Aug. 8, 1967 J. J. MADDEN 3,335,264

ARTICLE HANDLING APPARATUS

Filed March 21, 1963 5 Sheets-Sheet 1

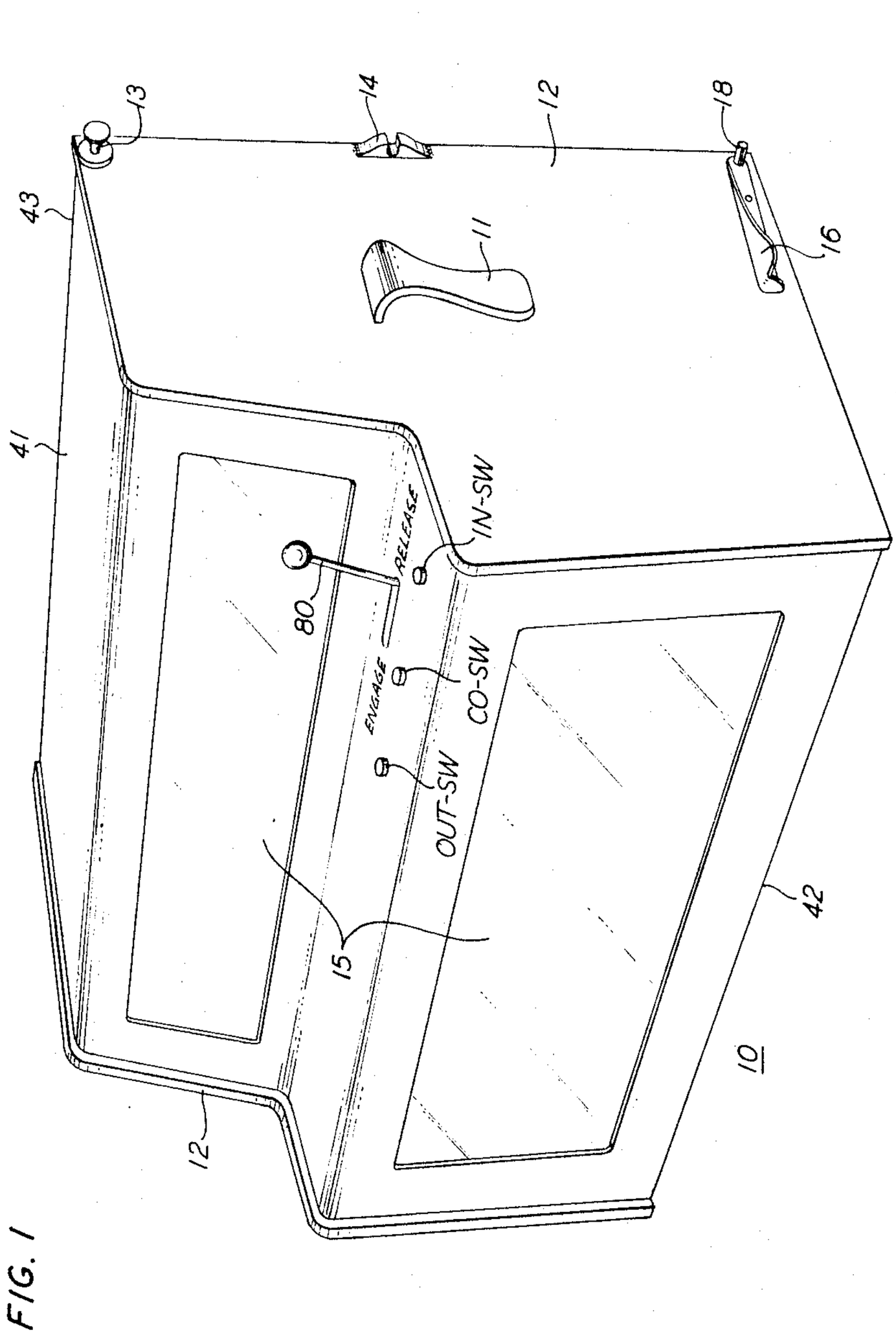

FIG. 1

