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(54) Method of operating document feeding mechanism to detect and recover from a multi-feed condition and an apparatus therefor

(57) A method is provided of operating a document feeding mechanism having a document feed path which extends through a nip defined between an advance roller (32) disposed on one side of a document feed path and a retard roller (36) disposed on an opposite side of the document feed path. The method comprises detecting a multi-feed condition in which a first document (60) and a second document (62) overlapping the first document have been fed through the nip from an upstream end of the document feed path to a downstream end of the document feed path, and controlling operation of the advance roller (32) and the retard roller (36) such that the second document (62) is driven backwards through the nip to allow the first document (60) to be fed through the nip by itself in a non-overlapping manner without any human intervention.

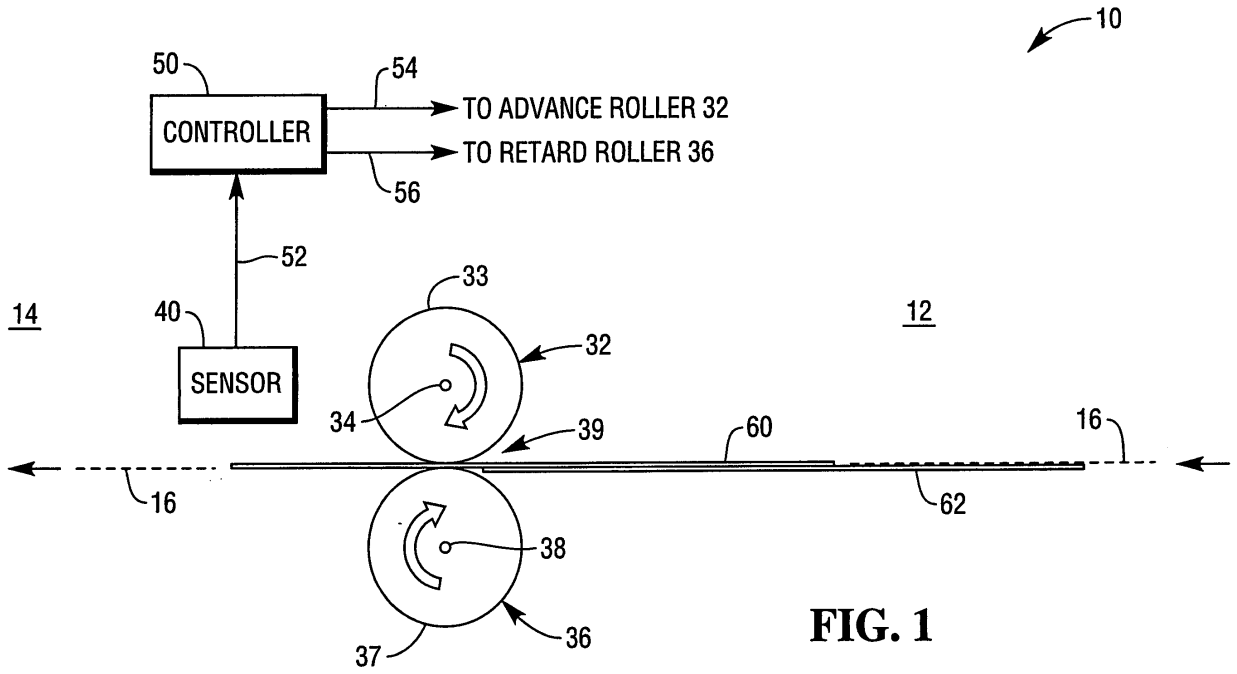

FIG. 1

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Description

[0001] The present invention relates to document feeding along a document feed path, and is particularly directed to a method of operating a document feeding mechanism to detect and recover from a multi-feed condition and an apparatus therefor.

[0002] Many different types of document feeding mechanisms are known. From time to time, a multi-feed document condition occurs in which more than one document is fed along a document transport path when only one document should have been fed along the document feed path. The occurrence of a multi-feed condition usually causes an undesirable result. For example, in an automated teller machine (ATM) type of application in which banknotes are being dispensed, a multi-feed condition of a banknote will result in a loss to the ATM owner. In another type of ATM type of application in which checks are being deposited, a multi-feed condition of a deposited check will result in a missing deposit item. It would be desirable to provide a document feeding mechanism in which multi-feed conditions are not only detected but are also recovered from.

[0003] In accordance with one embodiment of the present invention there is provided a method is provided of operating a document feeding mechanism having a document feed path which extends through a nip defined between an advance roller disposed on one side of a document feed path and a retard roller disposed on an opposite side of the document feed path. The method comprises detecting a multi-feed condition in which a first document and a second document overlapping the first document have been fed through the nip from an upstream end of the document feed path to a downstream end of the document feed path, and controlling operation of the advance roller and the retard roller such that the second document is driven backwards through the nip to allow the first document to be fed through the nip by itself in a non-overlapping manner without any human intervention.

[0004] Preferably after the first document has been fed through the nip by itself, controlling operation of the advance roller and the retard roller such that the second document is fed through the nip by itself in a non-overlapping manner without any human intervention.

[0005] In accordance with another embodiment of the present invention there is provided a method of operating a document feeding mechanism having a document feed path which extends through a nip defined between an advance roller disposed on one side of a document feed path and a retard roller disposed on an opposite side of the document feed path, the method comprising: detecting a multi-feed condition in which a first document and a second document overlapping the first document have been fed through the nip from an upstream end of the document feed path to a downstream end of the document feed path; halting operation of the advance roller when the multi-feed condition is detected; and reversing direction of rotation of the retard roller when the multi-feed condition is detected such that the second document which is adjacent to the retard roller is driven backwards through the nip from the downstream end of the document feed path to the upstream end of the document feed path while the first document which is adjacent to the halted advance roller is maintained in the nip between the advance roller and the retard roller.

[0006] In accordance with yet another embodiment of the present invention there is provided a document feeding apparatus comprising: an advance roller disposed on one side of a document feed path; a retard roller disposed on an opposite side of the document feed path and facing the advance roller to form a nip there between; a sensor for (i) detecting a multi-feed condition in which a first document and a second document overlapping the first document have been fed through the nip from an upstream end of the document feed path to a downstream end of the document feed path, and (ii) providing a sensor signal indicative of the multi-feed condition; a controller for (i) providing a first control signal to halt operation of the advance roller when the sensor signal indicative of the multi-feed condition is detected, and (ii) providing a second control signal to reverse direction of rotation of the retard roller when the sensor signal indicative of the multi-feed condition is detected such that the second document which is adjacent to the retard roller is driven backwards through the nip from the downstream end of the document feed path to the upstream end of the document feed path while the first document which is adjacent to the halted advance roller is maintained in the nip between the advance roller and the retard roller.

[0007] Embodiments of the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is a schematic view of a document feeding mechanism constructed in accordance with one embodiment of the present invention;

Figs. 2-11 are views similar to Fig. 1 and showing parts in different positions.

[0008] The present invention is directed to a method of operating a document feeding mechanism to detect and recover from a multi-feed condition and an apparatus therefor. The specific use and construction of the document feeding mechanism may vary. By way of example, a document feeding mechanism 10 constructed in accordance with one embodiment of the present invention is illustrated in Fig. 1.

[0009] The document feeding mechanism 10 has an upstream end 12, a downstream end 14, and a document feed path 16 extending between the upstream end and the downstream end. The document feeding mechanism 10 includes an advance roller 32 which is adjacent to the document feed path 16. The advance roller 32 has a longitudinal central axis and an outer circumferential surface 33. The advance roller 32 is rotatably mounted on a first

shaft 34 for rotation about its longitudinal central axis.

