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(54) A capacity control system for a paper supply elevator

(57) A capacity control system for a paper supply elevator comprises a paper support (16) and a paper sensor (52) for detecting the presence of paper on the paper support. A home position sensor (14) detects a home position of the paper support. A stack up sensor (36) detects a topmost sheet of paper in a stack of papers located on the paper support (16). An intermittent drive (22) raises and lowering the paper support (16). A control panel (32) inputs an expected paper stack size. A control circuit for the intermittent drive (22) causes the intermittent drive to move the paper support (16) to a position corresponding to the expected paper stack size.

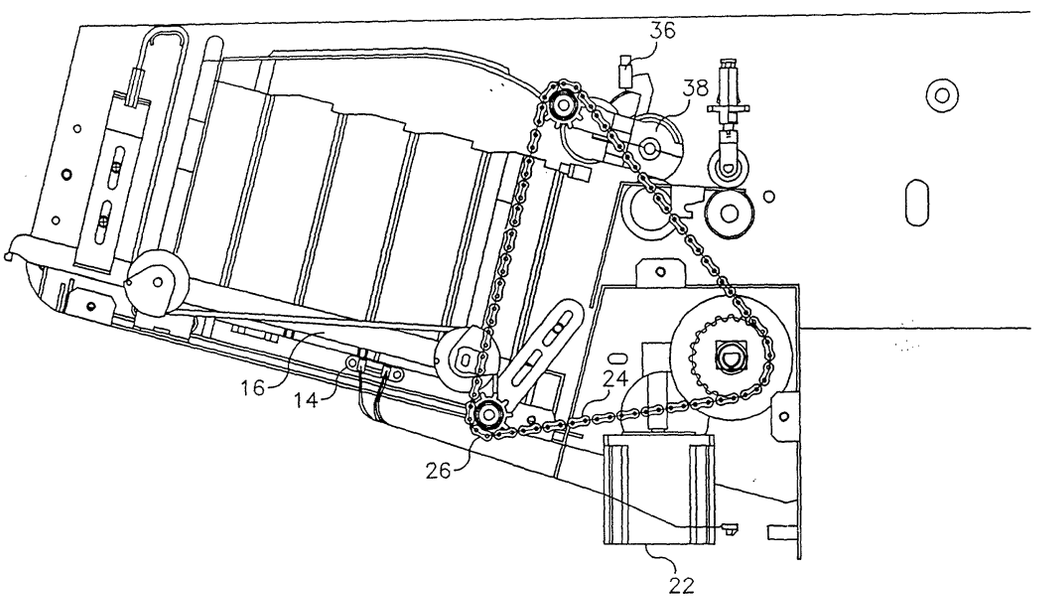

FIG. 1

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Description

[0001] The present invention relates in general to copiers, printers, facsimile apparatus, and scanners, and more particularly to a capacity control system for a paper supply elevator having variable capacity.

[0002] In image forming devices, for example, scanners, stack feeding subsystems are often used to feed a plurality of sheets from a stack into a paper transport where they are subsequently imaged by an illumination and imaging means such as CCD and reduction lens. The output of these devices is a digital file format such as TIFF and JPEG images.

[0003] The stack feeding subsystems are often configured with a paper supply elevator subsystem providing the ability to feed stack heights as great as 1,000 sheets of 20 lb. bond paper in sizes up to 11 inches wide x 17 inches long. Typically, customers desire to utilize the sheet feeding device in differing sheet capacities, i. e., number of sheets. Depending on the given set or job being imaged, the amount of sheets can vary from as little as one at a time to as many as the maximum capacity or 1,000 sheets or some batch size between one and 1,000 sheets.

[0004] In a typical elevating paper support trays, the tray supports a stack of paper. A tray down or home position sensor indicates when the tray is at its most downward position. In this position the tray is ready to be loaded with a stack of paper. A paper present sensor indicates that paper has been loaded into the tray and begins the tray rise sequence. A "stack up" sensor is employed to indicate when the stack of sheets has been raised to the level where auto feeding can commence. Typically, this is at a point where the stack has been brought into contact with a series of rollers or belts that utilize friction to remove the top or desired sheet from the stack and transport it into downstream rollers or belts that then pass it by the imaging subsystem.

[0005] The inherent drawback in utilizing a 1,000 sheet capacity elevator subsystem to handle all desired batch sizes is that for anything less than the full capacity, the elevator is spending time raising up or lowering. This raising and lowering time can be significant in high speed-high productivity scanners where pages are being scanned at rates of 160 pages-per-minute or greater. Typically, the time required for one of these trays to rise or lower their full range is about four seconds. In addition to the productivity loss, time wasted in waiting for the tray to raise or lower can become a customer annoyance in that many of the subsystems are implemented with motorized drives that can create undesirable acoustic noise.

[0006] In several products, an attempt has been made to deal with this concern by offering the customer a fixed number of intermediate capacities. Generally these intermediate positions offer two or three fixed points that break up the 1,000 sheet capacity (generally 1 to 50, 50 to 250 and 250 to 1,000.) For instance, if the customer typically deals with batch sizes of 250 sheets, they could select a paper support or feed tray intermediate position that is closest to this amount during scanner setup. The feed tray would then limit its downward travel to always stop at a capacity level equal to 250 sheets. These intermediate positions thereby reduce the unwanted time spent waiting for the tray to raise or lower.

[0007] There are two basic drawbacks to the "fixed intermediate position" approaches currently employed. First, the small number of intermediate choices can still leave the customer with a less than optimized tray position for any given job or batch size. Secondly, these implementations achieve these intermediate positions by incorporating additional sensors for the fixed set points. These additional sensors add unnecessary unit manufacturing cost to the product as well as add additional complexity that can reduce overall product reliability.

[0008] A more desirable means of optimizing the productivity of an elevating tray system would allow the customer to set the paper support tray capacity at the exact height or amount that they need to run their batches or jobs. This would eliminate any wasted time in raising the tray up to the "Stack Up" position or lowering it to accept the next batch of sheets.