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ARTICLE HANDLING APPARATUS

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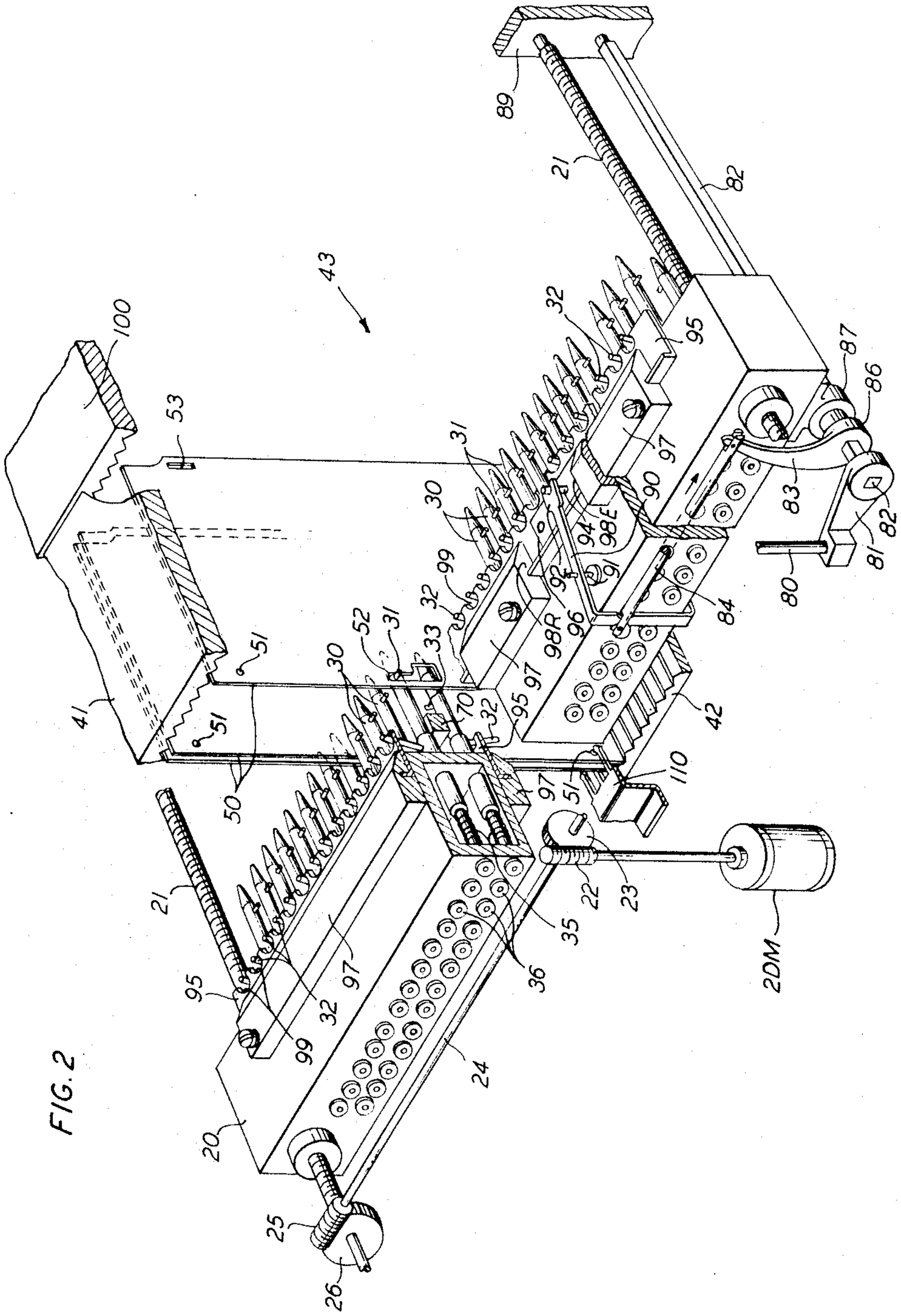

