **20** and **23** on transfer arm **24** are located over the mid-section of the conveyor. This arrangement causes the signatures to be gripped for transfer on the top center and leaves their edges unencumbered as they are moved through transfer guides **26** on the way to the delivery area.

The illuminators **13**, photosensitive cell **16** and microscope **14** are located on one side of the conveyor midway between jaws **20** and **23** and the outside edge of the conveyor. To reflect enough light to activate the photosensitive cell the illuminators are located in a position where the beams of light fall on the top edge of the signatures when they are directly under the microscope. Separator finger **19** is located on the opposite side of the conveyor midway between jaws **20** and **23** and the other edge of the conveyor. In these locations the forenamed members continuously count, separate, and transfer articles without one operation interfering with another.

FIGURES 3 to 6, and the description relating thereto, pertain primarily to the position of the signatures during counting, separating and transferring, and a more detailed description of the various members of the apparatus which make this possible as well as their interrelationship will follow.

Beginning with FIGURE 3, the uncounted signatures **25** are placed on conveyor **11** in an essentially horizontal stack with folded edge up. Basically only the upper portion of each signature is moved past the counter area, the lower portion remaining in the same location adjacent the feeder plate throughout the entire counting operation. The signatures to be counted are supported by the feeder plate and as the plate pivots in the clockwise direction the folded edge of each signature is caused to move past the microscope. The greater the number of signatures desired to be counted for transfer, the more the feeder plate must pivot.

As the signatures are moved through the counter area their uppermost edge, the folded edge, is flooded with light by illuminators **13**. There is located above the signatures photosensitive cell **16** in combination with microscope **14** which senses the intensity of light reflected by the signatures. The light cast on the signatures by illuminators **13** is reflected from the folded edge of the newspaper and into the microscope barrel. The space between the individual signatures in the stack is a natural black body area which absorbs much of the light cast by the illuminators, and as this black body passes under the microscope comparatively little light is reflected into the barrel of the microscope. The reflected light is of sufficient intensity to activate the photosensitive cell only when a signature is located in a position directly under the microscope.

Since the entire body of a signature is not translated past the center-line of the microscope barrel while being counted, the distance between the microscope lens and the folded edge of the signatures will increase as the feeder plate pivots and additional signatures are counted. Hence, if the lens is adjusted so that the folded edge of the first signature counted is in precise focus, by the time the feeder plate had pivoted to accommodate the last signature being counted, its folded edge would be at a greater distance from the lens than the first signature and the lens would no longer be in focus. The larger the number of signatures to be counted, the more the feeder plate would have to be pivoted thereby aggravating the inherent difficulty in keeping the top edges in focus.

To remedy this situation the conveyor height is adjusted automatically as the feeder plate rotates maintaining a fixed distance between the top edge of the signatures and lens regardless of the degree of rotation of the feeder plate. This correction is accomplished through a simple, purely mechanical cam arrangement connecting the feeder plate and conveyor assembly which is shown in FIGURE 9. As feeder plate **22** rotates counterclockwise, the portion of the conveyor under the microscope lens is lifted toward the lens by pivoting the conveyor in the area of roller **18**. Feeder plate **22** has affixed to it a cam **154** which moves through cam slot **155** which is located in the frame of conveyor **11**. The cam slot configuration reflects the vertical distance conveyor **11** must be raised in respect to all positions of feeder plate **22** to keep the edge of the signatures in focus at all times. As the feeder plate moves clockwise, cam **154** forces the entire conveyor assembly to pivot counterclockwise.

Referring again to FIG. 3, the continuous movement of signatures past the microscope barrel causes pulsations of adequately intense reflected light to be taken in by the microscope periodically thereby resulting in the intermittent activation of the photosensitive cell. Each time the photosensitive cell is activated, its output is fed into an ordinary electronic counter (not shown). In the manner explained above the number of signatures needed for each bundle is counted from the stack.

As can best be seen in FIGURE 4, prior to passing beneath the microscope barrel to be counted, each signature is subjected to a stream of air directed by nozzle 21. The air reaching the space between two pages in a signature causes the signature to expand, or balloon, thereby increasing the distance between the signatures to insure an accurate count.

After counting a desired number of signatures, separator finger 19 drops from its inactivated position above the stack to a position between the last counted signature and the remainder of the stack. The separator finger is activated electrically by a signal from the electronic counter, and its purpose is to, first, physically separate the group of counted signatures 27 from the stack, and, secondly, hold stationary in a substantially upright position the leading signatures of the stack until the counted signatures are transferred from the conveyor and feeder plate 22 has returned to support the stack.