[0009] Briefly, according to one aspect of the present invention a capacity control system for a paper supply elevator comprises a paper support and a paper sensor for detecting the presence of paper on the paper support. A home position sensor detects a home position of the paper support. A stack up sensor detects a topmost sheet of paper in a stack of papers located on the paper support. An intermittent drive raises and lowering the paper support. A control panel inputs an expected paper stack size. A control circuit for the intermittent drive causes the intermittent drive to move the paper support to a position corresponding to the expected paper stack size.

[0010] It is an object of the present invention to provide a means for controlling an paper support tray that allows the customer to set any desired intermediate position to maximize productivity and customer satisfaction. This needs to be configured in a manner that it does not require individual tray position sensors to enable all possible "intermediate positions" thereby reducing the product manufacturing cost and increasing the overall system reliability.

[0011] According to one embodiment the invention comprises:

(a) an elevator tray drive system (stepper motor and lift drive train) raises or lowers a stack support means, tray in small or fine-step increments. Small or fine increments meaning the equivalent of a few sheets of typical paper;

(b) a home position sensor that indicates when the stack support tray is at its home or maximum capacity position;

(c) a paper present sensor that indicates when paper is in the stack support tray;
(d) a tray control capable of controlling the elevator tray drive system so as to elevate or lower the stack support tray in small incremental based on the inputs it receives from the above sensing elements;
(e) an operator control panel for the customer to input a desired an intermediate position to the control means; and
(f) the tray control means to control the lifting and lowering of the stack support.

[0012] In another embodiment the operator control panel found on the scanner or from an attached host PC graphical user interface and a SCSI command set. The intermediate position to be selectable from one of many (greater than 50) possible selections, thereby optimizing the ability to match the tray's capacity to the customer job or batch.

Figure 1 shows a side view of the stack support in the home position.
Figure 2 shows a front view of a scanner.
Figure 3 shows a side view of the scanner incorporating the present invention.
Figure 4 shows a detailed view of the home position sensor with a tray flag in the home position.
Figure 5 shows a detailed view of the stack up sensor and the feed module flag with the stack in the stack up position.
Figure 6 shows a detailed view of the paper present sensor.
Figure 7 is a flowchart for control scenario.

[0013] Referring to now to Figure 1 and the flow chart found in Figure 7, the operation of the invention is as follows. At power on 12, the machine control logic polls the home or tray down position sensor 14 (see Figures 1 and 4) to see if it is blocked or unblocked. The home position 14 sensor is an opto interrupter type and is blocked when a tab on the paper support tray 16 moves into a position known as the home or tray down position 18. If the paper support tray 16 is determined to be down as indicated by the home position sensor 14 then the operation sequence continues, if not, then the machine logic will issue a set amount of stepper down steps 20 to the stepper motor 22 (see Figure 1). The stepper motor 22 then drives the paper support tray 16 downward through lift chain 24, and cable anchor point 26. A side view showing these drive train elements is found in Figure 1.

[0014] A complete description of the workings of this drive train system is not included, but this arrangement is typical within the art of elevating high capacity lift trays for autofeeding of sheet media.

[0015] The stepper motor 22 will continue to drive downward until the sensor 14 becomes blocked or a Max Step Count 28 is reached. "The Max Step Count" 28 represents a number of steps that should be able to have driven the paper support tray 16 it's full travel plus a small amount of extra steps. If the "Max Step Count" 28 is reached without blocking the sensor 14 then an error 30 is flagged and reported back to the operator through the operator control panel found in Figure 2. If the Home Position Sensor 14 is blocked, the process continues.

[0016] Machine logic looks at it's setup tables to see if an "Intermediate Position" 34 has been selected. This intermediate position 34 is set by the customer through a PC attached to the scanner and an appropriate PC to scanner communications (typically SCSI). The Graphical User Interface or GUI would contain a display that would allow the customer to choose an intermediate position that is best suited for the size of batches that the customer wants to feed. This intermediate position 34 can be set with granularity as fine as one stepper motor 22 step. For example, in the implementation described here, each stepper motor 22 steps equates to approximately 3 or 4 sheets of 20 lb. bond paper - (a command to move the stepper motor one full step will result in the paper support tray 16 being lifted or lowered approximately .015" which is the equivalent of about 3 to 4 sheets of paper.) Therefore, a GUI could be designed to allow the customer to break up the full capacity of 1,000 sheets into "Intermediate Positions" 34 separated by .015" or 1,000 sheets divided by 4 sheets per position giving as many as 250 possible intermediate positions 34 choices. This approaches totally variable capacity setting.

[0017] If an intermediate position 34 has not been selected, then the machine logic assumes that the maximum capacity or 1,000 sheets is desired. This 1,000 sheet tray position is equivalent to the paper support tray 16 being all the way down and at the position where the "Home Position" sensor 14 is blocked. At this point in the process, the machine logic checks to see if the stack up sensor 36 is indicating that the feed module 38 has been raised up which in turn unblocks the opto interrupter "Stack Up Sensor" 36. This is accomplished when the stack of documents 40 comes into contact with the drive tires located within the feed module. See Figure 5. A solid plastic flag 42 which is part of the feed module housing rotates with the housing until such a point where the flag 42 no longer block the opto interrupter sensor. (this point is known as the "Stack Up Position.") If the "Stack Up" sensor 36 is blocked, then the machine logic assumes that there is no paper loaded and commands the stepper motor 22 to drive up until the prescribed "Intermediate Position" 44 or number of steps has been met. At this point, the tray has been put in the "Intermediate Position" 44 desired by the customer and will return to this position each time a document stack 40 has been fed from the paper support tray 16 unless the "Intermediate Position" 44 is subsequently changed by the customer or a power down occurs to the scanner.