FIG. 2

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ARTICLE HANDLING APPARATUS

Filed March 21, 1963 5 Sheets-Sheet 3

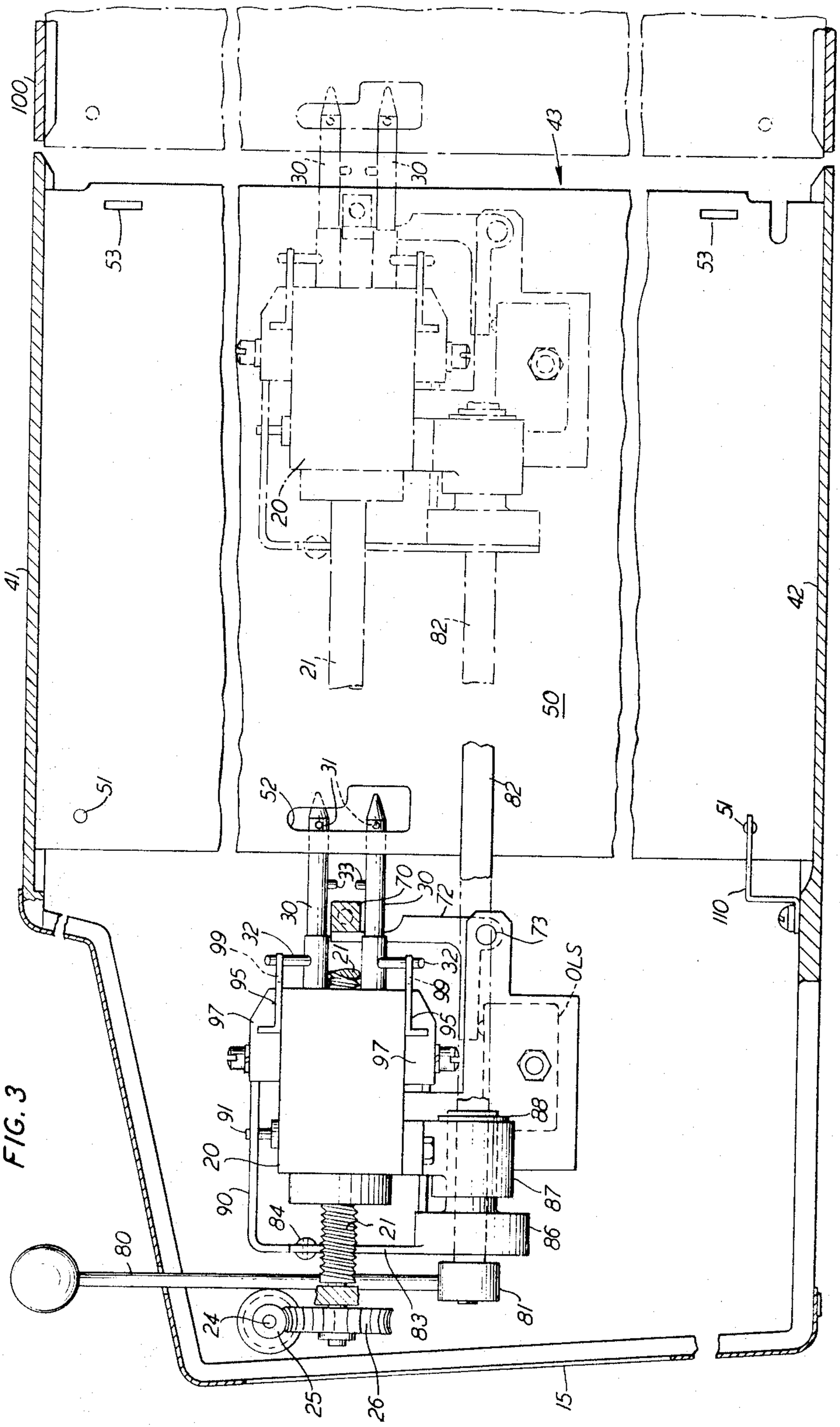

FIG. 3

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ARTICLE HANDLING APPARATUS

Filed March 21, 1963 5 Sheets-Sheet 4

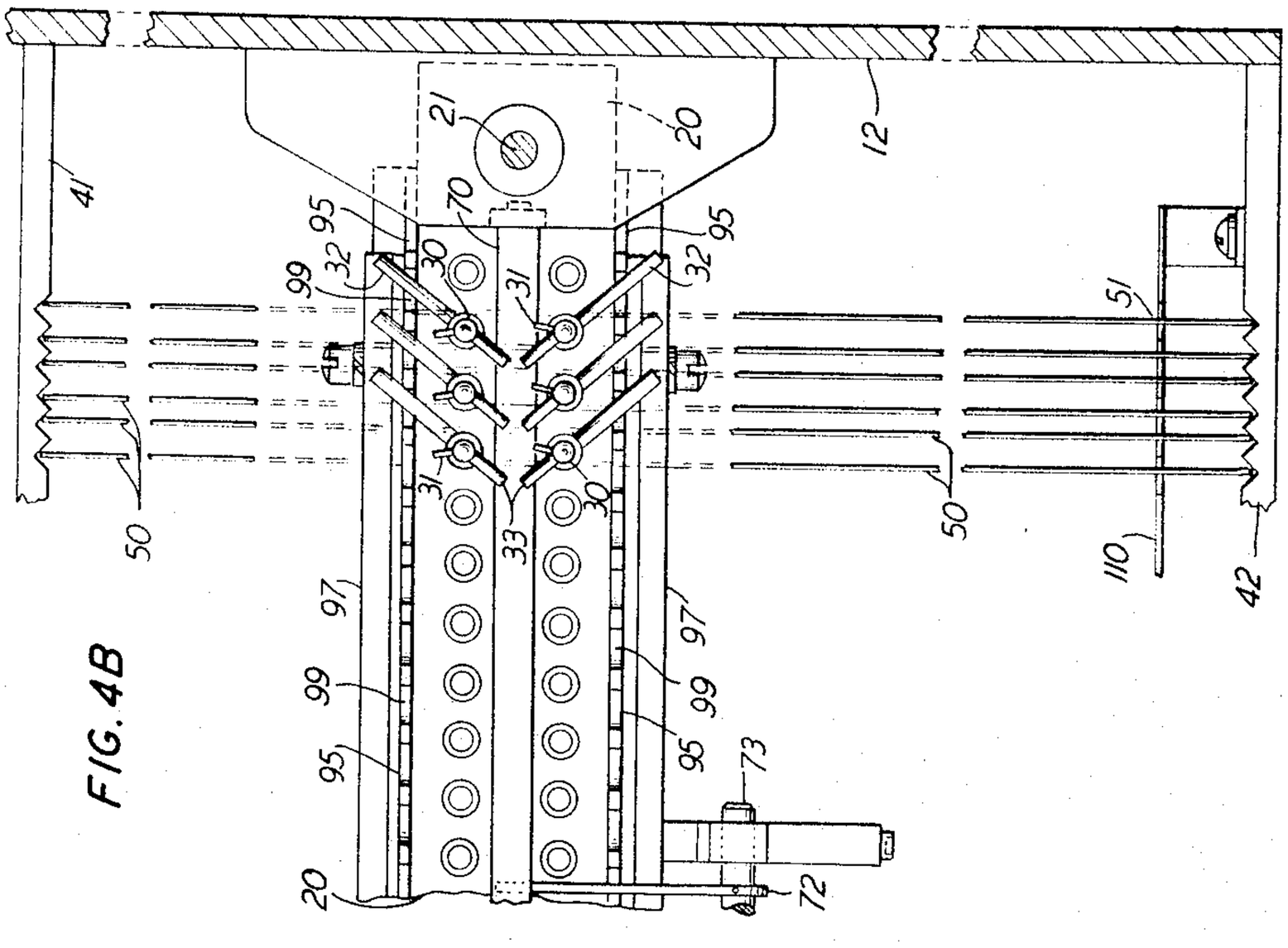

FIG. 4B

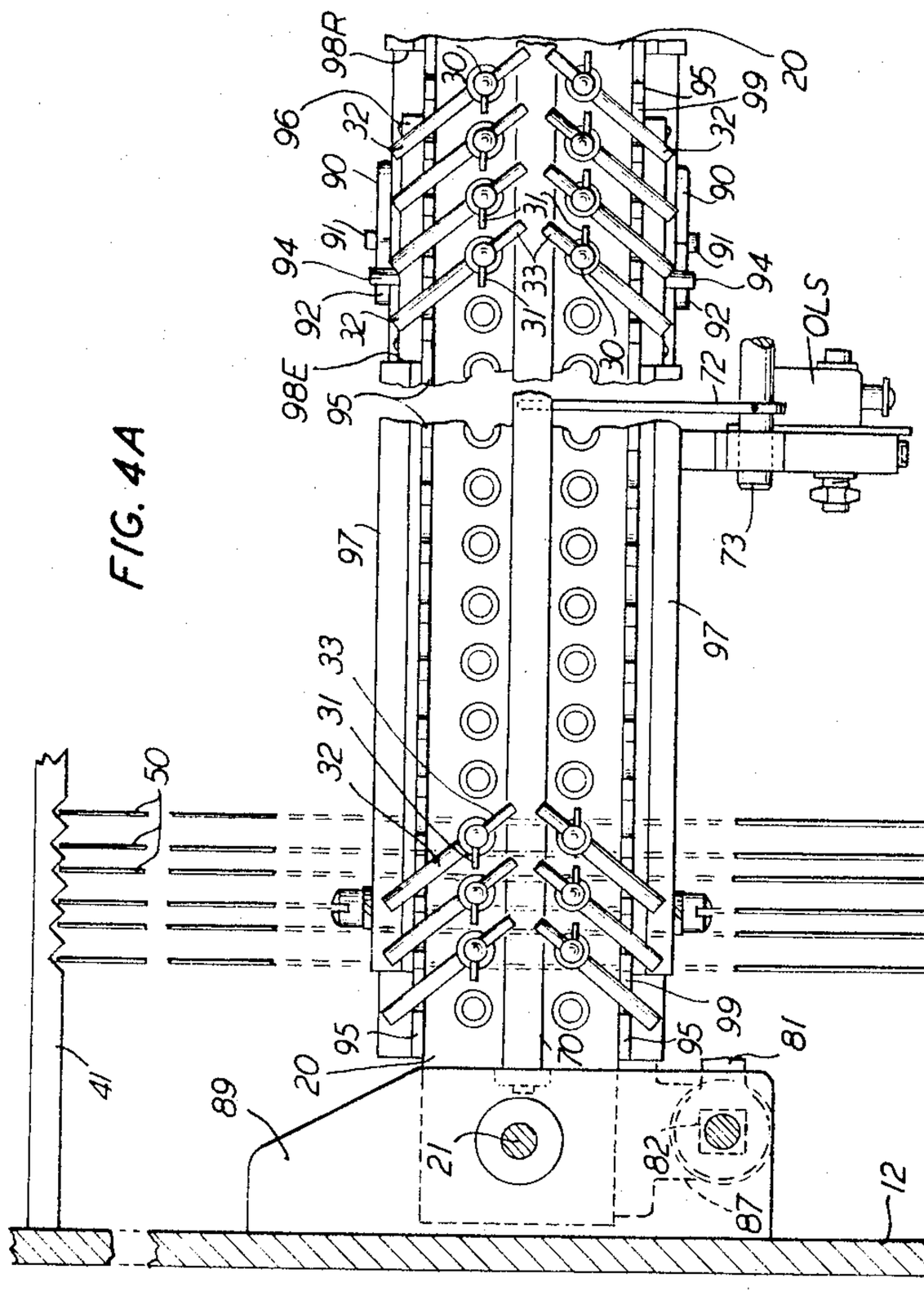

FIG. 4A

ARTICLE HANDLING APPARATUS

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FIG. 5