[0010] The document feeding mechanism 10 further includes a retard roller 36 which is adjacent to the document feed path 16 and lies opposite the advance roller 32. The retard roller 36 has a longitudinal central axis and an outer circumferential surface 37. The retard roller 36 is rotatably mounted on a second shaft 38 for rotation about its longitudinal central axis. A nip 39 is defined between the outer circumferential surface 33 of the picker roller 32 and the outer circumferential surface 37 of the retard roller 36.

[0011] The document feeding mechanism 10 also includes a sensor 40 for detecting a multi-feed condition in which more than one document has been fed through the nip 39 along the document feed path 16. The sensor 40 may be of the ultrasonic type, for example. A controller 50 monitors and receives a sensor signal via line 52 from the sensor 40. The controller 50 provides a control signal via line 54 to the advance roller 32 to control operation of the advance roller. The controller 50 also provides a control signal via line 56 to the retard roller 36 to control operation of the retard roller.

[0012] During normal operation of the document feeding mechanism 10 (as shown in Fig. 1), the controller 50 controls the advance roller 32 to rotate about its longitudinal central axis in the clockwise direction (as viewed looking at Fig. 1). The controller 50 controls the retard roller 36 to rotate about its longitudinal central axis also in the clockwise direction. As the advance roller 32 and the retard roller 36 both rotate in the clockwise direction, the rollers co-operate to feed a first document 60 through the nip 39 along the document feed path 16. More specifically, due to frictional engagement between the outer circumferential surface 33 of the advance roller 32 and the outer circumferential surface 37 of the retard roller 36, the first document 60 is transported from the upstream end 12 of the document feed path 16 towards the downstream end 14 along the document feed path for further handling and processing at the downstream end of the document feed path.

[0013] When the first document 60 is the only document fed through the nip 39 (such as shown in Fig. 1), the sensor 40 does not detect a multi-feed condition. Accordingly, the sensor 40 does not provide a signal on line 52 which is indicative of a multi-feed condition. Since the controller 50 does not receive a signal on line 52 indicative of a multi-feed condition, the controller continues to provide signals on lines 54, 56 to rotate the advance roller 32 in the clockwise direction and the retard roller 36 in the clockwise direction. After the first document 60 has been normally fed through the nip 39, the advance roller 32 and the retard roller 36 continue to feed a second document 62 (as shown in Fig. 2) through the nip 39 in the same manner as the first document 60 was normally fed through the nip.

[0014] However, when a multi-feed condition occurs in which both the first and second documents 60, 62 pass through the nip 39 in overlapping manner (such as shown in Fig. 3), the sensor 40 detects the occurrence of the multi-feed condition and provides a signal on line 52 indicative thereof. In response to receiving the signal on line 52 from the sensor 40, the controller 50 provides a control signal on line 54 to the advance roller 32 to halt rotation of the advance roller in the clockwise direction (as shown in Fig. 4). At the same time, the controller 50 continues providing the same previous signal on line 56 to the retard roller 36 so that the retard roller continues rotating in the clockwise direction.

[0015] When the advance roller 32 is halted and the retard roller 36 continues to rotate in the clockwise direction, the second document 62 is driven backwards (i.e., to the right as viewed looking at Fig. 4) through the nip 39 towards the upstream end 12 of the document feed path 16. After the second document 62 has been driven back completely through the nip 39 (as shown in Fig. 5), the controller 50 again provides a control signal on line 54 to control the advance roller 32 to rotate in the clockwise direction. This rotation of the advance roller 32 again in the clockwise direction moves the first document 60 (which is now by itself between the advance roller 32 and the retard roller 36) through the nip 39 towards the downstream end 14 of the document feed path 16. After the first document 60 has moved completely through the nip 39 towards the downstream end 14 of the document feed path 16 (as shown in Fig. 6), the advance roller 32 and the retard roller 36 co-operate to feed the next document (i.e., the second document 62 in this case) through the nip 39 towards the downstream end of the document feed path. The second document 62 is also now fed by itself through the nip 39 towards the downstream end 14 of the document feed path 16.

[0016] As the second document 62 is being driven backwards through the nip 39 as just described hereinabove, it is recognized that the controller 50 will detect absence of the multi-feed condition signal from the sensor 40 before the second document 62 is actually driven back completely through the nip 39. To ensure that the second document 62 has been driven back completely through the nip 39 before the advance roller 32 is again activated to rotate in the clockwise direction, the controller 50 is programmed with a sufficient time delay in responding to removal of the multi-feed condition signal on line 52 from the sensor 40 as an input signal. This time delay will provide sufficient time for the second document 62 to be driven back completely through the nip 39 before the controller 50 provides the control signal on line 54 to again control the advance roller 32 to rotate in the clockwise direction.

[0017] It should be apparent that the operation of the document feeding mechanism 10 described hereinabove enables a multi-feed condition to be not only detected but also to be automatically corrected without any human intervention. Accordingly, a human operator is not needed to halt operation of the document feeding mechanism 10 to remove documents from the document feed path 16 to clear a multi-feed condition which has occurred

along the document feed path.

[0018] Although the above description describes two overlapped documents (i.e., the first document 60 and the second document 62) passing through the nip 39, it is conceivable that more than two overlapped documents could pass through the nip 39. For example, as shown in Fig. 7, if three overlapping documents 70, 72, 74 have passed through the nip 39 and sensed by the sensor 40, then the advance roller 32 is controlled to halt rotation in the clockwise direction and the retard roller 36 is controlled to continue rotating in the clockwise direction. The advance roller 32 is halted and the retard roller 36 rotates in the clockwise direction until the document 74 has been driven backwards completely through the nip (as shown in Fig. 8). However, since the sensor 40 still detects a multi-feed condition in Fig. 8, the advance roller 32 remains halted and the retard roller 36 continues rotating in the clockwise direction until the document 72 has also been driven backwards completely through the nip 39 (as shown in Fig. 9).

[0019] After the two documents 72, 74 have been driven backwards completely through the nip 39 as shown in Fig. 9, the advance roller 32 is controlled to again rotate in the clockwise direction to feed the document 70 (which is now by itself between the advance roller 32 and the retard roller 36) through the nip 39 towards the downstream end 14 of the document feed path 16 (as shown in Fig. 10). Also as shown in Fig. 10, after the document 70 has been fed completely through the nip 39, the next document (i.e., the document 72) is fed through the nip. Accordingly, it should be apparent that the document feeding mechanism 10 is capable of not only detecting but also correcting a multi-feed condition in which more than two overlapping documents have passed through the nip 39, without any human intervention.

[0020] Further, it is conceivable that co-operation of the halting of the advance roller 32 and the reversing of the retard roller 36 may not result in driving multi-fed documents (such as the two documents 72, 74 shown in Fig. 7) back behind the nip 39 so that documents can be separated in the manner as described hereinabove. If this should occur, then the advance roller 32 could be driven to rotate in the reverse direction (i.e., in the counter-clockwise direction as viewed looking at Fig. 7) so that the entire bunch of documents (i.e., all three documents 70, 72, 74 in this example) is driven and fed back behind the nip 39 as shown in Fig. 11. After the entire bunch of documents has been fed behind the nip 39 as shown in Fig. 11, the advance roller 32 is controlled to again rotate in the clockwise direction in an effort to feed the documents 70, 72, 74 one by one through the nip. By driving and feeding the entire bunch of documents behind the nip 39 as shown in Fig. 11, the retard roller 36 is provided with a second chance to catch the edge of the underlying documents (i.e., the documents 72, 74 in this example) so that a clean separation of all three documents can be achieved.