[0018] By utilizing the number of steps as the means

of setting an "Intermediate Position" 44 this allows more customers settable positions and requires no additional hardware or sensors to accomplish this functionality. This reduction in hardware results in manufacturing cost benefits as well as better overall system reliability. Again, as was the case on initial power up, the stepper motor command is bounded by a "Max Step Count" 46 and if this count is reached, the machine logic will flag an error 48.

[0019] At this point in the process the customer can command the scanner to feed documents by pressing a start scan button 50 on the scanner. (It is also possible to give this command through the host PC and it's SCSI communications interface.) The machine logic receives the start command and polls the "Paper Present Sensor" 52 to determine is paper has been loaded into the paper support tray 16 to be fed. The "Paper Present Sensor" 52, see Figures 2 and 6, is a reflective type sensor located within the paper support tray 16. If there is no paper present 54, then no scanning will commence. If paper is present 54, then the machine logic will check to see if the "Stack Up Sensor" 36 is indicating that the document stack 40 is at the "Stack Up" position 56 or not. The "Stack Up" position 56 where the paper is at the desired elevation for reliable feeding 58. If the stack up sensor 36 is satisfied then feeding 58 commences. If the stack up sensor 36 is not satisfied then the tray is driven up until it become unblocked and the paper has reached the desired height for reliable feeding and feeding commences. Feeding of the sheets involves engaging an electromechanical clutch that causes the feed module 38 tires to rotate and thereby advance the top sheet into the paper path 60. This electromechanical clutch is in turn coupled to the scanner's main drive motor and drive system from which it receives it's power. Once a sheet is fed from the paper support tray 16, it is advanced through the scanner via a series of rollers and belts. At some point in the paper travel, an illumination source and a CCD - Lens Reduction image forming system produces the desired electronic image. The sheet continues through the paper transport and is delivered to an output tray. See Figure 3 which depicts a side view of a typical image forming paper path.

[0020] At this point in the process, sheets are being fed from the paper support tray 16 and the machine logic monitors the state of the "Stack Up" and paper present sensors 52. As the sheets feed out from the original "Stack Up" position, the feed module gradually rotates downward until such time that the "Stack Up" sensor 36 becomes blocked again (see Figures 1 and 5). The machine logic command the motor to step upward and satisfy the "Stack Up Sensor" 36. This process continues until all sheets have been successfully fed from the support tray which is then indicated by the "Paper Present Sensor" becoming unblocked at the end of the batch. The tray then returns to the prescribed "Intermediate Position" 34 and is ready to accept the next batch of documents for feeding.

Claims

1. A capacity control system for a paper supply elevator comprising:

a paper support;
a paper sensor for detecting presence of paper on said paper support;
a home position sensor for detecting a home position of said paper support;
a stack up sensor for detecting a topmost sheet of paper in a stack of papers located on said paper support;
an intermittent drive for raising and lowering said paper support;
a control panel for inputting an expected paper stack size; and
a control circuit for said intermittent drive which causes said intermittent drive to move said paper support to a position corresponding to said expected paper stack size.

2. A capacity control system as in claim 1 wherein said control circuit causes said intermittent drive to return said paper support to said position corresponding to said expected paper stack size after said stack of paper has been fed to a processing device.

3. A capacity control system as in claim 1 wherein said intermittent drive is a stepper motor.

4. A capacity control system as in claim 1 wherein said intermittent drive is a servo control motor.

5. A capacity control system as in claim 1 wherein said paper supply elevator is mounted on a scanner.

6. A capacity control system as in claim 4 wherein said control panel is mounted on said scanner.

7. A capacity control system as in claim 4 wherein said control panel is a computer electronically connected to said scanner.