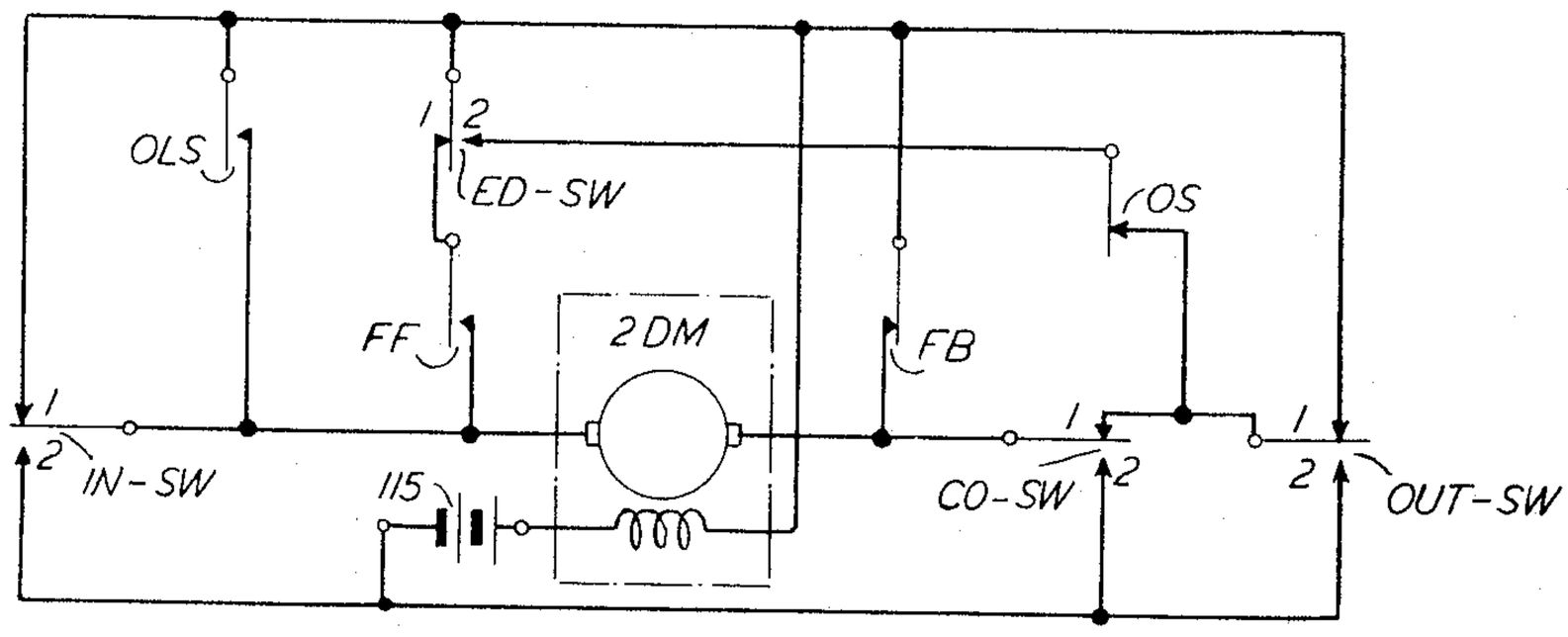


FIG. 6A

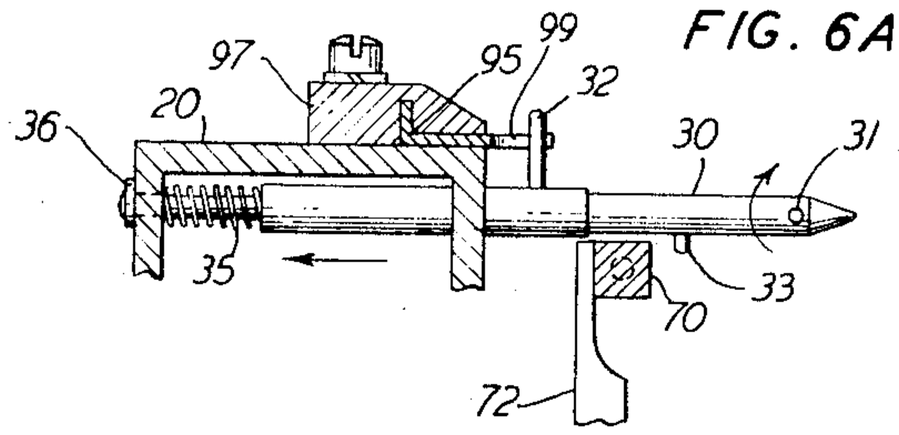
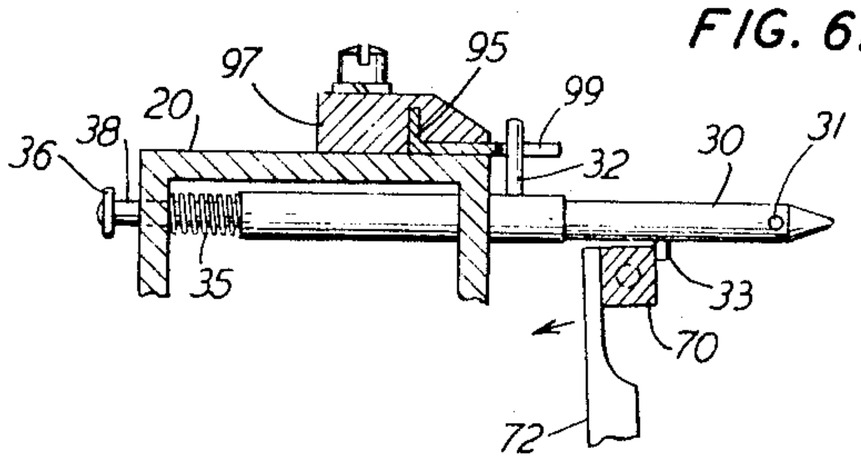


FIG. 6B



United States Patent Office

3,335,264

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3,335,264

ARTICLE HANDLING APPARATUS

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Filed Mar. 21, 1963, Ser. No. 266,993

10 Claims. (Cl. 235—61.11)

ABSTRACT OF THE DISCLOSURE

Individual article engaging elements in a portable housing operate to withdraw a plurality of parallel card-type articles from a storage location into the housing or to insert into a storage location a plurality of card-type articles from the housing. The article engaging elements are driven by a common electric motor.

This invention relates to article handling apparatus and more particularly to such apparatus for handling a plurality of card-type articles.