[0021] The particular arrangements disclosed are meant to be illustrative only and not limiting as to the scope of the invention. From the above description, those skilled in the art to which the present invention relates will perceive improvements, changes and modifications. Numerous substitutions and modifications can be undertaken without departing from the true spirit and scope of the invention. Such improvements, changes and modifications within the skill of the art to which the present invention relates are intended to be covered by the appended claims.

Claims

1. A method of operating a document feeding mechanism having a document feed path which extends through a nip defined between an advance roller disposed on one side of a document feed path and a retard roller disposed on an opposite side of the document feed path, the method comprising:

   detecting a multi-feed condition in which a first document and a second document overlapping the first document have been fed through the nip from an upstream end of the document feed path to a downstream end of the document feed path;
   halting operation of the advance roller when the multi-feed condition is detected; and
   reversing direction of rotation of the retard roller when the multi-feed condition is detected such that the second document which is adjacent to the retard roller is driven backwards through the nip from the downstream end of the document feed path to the upstream end of the document feed path while the first document which is adjacent to the halted advance roller is maintained in the nip between the advance roller and the retard roller.

2. A method according to claim 1, further comprising:

   after the second document has been driven backwards completely through the nip, continuing operation of the advance roller such that the first document continues to be fed through the nip from the upstream end of the document feed path to the downstream end of the document feed path.

3. A method according to claim 2, further comprising:

   after the first document has been fed through the nip from the upstream end of the document feed path to the downstream end of the document feed path, continuing operation of the advance roller such that the second document is fed through the nip from the upstream end of the

document feed path to the downstream end of the document feed path.

4. A document feeding apparatus comprising:

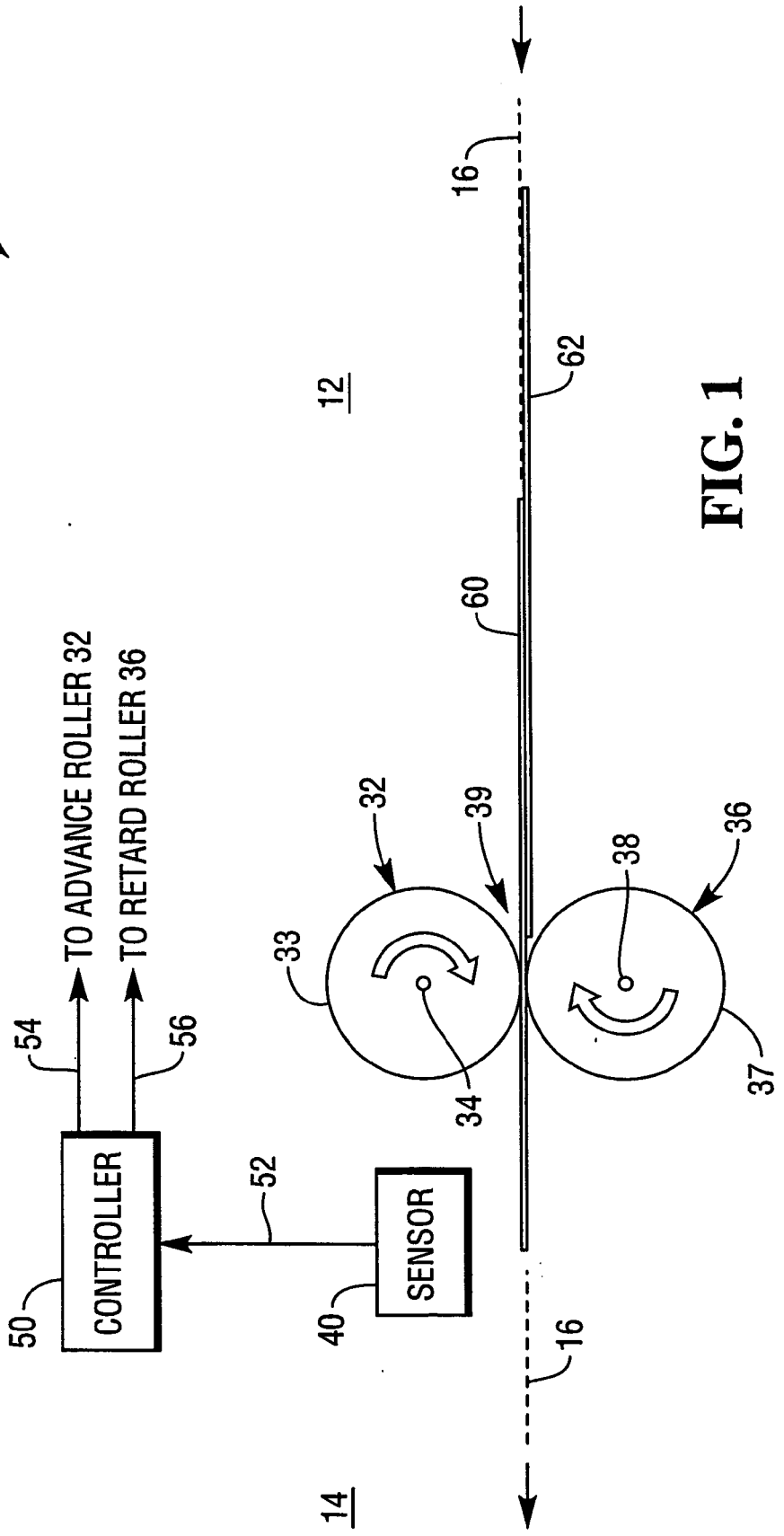
an advance roller disposed on one side of a document feed path;
a retard roller disposed on an opposite side of the document feed path and facing the advance roller to form a nip therebetween;
a sensor for (i) detecting a multi-feed condition in which a first document and a second document overlapping the first document have been fed through the nip from an upstream end of the document feed path to a downstream end of the document feed path, and (ii) providing a sensor signal indicative of the multi-feed condition;
a controller for (i) providing a first control signal to halt operation of the advance roller when the sensor signal indicative of the multi-feed condition is detected, and (ii) providing a second control signal to reverse direction of rotation of the retard roller when the sensor signal indicative of the multi-feed condition is detected such that the second document which is adjacent to the retard roller is driven backwards through the nip from the downstream end of the document feed path to the upstream end of the document feed path while the first document which is adjacent to the halted advance roller is maintained in the nip between the advance roller and the retard roller.

5. A document feeding apparatus according to claim 4, wherein after the second document has been driven backwards completely through the nip, the controller provides a third control signal to continue operation of the advance roller such that the first document continues to be fed through the nip from the upstream end of the document feed path to the downstream end of the document feed path.

6. A document feeding apparatus according to claim 5, wherein after the first document has been fed through the nip from the upstream end of the document feed path to the downstream end of the document feed path, the controller provides a fourth control signal to continue operation of the advance roller such that the second document is fed through the nip from the upstream end of the document feed path to the downstream end of the document feed path.

7. A document feeding apparatus according to claim 6, wherein the third control signal and the fourth control signal are substantially the same.