After the separator finger has dropped into the stack, transfer arm 24 arrives at a position just above the counted signatures at which time upper jaw 23 is activated. Jaw 23, when activated, always is located at the same distance from the fulcrum of the transfer arm regardless of the number of signatures to be transferred. The distance between the activated upper jaw and the fulcrum of the arm is equivalent to the distance between the activated separator finger and the fulcrum of the arm. Consequently, the upper jaw falls into the space of separation between the counted and uncounted signatures made by the finger prior to transfer.

The transfer arm reaches the limit of its counterclockwise rotation when the upper jaw is located between the counted and uncounted signatures, and immediately thereafter, lower jaw 20 is activated until it contacts and tightly compresses the signatures between it and the upper jaw.

As illustrated in FIGURE 8 jaws 20 and 23 are located at the extremity of the transfer arm. Jaw 23 is activated by air cylinder 28, while jaw 20, on the other hand, is activated by air cylinder 29. Jaw 20, actually travels along connecting rod 32, which connects jaw 23 to air cylinder 28; however, connecting rod 32 only serves as a support for jaw 20 and each jaw acts independently of the other. Air cylinders 28 and 29 are connected to a supply of compressed air (not shown).

Again referring to FIGURE 4, the transfer arm is in approximately parallel relationship to the conveyor when the counted signatures are grasped by the jaws, thereby making certain that a neat, square packet of signatures is transferred to the delivery area. The jaws grip the signatures in the middle of their folded-edge to insure that both ends of the signatures are able to be guided freely during transfer.

Now referring to FIGURE 5, after the feeder plate has reached the proper clockwise rotation for transfer, its exact extent of rotation dependent upon the number of signatures counted, and the jaws have gripped the signatures, the transfer arm rotates in the opposite direction, or the clockwise direction, drawing the signatures through transfer guides 26. These guides are utilized to compress the signatures into a compact unit in preparation for the tying and bundling operations (not shown).

As the transfer arm rotates clockwise moving the signatures away from the conveyor, feeder plate 22 pivots in the counterclockwise direction until it assumes its former upright position, i.e., the position where it supports the leading signatures in the uncounted stack. Feeder plate 22 is hollow and its cavity is connected to a supply of compressed air. The surface of the feeder plate facing the stack of signatures contains many minute air holes which emit streams of air to aid the sliding of the counted signatures across the feeder plate during transfer.

Referring now to the final figure in the operating sequence, FIGURE 6, after the feeder plate returns to its initial upright position and while the counted signatures are being transferred, separator finger 19 returns to its inactivated position by lifting to a position above the stack, thus preparing the device for another cycle of operation. The separator finger acts as the support for the stack of signatures only when the transfer arm is over the stack, otherwise, the stack is supported by the feeder plate.

When the transfer arm has delivered the counted signatures to the bundling station, jaws 20 and 23 release. Lower jaw 20 is released first by moving back to its inactivated position; i.e., it moves closer to the fulcrum of the transfer arm, causing the transferred signatures to come to rest on the transfer guides. After jaw 20 is released, transfer arm 24 continues to rotate clockwise until the jaws completely clear the delivered signatures. At this time upper jaw 23 is moved back to its inactivated position; i.e., it also moves closer to the fulcrum of the transfer arm. Transfer arm 24 then rotates in the counterclockwise direction for another group of signatures without interfering with any other part of the apparatus since both jaws remain in their inactivated positions until the transfer arm reaches the area of the feeder plate. The signatures in the delivery area can be removed any time prior to the time a subsequent group reaches the delivery area.

The drive system which makes possible the sequential operations described above in FIGURES 3–6 is illustrated in detail in FIGURE 7. Timing belt 112, which is driven by motor 105, drives sprocket 101 which is keyed to shaft 109, the main drive shaft of the apparatus. Mounted on shaft 107 are clutch 103 and brake 104 and conveyor drive pulley 106. The assembly on shaft 107 controls the movement of conveyor 11 and, thus, the movement of the stack of signatures. Shaft 107 derives its power from the main drive shaft through pulleys 102 and 110 which are linked by timing belt 141 and are in continuous rotation. At the time conveyor 11 advances bringing the stack of signatures towards the feeder plate electric brake 104 is disengaged while electric clutch 103 is engaged, both being controlled by microswitch 153.