Currently, there are an increasing number of systems and circuit arrangements employing large pluralities of movable cards or sheets. This is particularly apparent in the areas of information handling and information storage wherein movable cards are being advantageously utilized having translation patterns, circuit components, storage elements, or the like printed or attached thereon. For example, an information translating arrangement employing a plurality of movable cards having translation patterns of memory elements printed thereon is shown in R. C. Avery-R. H. Gumley-A. Majlinger application Ser. No. 162,162, filed Dec. 26, 1961, now Patent 3,156,898, issued Nov. 10, 1964. Illustrative storage arrangement utilizing pluralities of movable cards upon which information storage elements are located may be found, for example, in the application of S. M. Shackell Ser. No. 708,127, filed Jan. 10, 1958, and in an article entitled, "A Card-Changeable Permanent-Magnet-Twistor Memory of Large Capacity," published in the "I.R.E. Transactions on Electronic Computers," vol. EC–10, pages 451–461, September 1961.

The advantages of using such cards are becoming well known. Thus, printed cards may be readily and economically manufactured in large quantities and they can be easily and compactly stored until their use is desired. Moreover, movable cards may be removed readily and replaced, permitting desired circuit or storage alterations and modifications to be made quickly and accurately with a minimal requirement for specially trained personnel therefor.

However, a usual requirement of such systems and circuit arrangements is that each of the plurality of movable cards be positioned accurately with respect to certain portions of the remainder of the system or circuit arrangement. Further, although the orientation of the cards relative to each other is sometimes fixed or predetermined, in other arrangements random linear and skew variations occur in the relative orientation of the cards which necessitate positioning each card independently at its respective correct location. Thus in information storage arrangements of the type shown in the above-mentioned article and in the S. M. Shackell patent application, for example, each of the movable memory storage cards must be positioned accurately in the memory so that the plurality of bar magnets bonded on the card are each adjacent a respective memory crosspoint. The memory crosspoints are arranged in coordinate rows and columns and in parallel planes; and the memory cards are thus arranged in coplanar relationship, each card being positioned adjacent

a respective memory plane. There is often no correlation, however, between the location of the crosspoints of one plane relative to the crosspoints of the other planes. Therefore, independent accommodation is required in the positioning of each of the cards in the memory to assure that each bar magnet thereon is properly oriented adjacent its respective crosspoint.

Heretofore, the individual cards have generally been handled and positioned manually; but this becomes less desirable as the quantity of cards employed in the system increases, inasmuch as considerable time and energy is required therefor which detracts from the advantages for using movable cards. Further, manual manipulation of the cards is a major source of error in the operation of such systems, arising from improper card selection or improper card positioning. Moreover, manual manipulation tends to decrease the life of the cards and may lead to errors due to the elements thereon being damaged or dislocated. Therefore, it is desirable to handle the cards automatically, without the need for intervening manual manipulation thereof, through the use of article handling apparatus.

It is further desirable that such apparatus be capable of handling and positioning large pluralities of cards rapidly and accurately. However, the cards employed in most systems are compactly constructed of relatively thin sheets of material and, consequently, must be handled carefully to avoid bending or damaging the cards during insertion or withdrawal from the system. Therefore, automatic card handling apparatus must be sensitive to pressures due to friction, binding or the like, which may be exerted on each individual card during insertion. Should excessive resistance be met by a card during insertion and positioning, operation should be halted quickly to prevent damage to the cards or to the system, and an indication should be provided directing an operator to the particular card in trouble.

Accordingly, it is a general object of this invention to provide simple, compact and economical article handling apparatus which may be utilized to handle a plurality of card-type articles.

More specifically, it is an object of this invention to provide simple, compact and economical apparatus for inserting and withdrawing a plurality of card-type articles to and from individual predetermined positions.

It is another object of this invention to provide apparatus for automatically transferring each of a plurality of card-type articles substantially simultaneously from first card locations to second card locations, the first and second card locations being in random relative orientation with one another.

A further object of this invention is to provide apparatus for accurately and rapidly positioning each of a plurality of card-type articles individually with respect to predetermined orientations.

A still further object of this invention is to provide apparatus for automatically handling card-type articles to minimize the need for manual intervention or manipulation.

The above and other objects are attained in an illustrative embodiment of card handling apparatus in accordance with the principles of the present invention, wherein each of a plurality of cards is individually engaged by a respective card engaging element for concurrent movement between first card locations and second card locations. The individual card engaging elements are operable at both the first and second card locations to engage the respective cards independently for concurrent movement of the cards. The first card locations may be situated advantageously in a movable housing comprising the plurality of card engaging elements. In this manner a plurality of cards are insertable from the first card loca-

tions in the housing into variously situated second card locations and, conversely, a plurality of cards are withdrawable from variously situated second card locations into the housing.

According to one aspect of the present invention, each card engaging element in the housing pivotally engages a respective card, the pivotal engagement accommodating random variations in the individual card orientations at the first and second card locations.

In accordance with another aspect of my invention each card engaging element is individually sensitive to unusual or excessive resistance to movement of the respective card engaged thereby. Such unusual resistance to movement may occur, for example, in the case of a damaged card or a damaged card location. Responsive to excessive resistance to movement of one or more cards, apparatus including the respective individual card engaging element or elements operates to halt further movement of the cards and to signal an operator. An indication is provided to the operator to permit identification of the particular card or cards in trouble.

In accordance with a further aspect of my invention, particularly where the first card locations are situated in a movable housing, individual detent apparatus is provided to releasably retain the plurality of cards in the first card locations upon disengagement of the card engaging elements from the cards. The detent apparatus minimizes the possibility of accidentally dislodging the cards from the first card locations or the housing, yet permits them to be individually withdrawn therefrom and reinserted manually when desired, such as for replacement of individual cards.