8. A document feeding apparatus according to any one of claim 4 to 7, wherein the sensor comprises an ultrasonic-type of sensor.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SENSOR
TO ADVANCE ROLLER 32
TO RETARD ROLLER 36

FIG. 1

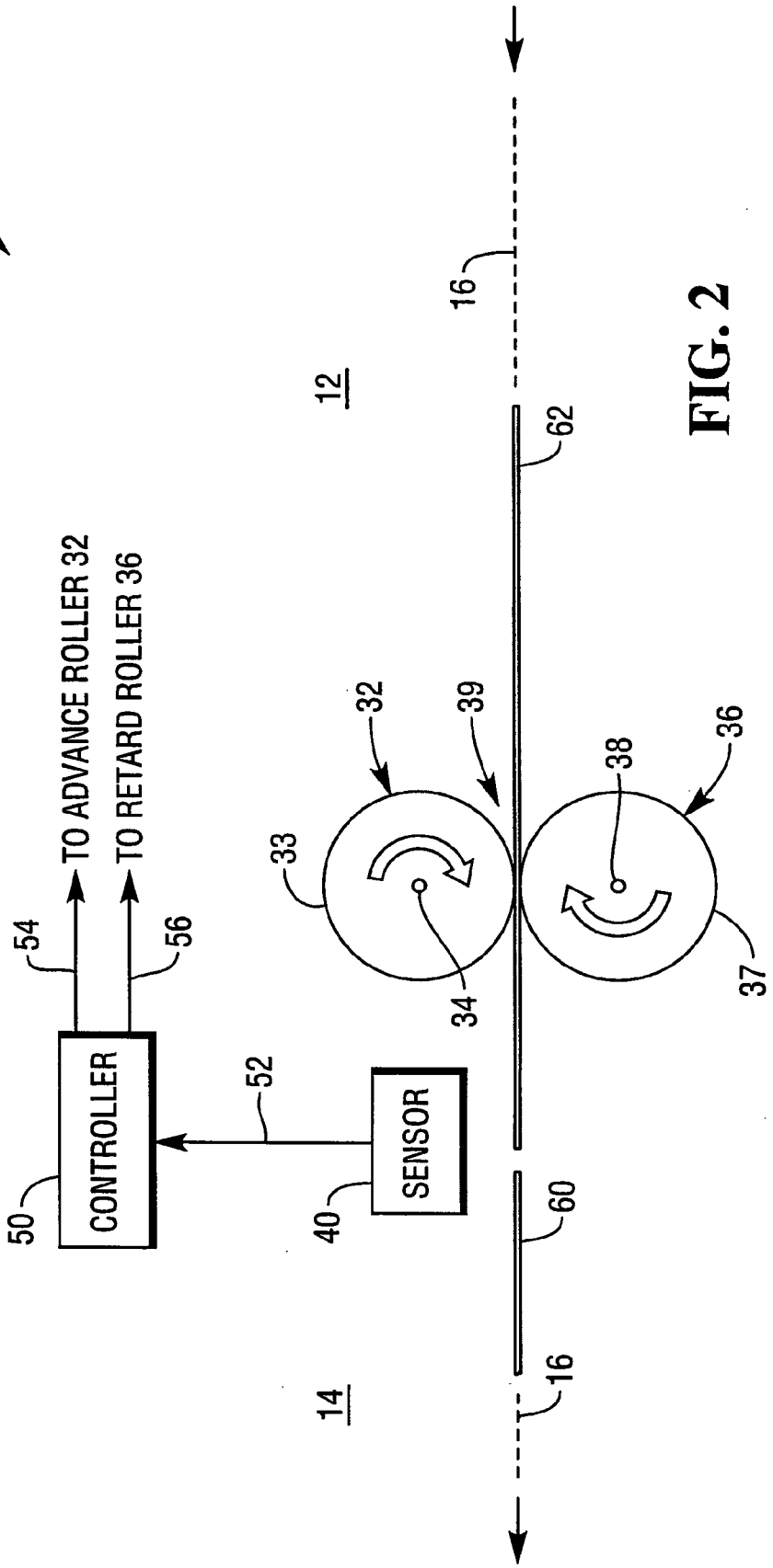
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FIG. 2

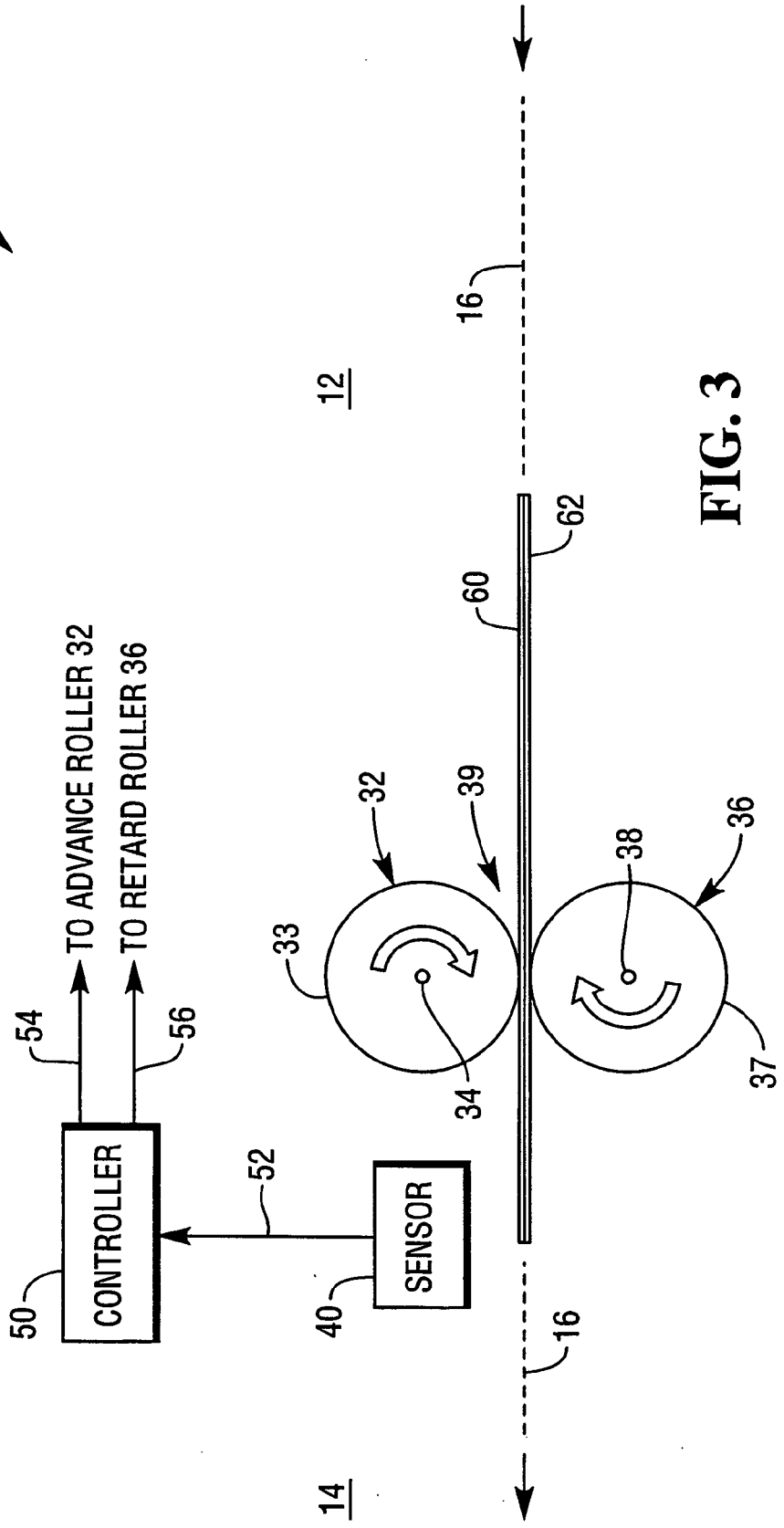
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FIG. 3