Switch 153 is activated by the stack of signatures and its operation can best be understood by reference to FIGURE 9. When feeder plate 22 rotates in the clockwise direction to cause the individual signatures to be counted, the signatures that are directly supported by the plate force switch 153 to rotate with the plate. When switch 153 is in the static condition; i.e., when it is closest to the oncoming stack of signatures, clutch 103 is activated, brake 104 is inactivated and the conveyor is feeding. However, as switch 153 is forced to rotate clockwise with the feeder plate, the switch itself is deactivated causing clutch 103 to be inactivated, brake 104 to be activated, and the conveyor to stop. Brake 104 is necessary in order to prevent the conveyor from being carried on by momentum after clutch 103 is inactivated and to prevent the conveyor from creeping while stopped.

After the counted signatures are transferred from the feeder plate, switch 153 returns to its static condition reactivating its electrical circuit. However, even though the counting area of the apparatus is clear to count the next group of signatures, switch 153 alone will not automatically start the conveyor. Before the conveyor is allowed to be started, the control circuit must receive simultaneously a signal from switch 153, a signal indicating that the transfer arm is in the proper location to begin the sequence and a signal representing the number of signatures to be counted. Without the three signals occurring together, the conveyor will not restart in spite of the fact that switch 153 is in the static position.

The constant rotation of the main drive shaft is transmitted to shaft 121 through timing belt 113 and pulleys 111 and 114. In addition to pulley 114, gear 119 and transfer arm 24 are both mounted on shaft 121 and turn independently of shaft **121**. Feeder plate cam **123**, transfer arm cam **116** and gear **131** are keyed to shaft **121**.

The train controlling the operation of the transfer arm includes transfer arm cam **116**, transfer arm cam follower **117**, gear segment **118** and gear **119**. As mentioned above, transfer arm cam **116** turns with shaft **121** and due to the configuration of the cam's slot track, transfer arm cam follower **117** oscillates back and forth through an arc of approximately 24°. Both the transfer arm cam follower and gear segment **118** are mounted on shaft **142** and act together. Gear **118** is in the form of a segment since, due to the oscillatory motion of train, only a small portion of its periphery mates with gear **119**. Gear **119** and arm **24** are physically connected and turn together. Although the transfer arm is supported by shaft **121**, it rotates independently of the shaft and follows the oscillatory motion of gear **119** which causes it to rise and fall over the stack of signatures. The cam pattern and gearing arrangement locate the transfer arm over the signatures during the time when jaws **20** and **23** grasp the group of signatures in preparation for transfer. After the signatures are securely held by the jaws the transfer arm rotates causing the signatures to be lifted to the delivery area.

Gear **131** drives idler **132**, located on shaft **138**, which, in turn, drives gear **133** on shaft **139**. Shaft **139** supports five cams, **156**, **157**, **158**, **159**, and **160**, which activate the microswitches for lower jaw **20**, upper jaw **23**, separator finger **19**, feeder plate **22**, and for indicating the location of transfer arm **24**, respectively.

When switch S–2 is activated by cam **157**, upper jaw **23** moves away from the pivot-point of the transfer arm until it reaches a predetermined position where it remains until cam **157** releases switch S–2. The predetermined position reached by the upper jaw allows the jaw to fall into the space between the counted and uncounted signatures when the transfer arm pivots over the stack.

After the upper jaw is activated, cam **156** activates S–1 which moves lower jaw **20** away from the pivot-point of the transfer arm. Unlike the upper jaw, lower jaw **20** does not arrive at the same predetermined position each time activated and its final position depends entirely on the number of signatures to be transferred. The lower jaw grips the counted signatures and compresses them between itself and the fixed upper jaw until the signatures are firmly and compactly held between the two. After transfer is complete, cam **156** releases the lower jaw returning it to its original position.

For each revolution of cam **158** switch S–3 is activated twice; first, to cock the mechanism that drives separator finger **19** (not shown) and, secondly, to release the finger so that it drops between two adjacent signatures in the stack. Separator finger **19** is spring-loaded to insure that it drops into the stack of signatures almost instantaneously.

Switch S–4, which controls clutch **127**, is activated by cam **159**. When the feeder plate has rotated clockwise to its limit for the particular number of signatures being counted, clutch **127** is activated preventing the feeder plate from any further clockwise movement.

Switch S–5, activated by cam **160**, prevents switch **153** from starting the conveyor when transfer arm **24** is not in the proper location. As mentioned above, even though S–5 alone would allow the conveyor to move, the conveyor will not start until the transfer arm is in the proper location, as indicated by switch S–5, in concurrence with switch **153**.