8. A capacity control system as in claim 1 wherein said paper sensor is mounted on said paper support.

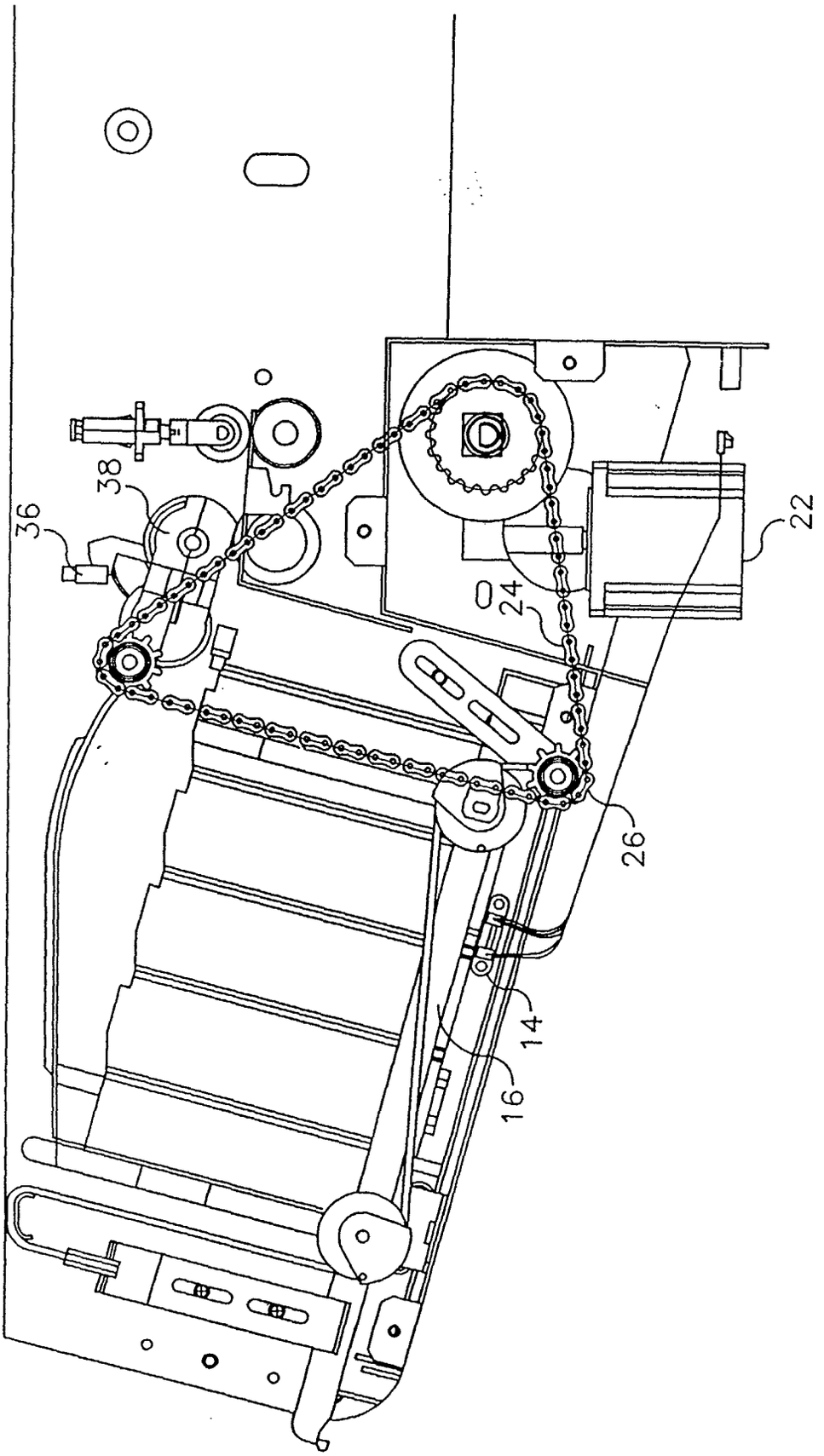

FIG. 1

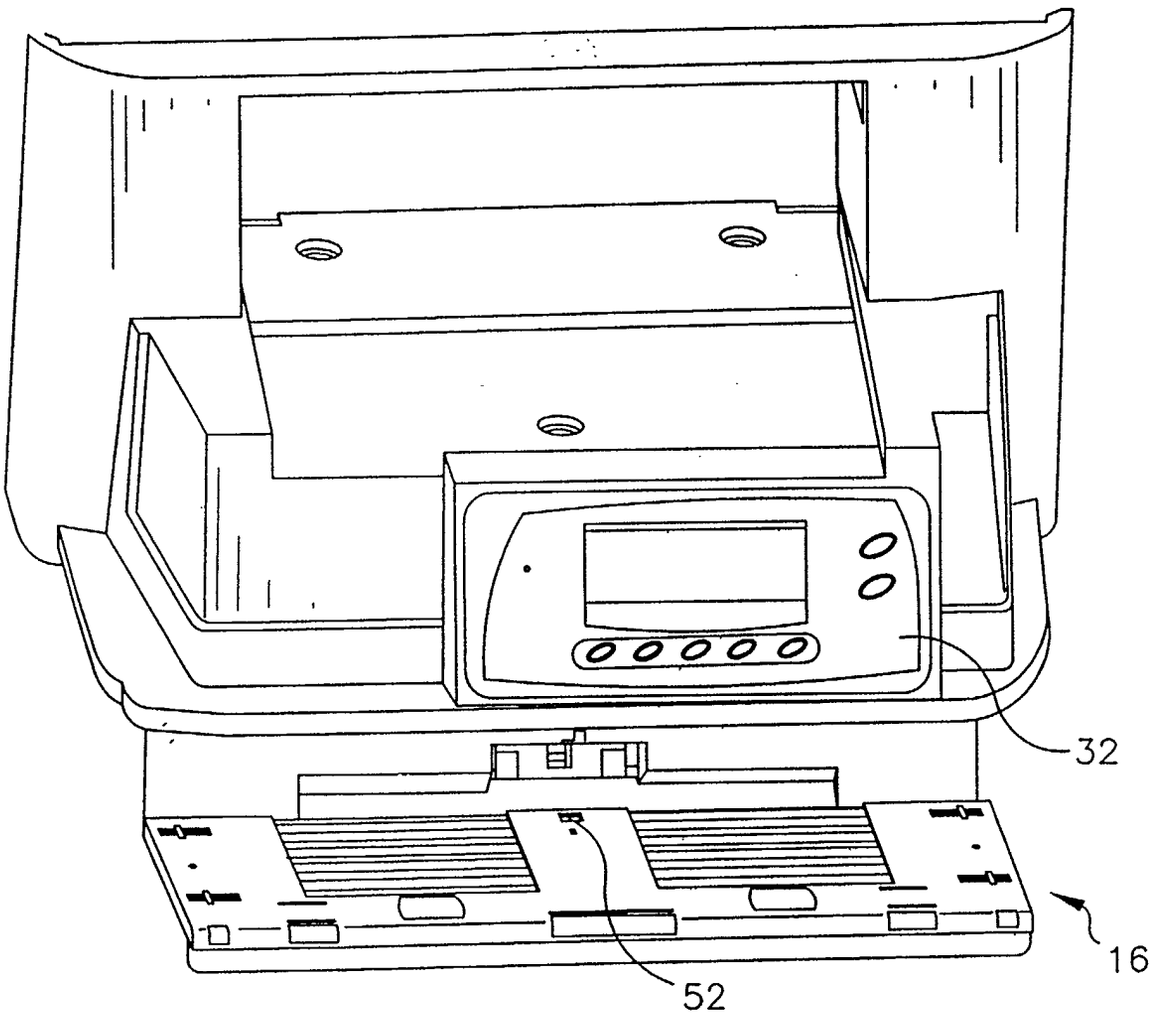

FIG. 2