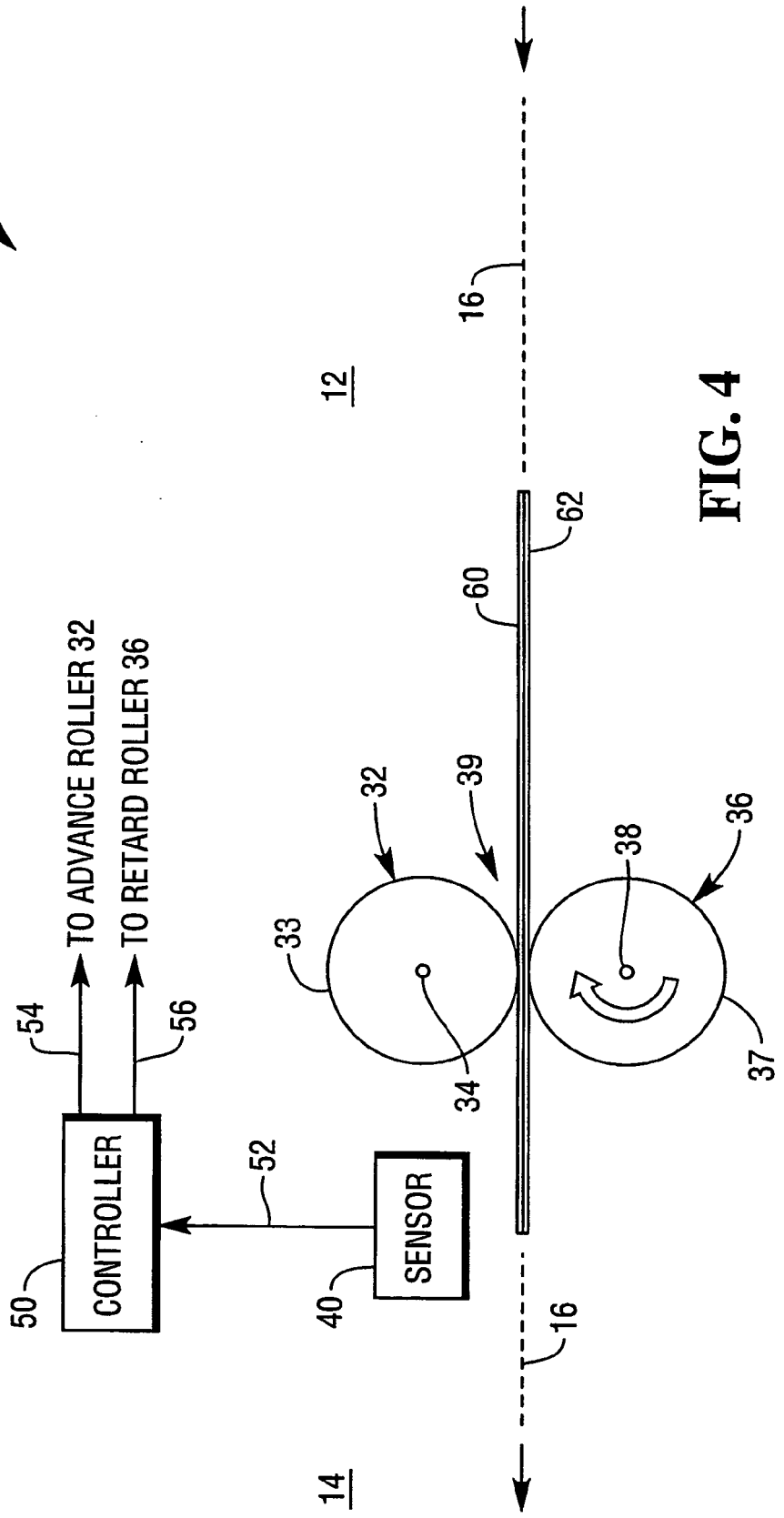
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FIG. 4

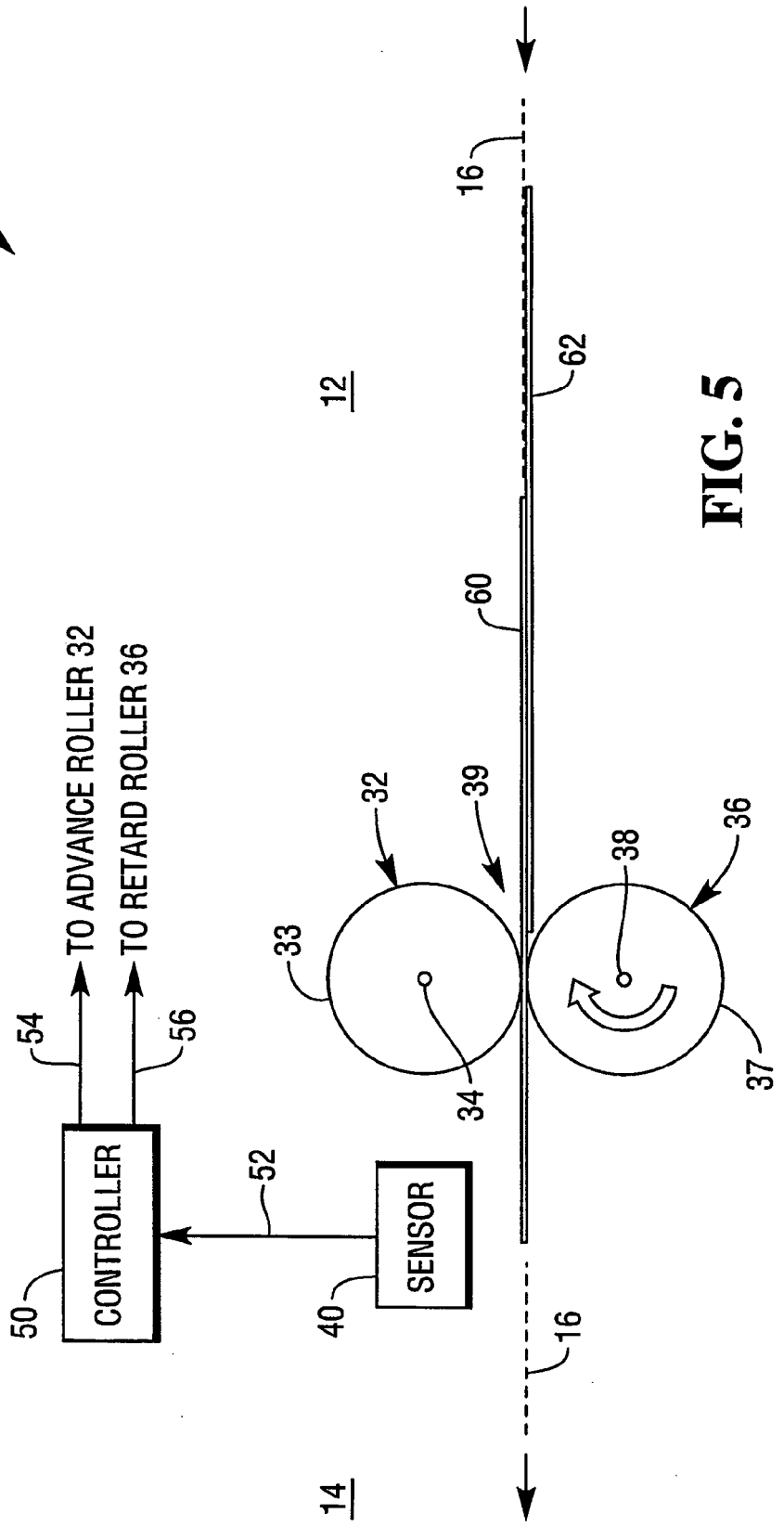
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FIG. 5