It is, therefore, a feature of my invention that card handling apparatus comprise individual card engaging elements operable to pivotally engage respective ones of a plurality of cards for bidirectional movement between randomly oriented card locations.

A further feature of my invention relates to card handling apparatus comprising card engaging elements individually responsive to a predetermined resistance to movement of a respective card engaged thereby for halting movement of the card and for identifying the respective card in trouble.

Another feature of my invention relates to card handling apparatus comprising a movable housing including a plurality of card engaging elements for individually engaging a plurality of cards for withdrawing the cards from randomly oriented locations into the housing and, also, for inserting and positioning the cards into randomly oriented locations.

The above and other objects and features of the present invention may be better understood upon consideration of the following detailed description and the accompanying drawing in which:

FIG. 1 is a pictorial representation of an illustrative movable housing embodying the present invention;

FIG. 2 shows an illustrative embodiment of card handling apparatus in accordance with the principles of the present invention;

FIG. 3 is a side view of the illustrative embodiment of card handling apparatus shown in FIG. 2;

FIGS. 4A and 4B show another view of the illustrative embodiment of card handling apparatus shown in FIGS. 2 and 3;

FIG. 5 is an illustrative circuit diagram for operating the card handling apparatus of FIGS. 2, 3 and 4; and

FIGS. 6A and 6B show details of an individual card engaging element of the illustrative embodiment of card handling apparatus shown in FIGS. 2 through 4.

For the purpose of facilitating description of an illustrative embodiment of the present invention, it has been assumed that the articles to be handled thereby are cards such as used in card-changeable memories of the type described, for example, in the above-mentioned article and in the S. M. Shackell patent application. Therein the

removable memory cards each have a plurality of information bit magnets bonded or deposited on one surface of the card and arranged in coordinate rows and columns. The individual memory cards are situated in respective planes of the memory so that each bit magnet is accurately located in the proximity of a respective memory crosspoint. However, as mentioned above, there is often no correlation between the location of the crosspoints of one memory plane relative to the crosspoints of the other memory planes. Rather, the correct location for a card adjacent to a plane is independently defined for the respective plane during construction of the memory, such as through individual card positioning stops for the respective memory planes. Thus random linear and skew variations may be present in the relative orientation of the individual cards when correctly positioned in the memory, which variations are advantageously accommodated by operation of the present card handling apparatus.

The present apparatus for handling such cards is arranged in a movable housing **10**, illustratively depicted in FIG. 1. A plurality of cards are transportable in housing **10** for insertion through open side **43** thereof into various remote card locations and, further, may be withdrawn from various remote card locations through open side **43** into housing **10**. Within housing **10** the cards are respectively disposed in individual card locations such as individual slots or grooves located along the inner surfaces of sides **41** and **42**. Housing **10** has a pair of handles **11** arranged on sides **12** thereof to permit the housing, and any cards therein, to be manually transported by an operator. A hanger guide pin **13** is provided on each side **12** which engages mating elements at the card locations for supporting and positioning housing **10** adjacent thereto when inserting or withdrawing cards. Guide elements **14** accurately located housing **10** adjacent the card locations; and a locking level **16** on each side **12** operates to clamp housing **10** in position, movement of lever **16** causing pin **18** thereof to engage a mating element at the card locations. Openings or transparent windows **15** are provided in housing **10** to permit operation of the card handling apparatus therein to be visually observed. Operation of the apparatus is controlled by pushbutton switches IN–SW, OUT–SW and CO–SW, and by operating lever **80** which is movable between two positions, respectively designated "ENGAGE" and RELEASE" in FIG. 1. The function and operation of these switches and of lever **80** are described in detail below.

Card-changeable memories are typically arranged in modules each comprising like pluralities of removable storage cards. The present card handling apparatus advantageously has sufficient capacity for handling a module of cards at one time, illustratively 128 cards. For the purposes of clarity, however, only a small number of cards **50** and card engaging elements **30** are shown in FIGS. 2, 3, 4A and 4B, these being deemed adequate for a clear understanding of the principles and the operation of the present invention. Each card **50** as shown in FIG. 3 has a centrally located aperture **52** along one side thereof which is pivotally engaged by a respective one of card engaging elements **30** for moving and positioning the individual cards **50**. Apertures **51** on each card **50** are utilized in connection with detent apparatus **110** to releasably retain individual ones of cards **50** in position within housing **10** when aperture **52** is not engaged by elements **30**. Each card **50** also has a pair of apertures **53** which are utilized by information recording apparatus, such as shown in C. F. Ault-D. Friedman-R. H. Granger-J. J. Madden Patent 3,281,807, issude Oct. 25, 1996, to withdraw cards **50** individually from housing **10** for recording information thereon. The location of apertures **51**, **52** and **53** is such as to permit cards **50** to be advantageously handled by the present apparatus with their magnet bearing surfaces facing either left or right in FIG. 2. This is desirable inasmuch as the cards in a memory module are

often arranged in an interleaved fashion, the magnet-bearing surfaces of successive cards alternately facing in opposite directions. Thus, for the purposes of illustration, it is assumed herein that cards **50** are divided into two interleaved groups with respect to the direction their magnet-bearing surfaces face, one group having their magnet-bearing surfaces facing left and the other group having their magnet-bearing surfaces facing right.