Feeder plate cam **123** turns with shaft **121** and determines the nature of the oscillation of feeder plate cam follower **124** which is mounted on shaft **129**. Shaft **129** also supports clutch **128**, clutch **127** and feeder plate arm **126**.

The maximum degree of rotation permitted by arm **126** depends on the configuration of cam **123**. However, because the number of signatures to be transferred at any one time varies and the amount of rotation of the feeder plate depends on the number of signatures to be counted, arm **126** will not necessarily move through the maximum degree of rotation permitted by follower **124** each time signatures are counted.

Clutches **127** and **128** permit arm **126** to be stopped at any point although follower arm **124** oscillates fully during each cycle of shaft **121**. Clutch **127**, when activated, secures arm **126** to shaft **129** and clutch **128**, a one-way mechanical clutch allows shaft **129** to rotate only in the clockwise direction. Thus, when clutch **127** is activated shaft **129** and arm **126** cannot rotate any farther in the counterclockwise direction, but, until the time clutch **127** is activated, arm **126** is free to rotate about shaft **129**.

Due to the weight of signatures pressing against feeder plate **22**, link **150** is always in compression and, therefore, there will always be a torque exerted on arm **126** tending to turn the arm in the counterclockwise direction. A bumper arrangement (not shown) between follower **124** and arm **126** permits arm **126** to rotate in the counterclockwise direction only to the extent that follower **124** rotates in the counterclockwise direction.

As the feeder plate begins to rotate to count signatures, its movement is determined by cam **123**, i.e., cam **123** causes follower **124** to rotate in the counterclockwise direction. Because of the compression on link **150** and because clutch **127** is not activated, arm **126** rotates in the counterclockwise direction also, but will never rotate through a greater angle in that direction than the follower has rotated due to the bumper arrangement. When the desired number of signatures are counted, clutch **127** will be activated. Clutch **127** secures arm **126** to shaft **129** and because one-way clutch **128** does not allow shaft **129** to turn in the counterclockwise direction, arm **126** will not turn any further in the counterclockwise direction although if allowed to turn it could rotate through the angle follower **124** does. Arm **126** will not turn in the clockwise direction at this time because of the compression on link **150**.

Even though arm **126** is stopped by the action of clutch **127** in the manner described above, follower **124** continues to rotate in the counterclockwise direction as it follows cam **123**. Subsequently, the cam configuration causes follower **124** to reverse and rotate in the clockwise direction until both arm and follower resume contact through the bumper arrangement at which time both return to their original positions by rotating together in the clockwise direction. Arm **126** is able to move clockwise because one-way clutch **128** allows shaft **129** to rotate freely in this direction, and because the force exerted on arm **126** by the bumper arrangement exceeds the force exerted by the compression of link **150**. Clutch **127** is inactivated anytime after the bumper arrangement reengages causing both follower and cam to rotate together in the clockwise direction, but before the time the follower begins to rotate counterclockwise during the next sequence.

Because the mechanical elements of the apparatus operate rapidly, the relative timing of the various elements in the mechanism is very important. FIGURE 10, a time chart, diagrammatically illustrates the operating relationship between the crucial elements of the mechanism. The mechanism can run through a complete cycle of feeding, counting, separating, gripping and transferring groups of signatures in a wide range of speeds, but for the purposes of the time chart the cycle is specified as 1.5 seconds.

In referring to FIGURE 10, it assumed that the machine cycle commences at time zero and terminates at 1.5 seconds. At time zero feeder plate **22** begins to pivot away from the stack so that the top edge of the signatures are counted. At the same time transfer arm **24** is rotating toward the conveyor and air nozzle **21** is directing a jet of air into the stack. As the transfer arm nears the stack, or approximately .4 second into the cycle, upper jaw **23** is activated to assume the position where it will fall into the space between the counted and uncounted signatures. Just prior to the time when the transfer arm arrives over the signatures and after the desired number of signatures are counted, feeder plate **22** stops rotating, separator finger **19** drops into the stack and air nozzle **21** is shut off. After the transfer arm does arrive at the counted signatures, at approximately .6 second, lower jaw **20** is activated. After lower jaw **20** has had time to grip the counted signatures and approximately .7 second after the cycle starts, the transfer arm pivots to carry the signatures from the conveyor to the delivery area.