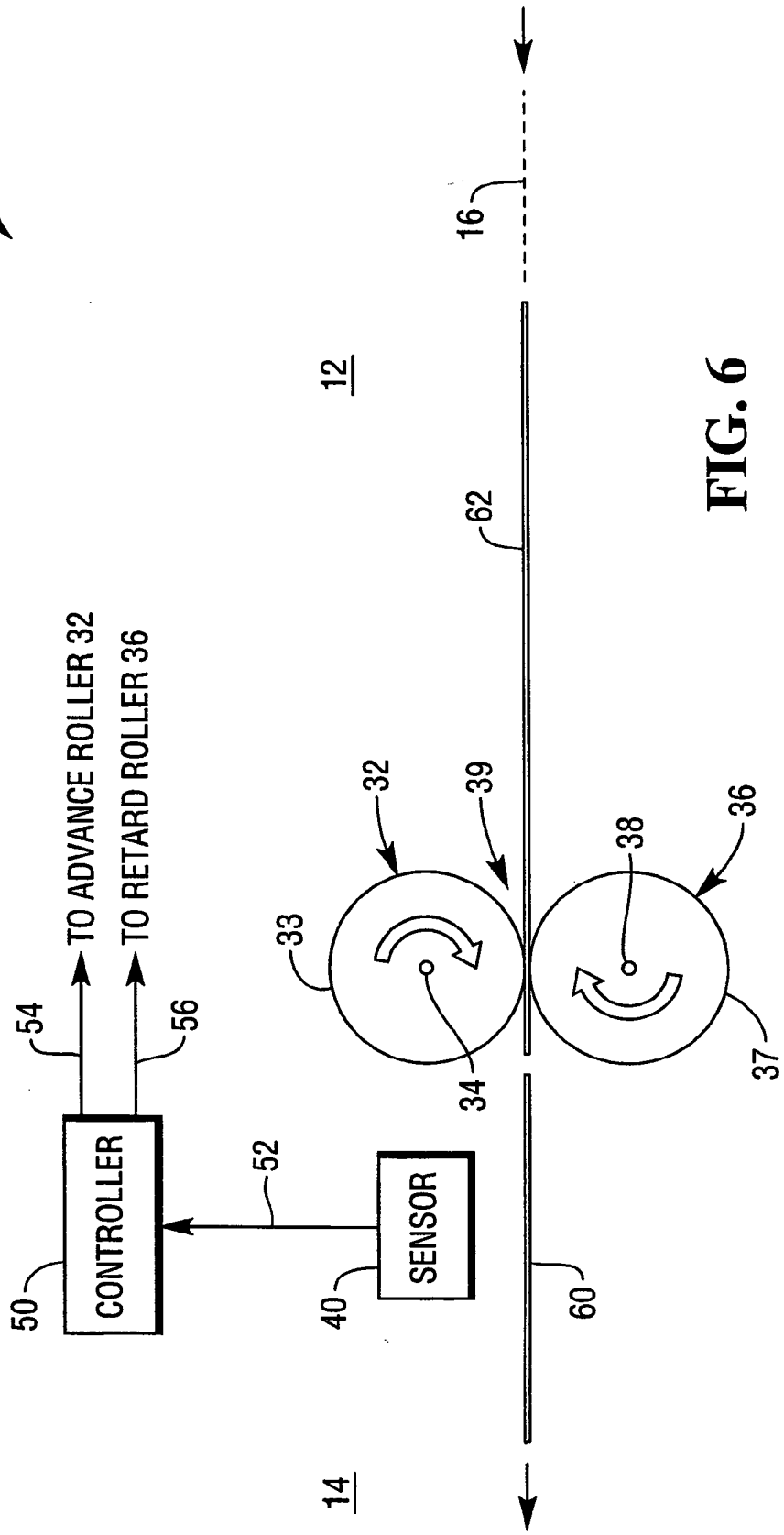
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FIG. 6

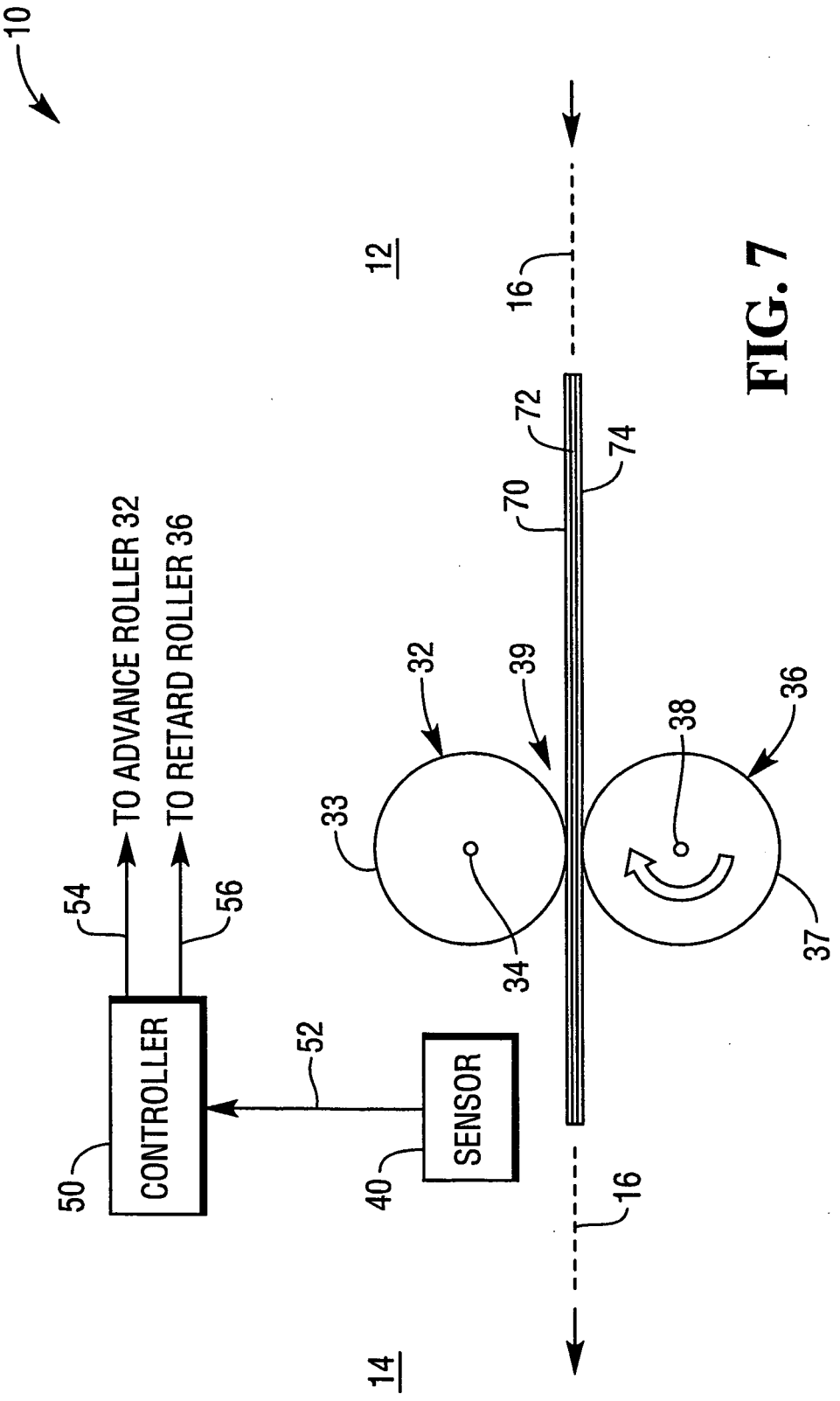
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FIG. 7