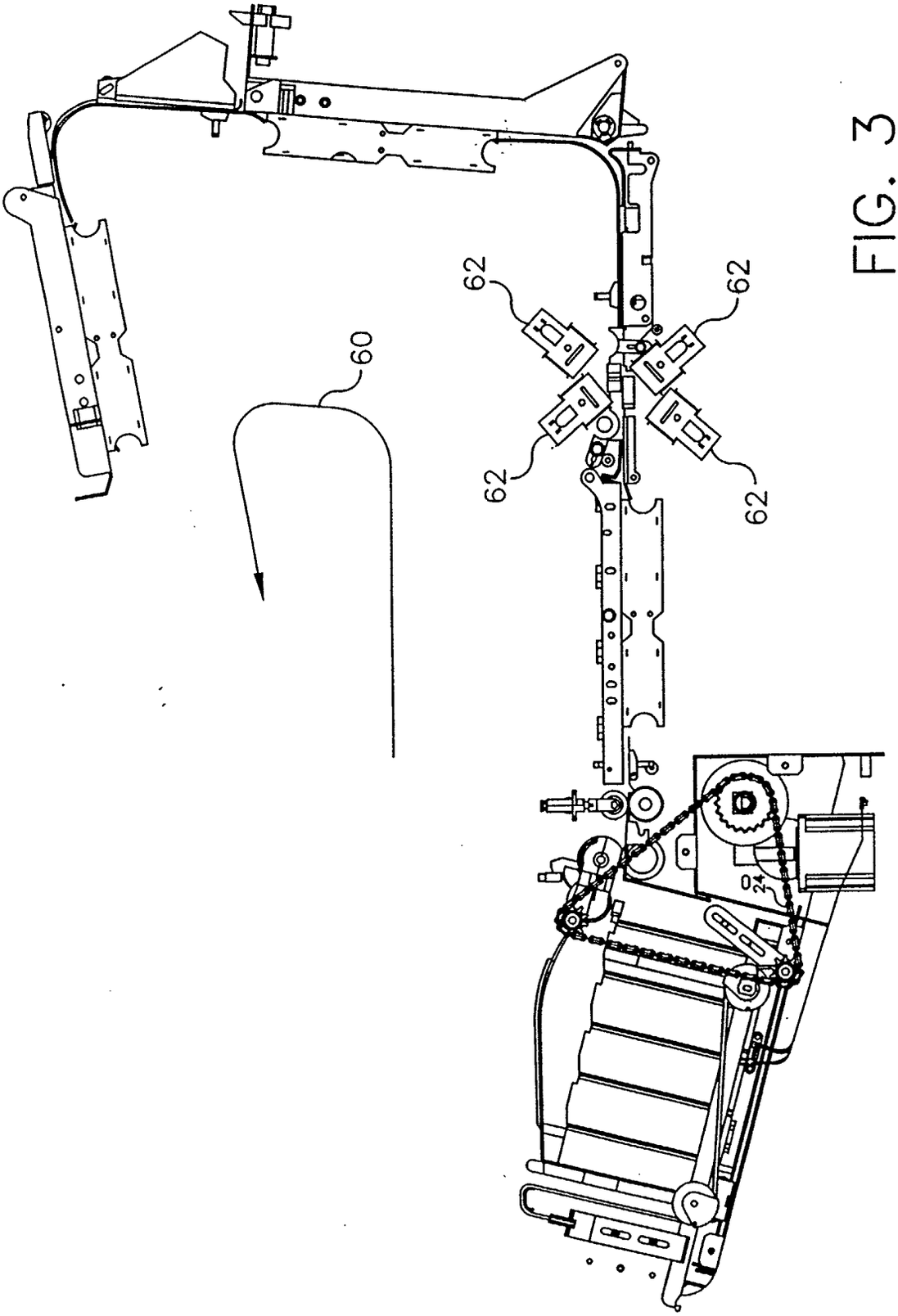

FIG. 3

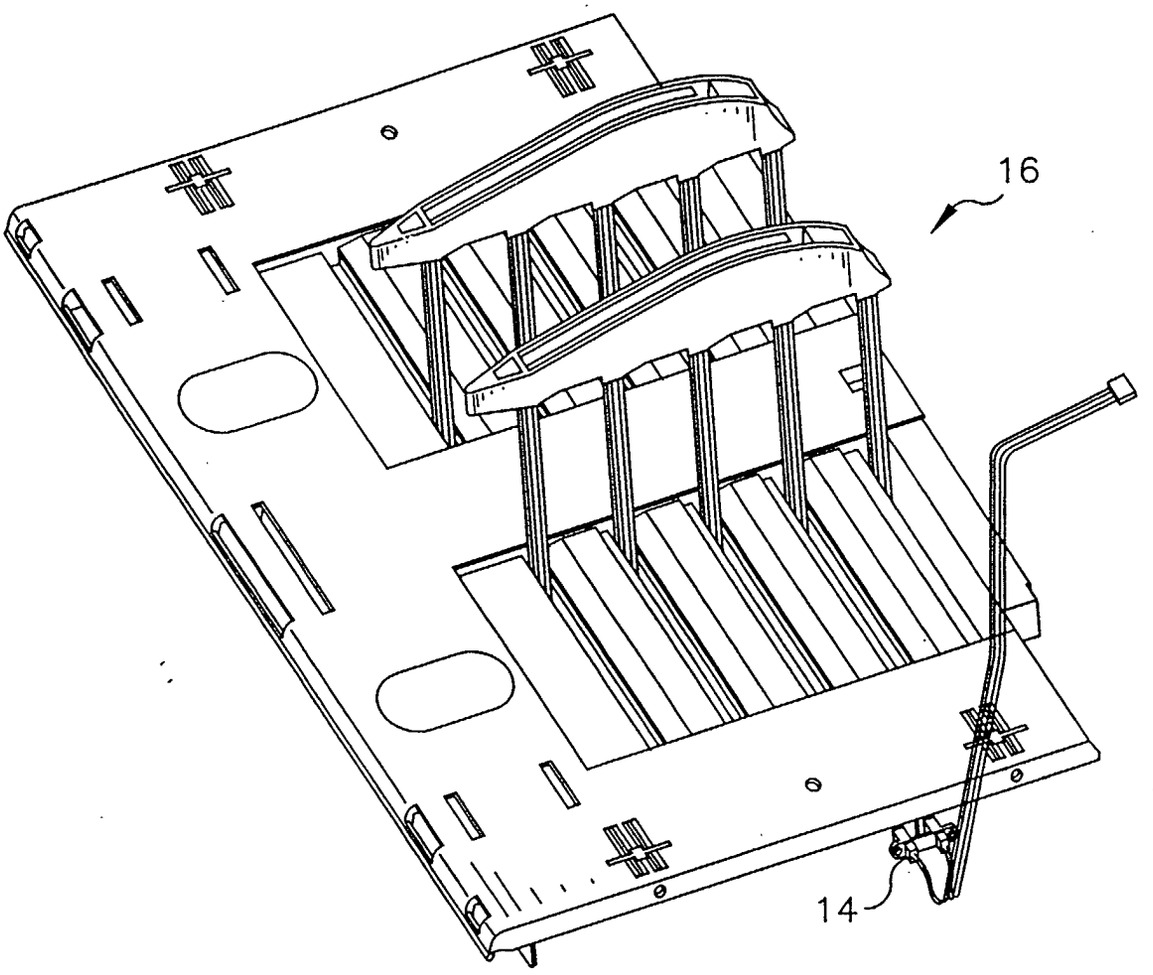

FIG. 4

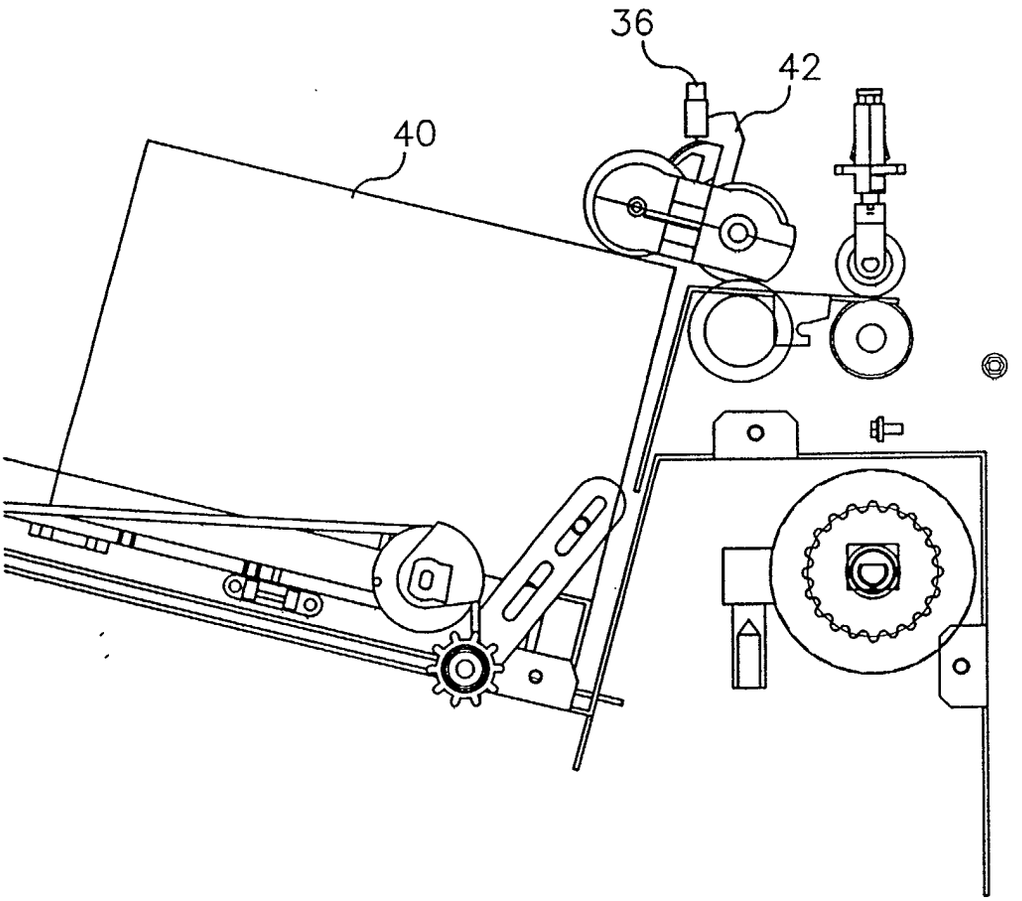

FIG. 5

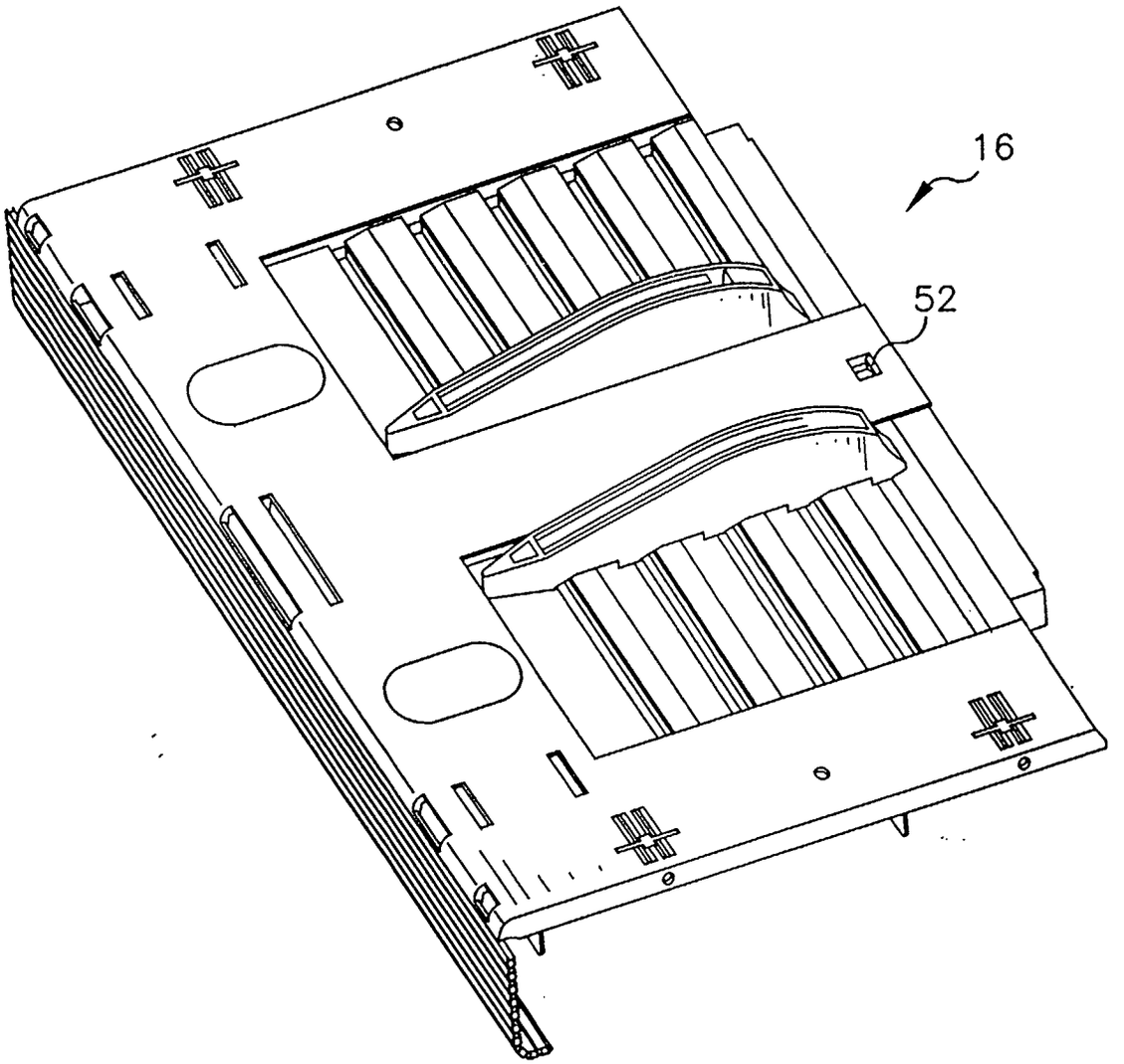

FIG. 6