After the counted signatures have started away from the conveyor, the feeder plate pivots back towards the uncounted stack to support the leading signatures and the conveyor advances the stack. When the counted signatures reach the delivery area lower jaw **23** returns to its original or inactivated position releasing the grip on the signatures arriving in the delivery area. The transfer arm continues to rotate in the same direction when the lower jaw is inactivated, and after the jaws have travelled beyond the signatures left in the delivery area, at approximately 1.3 seconds, upper jaw **23** returns to its inactivated position.

By this time, 1.3 seconds into the cycle, the conveyor has advanced the stack sufficiently and is stopped. By the time 1.4 seconds have elapsed, the plate has returned to support the stack, and after a short period of dwell, the transfer arm, at 1.45 seconds, begins to rotate back towards the stack, the air nozzle is turned on, and the cycle begins again.

In addition to the specific embodiment of the invention described above, many other modifications and/or additions to this system will be readily apparent to those skilled in the art upon reading this disclosure, and these are intended to be encompassed with the spirit of the invention.

Any type of article which can be stacked is capable of being handled easily by this apparatus. Containers, bakery goods such as biscuits and cookies, envelopes, razor blades, and books are examples of the various types of articles which the apparatus can count with very little modification to the embodiment disclosed above. This list is only exemplary and is not meant to be exhaustive.

What is claimed herein is:

1. A material handling apparatus for separating and transferring a preselected number of flat, relatively thin articles from a large stack comprising conveyor means to support said articles on end with their flat sides in face-to-face contact and to advance said stack, a separator finger positioned adjacent to the feed path of said articles, means to drive said finger between two adjacent articles when the desired number of articles have been advanced beyond said finger, a transfer member carrying a pair of gripping jaws, means to position said transfer member so that said jaws encompass the articles separated from said stack by said finger, means to move said transfer member so as to transfer said gripped articles to a remote location.

2. An apparatus according to claim **1** further including means to count said articles as they are advanced by the conveyor means and means to activate said separator finger drive means in response to a signal from said counter after a preselected number of articles have been counted.

3. An apparatus according to claim **1** wherein said transfer member is a pivotably mounted arm having said gripping jaws mounted thereon at a point remote from the pivot axis.

4. The apparatus according to claim **1** further including a feeder plate positioned adjacent said conveyor means at a point in the direction of said conveyor advance beyond where said separator finger enters said stack whereby said stack is supported in an upright position, and means to pivot the top of said feeder place away from said stack of articles to separate from the stack the group of articles which are to be gripped by said jaws whereby said jaws can easily grip said group of articles for transfer.

5. The apparatus according to claim **4** where said conveyor means is inclined from the horizontal to feed said articles down said conveyor and against said feeder plate.

6. The apparatus according to claim **1** further including at least one set of spaced guides positioned to embrace said articles as they are transferred along a feed path defined by the movement of the jaws gripping them, with the spacing between said guides being larger near said conveyor means than it is at a more remote location therefrom whereby said articles are compressed together during their transfer.

7. The apparatus according to claim **2** where said means to count comprises a light source directed onto the edges of said articles, means to gather light reflected from the edges of said articles through a small aperture and means behind said aperture to convert said given light into an electrical signal whereby said light is reflected from each article to cause a pulsation in said converter followed by a period of no signal because of the dark area between articles.

8. The apparatus according to claim **7** further including means to apply positive air pressure to at least one side of said articles on said conveyor means before said articles are counted whereby flexible multi-layer articles are expanded to assure counting of each article being conveyed.

9. The apparatus according to claim **7** further including means to elevate the lowest end of said inclined conveyor as said feeder plate pivots away from said stack whereby the top edges of said articles maintain a predetermined distance from said aperture while being counted regardless of the position of said feeder plate.

10. An apparatus according to claim **9** wherein said elevating means comprises a driving cam located on the portion of said feeder plate located below said conveyor means, a frame supporting said conveyor means adjacent said feeder plate, said frame pivoting at the highest end of said inclined conveyor means, and a cam track located on said frame, said cam being contained in said cam track and defining the motion thereof, whereby the lower end of said conveyor means is elevated and lowered in direct proportion to the degree of rotation of said feeder plate.

11. The apparatus according to claim **7** further including means to apply positive air pressure to at least one side of said articles on said conveyor means before said articles are counted, whereby articles are at least partially separated to assure counting of each article being conveyed.

12. The apparatus according to claim **4** wherein at least the surface of the feeder plate facing the stack is porous including means to apply positive air pressure through at least some of the pores to aid in the sliding of the counted articles across the feeder plate during transfer.

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