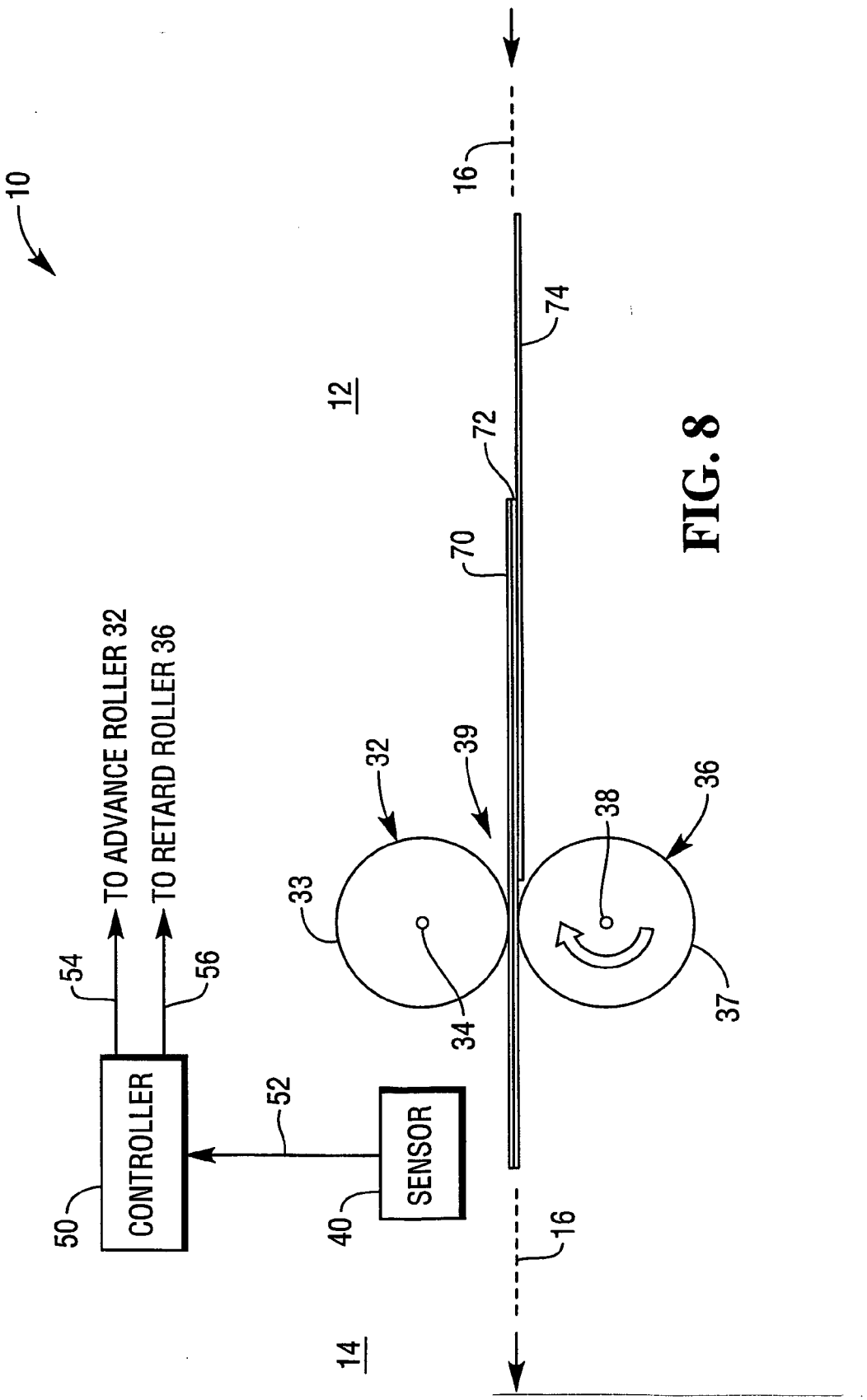
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FIG. 8

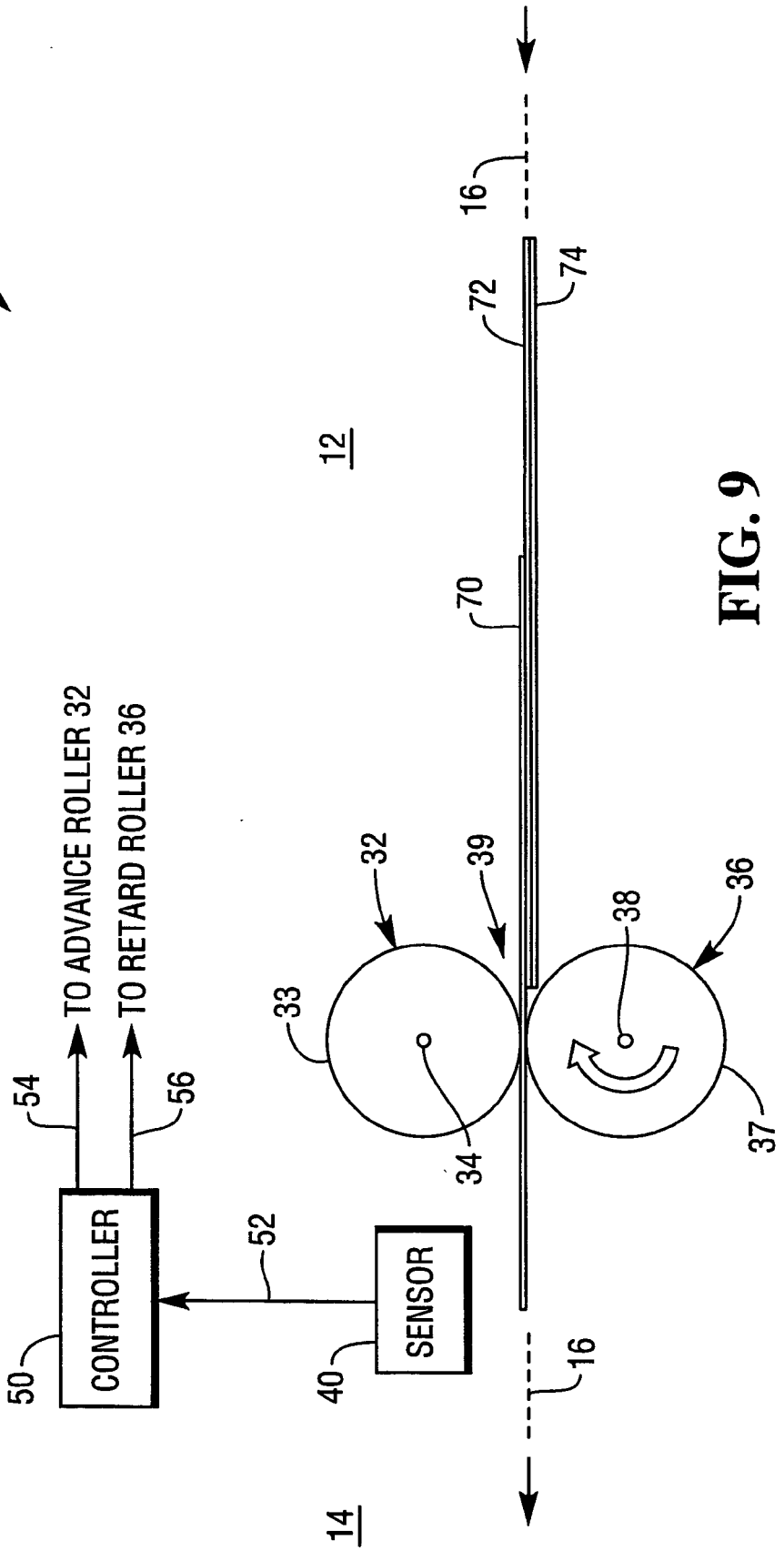
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FIG. 9