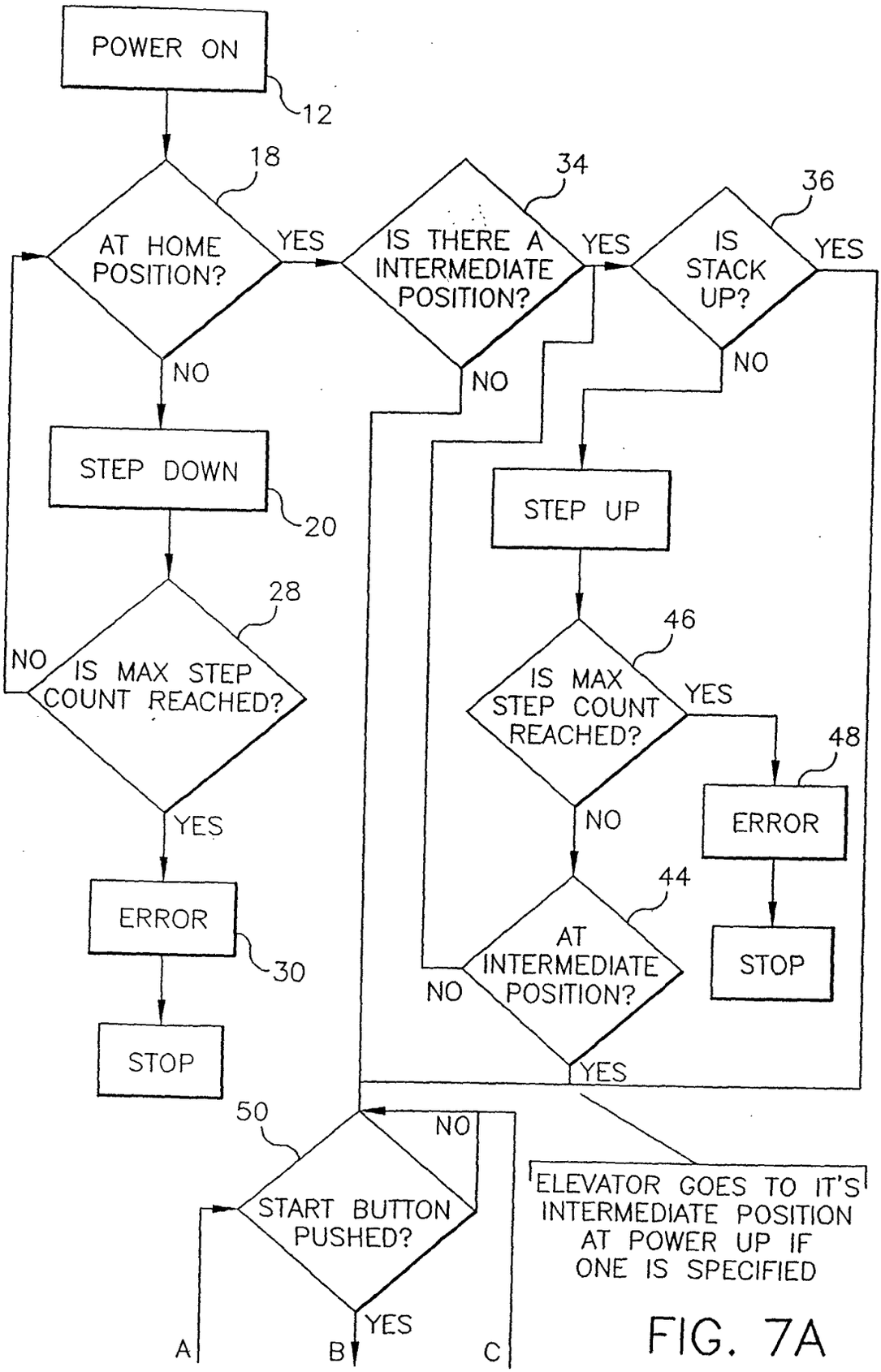
POWER ON
12
18
AT HOME POSITION?
YES
NO
STEP DOWN
20
28
IS MAX STEP COUNT REACHED?
NO
YES
ERROR
30
STOP
34
IS THERE A INTERMEDIATE POSITION?
YES
NO
36
IS STACK UP?
YES
NO
STEP UP
46
IS MAX STEP COUNT REACHED?
YES
NO
48
ERROR
STOP
44
AT INTERMEDIATE POSITION?
NO
YES
50
START BUTTON PUSHED?
NO
YES
A
B
C
ELEVATOR GOES TO IT'S INTERMEDIATE POSITION AT POWER UP IF ONE IS SPECIFIED