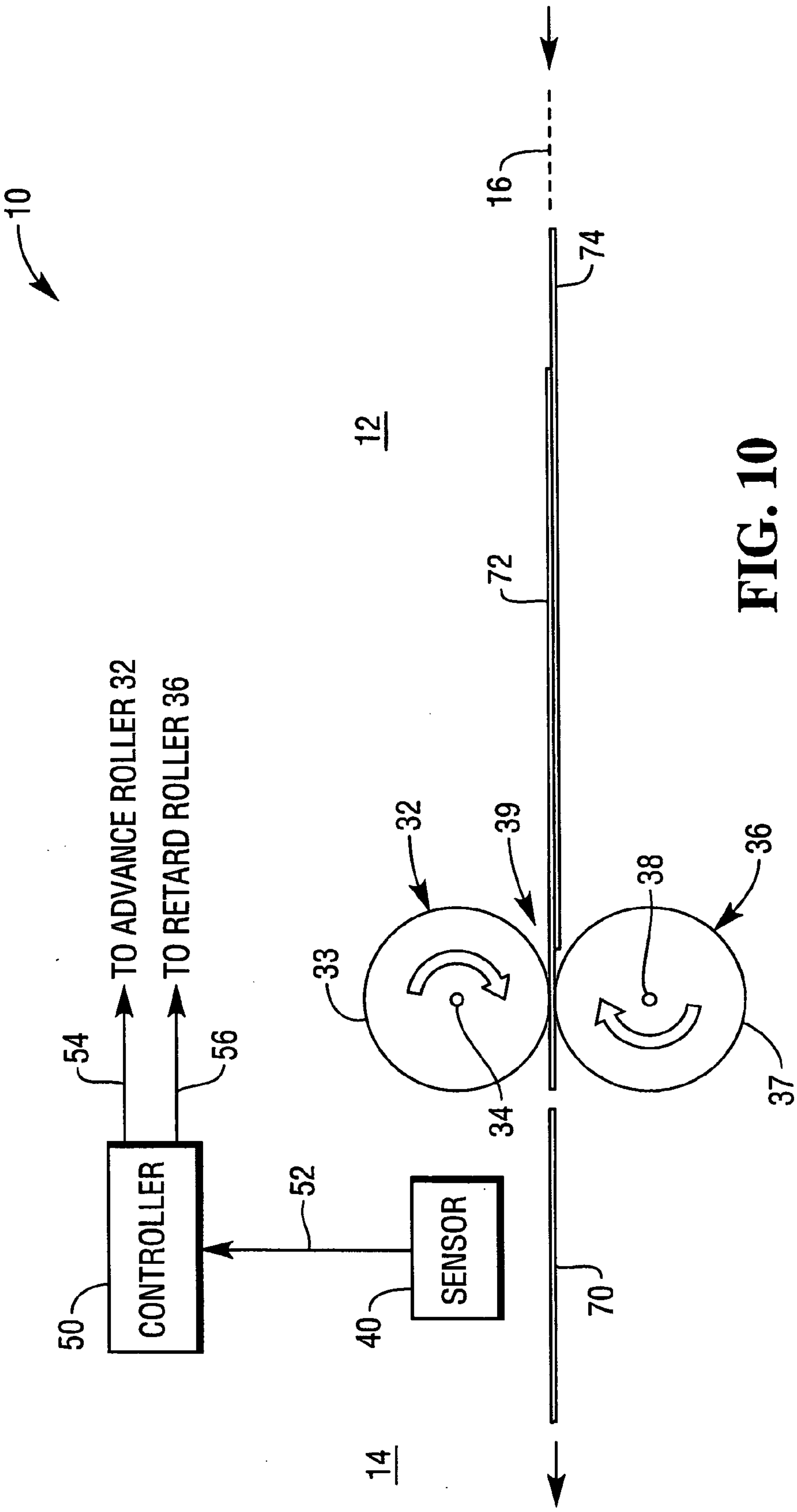
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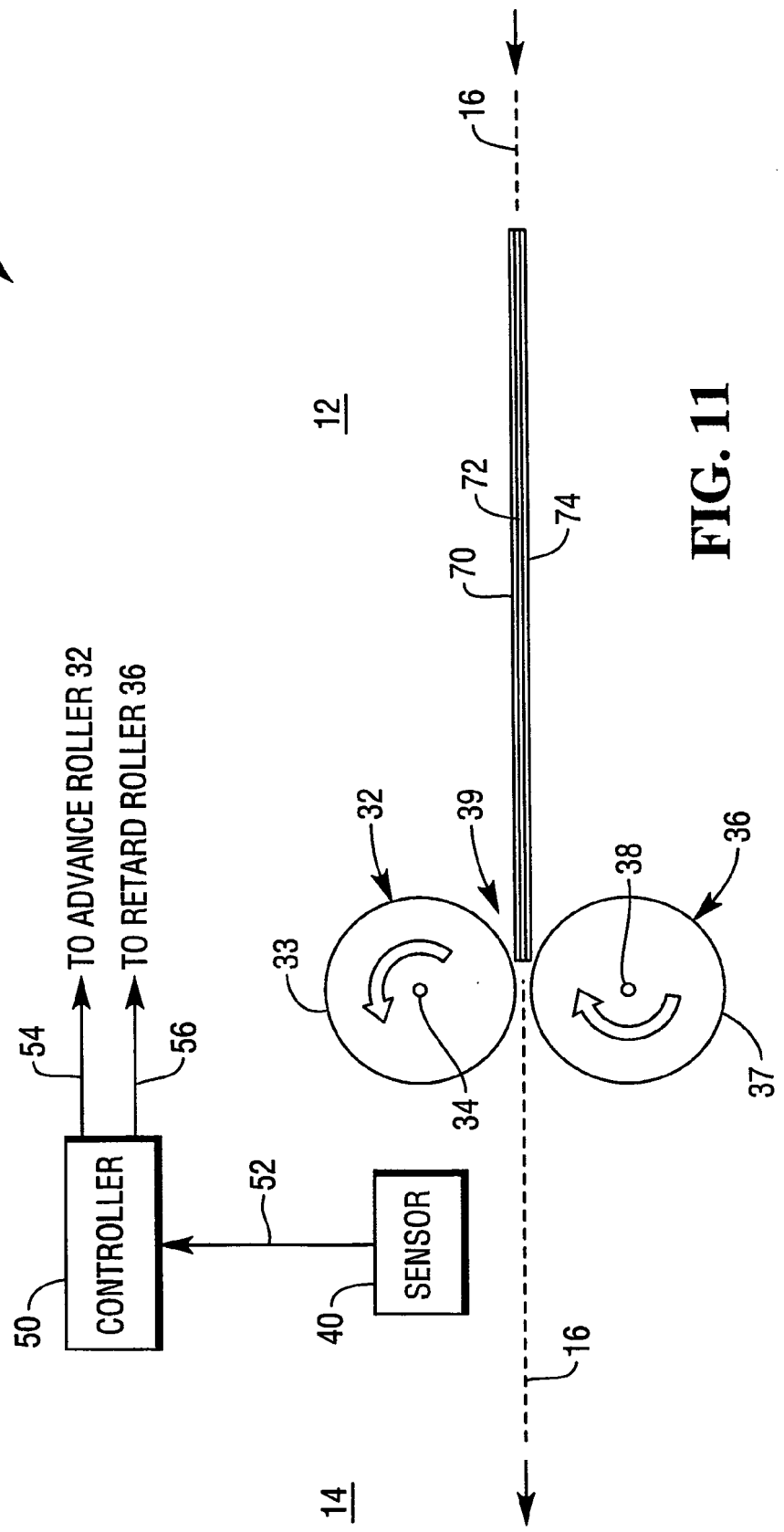
FIG. 10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CONTROLLER
SENSOR
TO ADVANCE ROLLER 32
TO RETARD ROLLER 36

FIG. 11