FIG. 7A

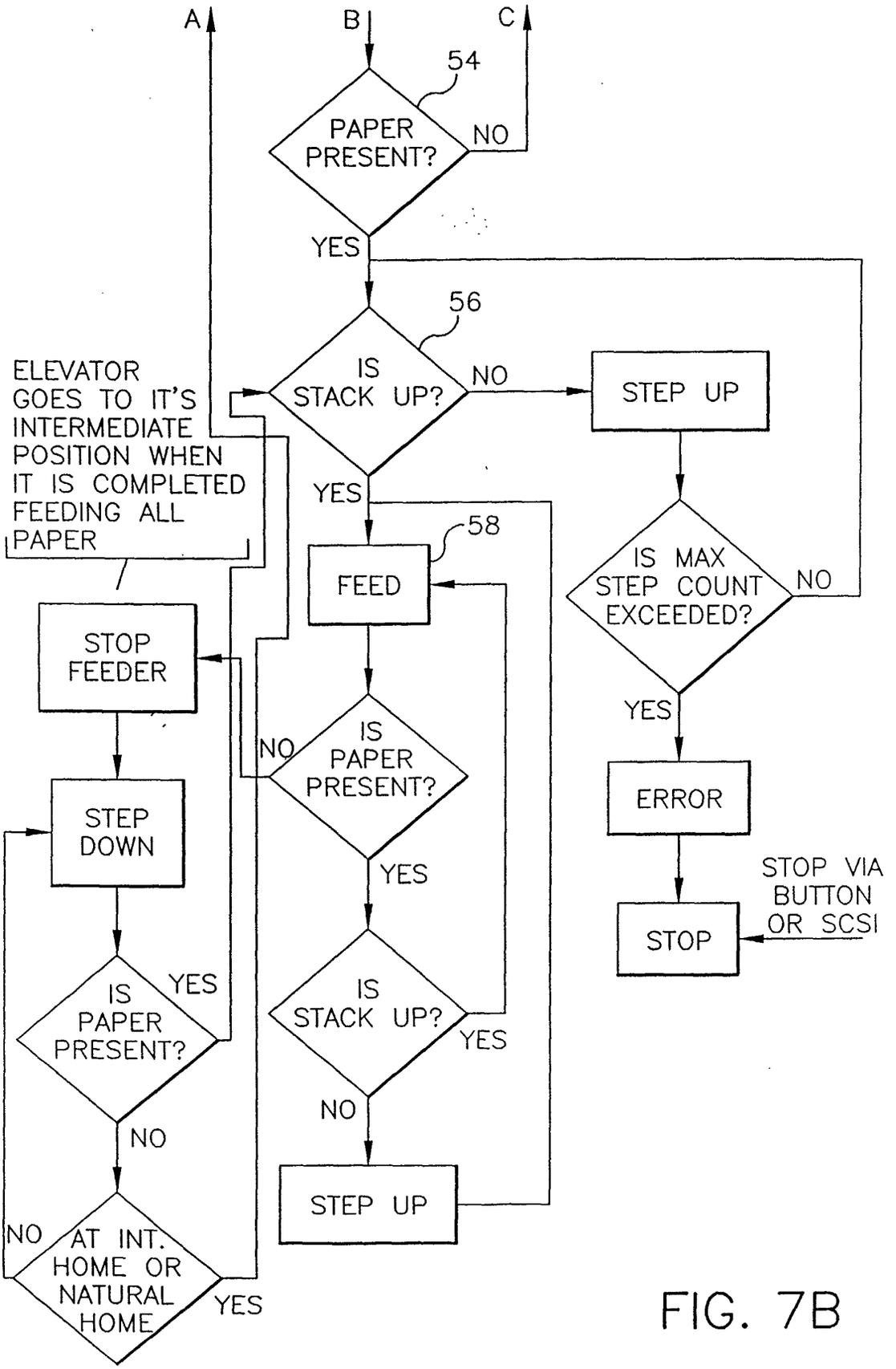
A
B
C
54
PAPER PRESENT?
NO
YES
56
IS STACK UP?
NO
STEP UP
YES
58
FEED
IS MAX STEP COUNT EXCEEDED?
NO
YES
ELEVATOR GOES TO IT'S INTERMEDIATE POSITION WHEN IT IS COMPLETED FEEDING ALL PAPER
STOP FEEDER
NO
IS PAPER PRESENT?
YES
ERROR
STOP VIA BUTTON OR SCSI
STOP
STEP DOWN
IS PAPER PRESENT?
YES
NO
IS STACK UP?
YES
NO
STEP UP
NO
AT INT. HOME OR NATURAL HOME
YES

FIG. 7B