Card engaging elements **30** are mounted in carriage assembly **20** which is supported within housing **10** on lead screws **21**. Carriage assembly **20** is in threaded engagement with lead screws **21** for movement therealong when motor 2DM is energized. Rotation of motor 2DM is coupled to lead screws **21** through a gear arrangement of suitable ratio, such as shown in FIG. 2. Thus motor 2DM is coupled, for example, through worm **22** and wheel gear **23** to cross-shaft **24**, which is in turn coupled through individual sets of worm and wheel gears **25** and **26** to each of lead screws **21** (one set of gears **25** and **26** is not shown in FIG. 2). When motor 2DM is energized in one rotational direction, forward movement is imparted to carriage assembly **20** toward open side **43** of housing **10** via lead screws **21**. Open side **43** of housing **10**, through which cards **50** are handled, will be referred to herein as the front of housing **10**. Energization of motor 2DM in the opposite rotational direction imparts movement to carriage assembly **20** in the reverse direction toward the rear of housing **10**. The rearmost position of carriage assembly **20** within housing **10**, the position in which assembly **20** is shown in FIGS. 2 and 3, will be referred to herein as the home position of carriage assembly **20**. Carriage assembly **20** is normally situated in its home position between card handling operations and when cards **50** have been fully withdrawn into housing **10** by card engaging elements **30**.

Each card engaging element **30** is individually mounted in carriage assembly **20** for linear movement in an axial direction and for rotational movement about its axis, as shown in FIGS. 6A and 6B to which reference is now made. Each element **30** is spring-biased in its linear position relative to assembly **20** by an individual spring **35** and is limited in movement from this position by retaining clip **36** to the direction indicated in FIG. 6A. The bias presented by spring **35** is sufficient to prevent any substantial linear movement of element **30** relative to carriage assembly **20** during normal card handling operation. If, however, during the movement of carriage assembly **20** toward the front of housing **10** by any card engaging element **30** encounters greater than normal resistance to movement, the bias of its spring **35** is overcome thereby. Thus, spring **35** is compressed and a portion **38** of the particular card engaging element **30** is caused to protrude from carriage assembly **20**, as shown in FIG. 6B. The protruding portion **38** of element **30** is visible through windows **15** of housing **10**, advantageously identifying the particular card engaging element **30** encountering trouble. As will be described in greater detail below, movement of element **30** relative to assembly **20** in the direction indicated causes overload pin **33** of the particular element **30** to impinge upon overload bar **70**, thereby operating switch OLS to brake forward movement of carriage assembly **20**.

In addition to overload pin **33**, each card engaging element **30** has an individual card engaging pin **31** and an operating pin **32** rigidly disposed thereon in the relationship shown, for example, in FIGS. 3, 4A and 4B. Card engaging elements **30** are rotatable within assembly **20** between two distinct positions designated "ENGAGE" and "RELEASE," shown in FIGS. 4A and 4B, respectively. When card engaging elements **30** are rotated to the "ENGAGE" position shown in FIG. 4A, such as when cards are to be withdrawn from a memory module, card engaging pins **31** move into engagement with apertures **52** of respective cards **50** adjacent thereto. Subsequent movement of carriage assembly **20** consequently imparts movement to cards **50** thus engaged. When card engaging elements **30** are rotated to the "RELEASE" position shown in FIG. 4B, such as following insertion of cards **50** into a memory module, pins **31** are disengaged from apertures **52** and subsequent movement of carriage assembly **20** toward its home position imparts no movement to cards **50**.

Card engaging elements **30** may be arranged advantageously in two rows in carriage assembly **20**, as illustratively shown herein. Elements **30** in the top row of the illustrative embodiment thus engage alternate ones of cards **50**, that is, those cards having their magnet-bearing surfaces facing in one direction; and elements **30** in the bottom row engage cards **50** having their magnet-bearing surfaces facing in the opposite direction. This arrangement provides greater spacing between adjacent ones of elements **30** and minimizes the possibility of interference between card engaging pins **31** and adjacent elements **30** during rotational movement of elements **30**. Further, this permits card engaging pins **31** to be of greater length to insure proper engagement of apertures **52** of respective cards **50** when elements **30** are rotated to the position shown in FIG. 4A. Apertures **52** may be shaped, as illustratively shown in FIGS. 2 and 3, to insure that a card **50** is engaged during insertion by pin **31** of its respective card engaging element **30** only. If pin **31** of a card engaging element **30** extends sufficiently through aperture **52** of card **50** engaged thereby so as to enter aperture **52** of an immediately adjacent card **50**, it will enter the enlarged portion thereof and thus will not engage adjacent card **50** during insertion.

The rotational position of card engaging elements **30** is controlled by operating lever **80**. Movement of operating lever **80** into its "ENGAGE" or "RELEASE" position effects the rotation of elements **30** to their correspondingly designated positions. Operating lever **80** is rigidly coupled via arm **81** to shaft **82**, as shown in FIG. 2, such that movement of lever **80** between its two positions effects a corresponding rotation of shaft **82**. Rotational movement of shaft **82** is transmitted via arm **83** into longitudinal movement of connecting member **84** which is coupled to U-shaped lever yoke **90**. Yoke **90** is pivotally mounted on carriage assembly **20** via pins **91**; and ends **92** of yoke **90** engage pins **94** of each of element operating members **95**, members **95** being coupled via bearing blocks **97** for sliding longitudinal movement relative to carriage assembly **20**. Thus longitudinal movement of member **82** in one direction is transmitted through lever yoke **90** into longitudinal movement of both of element operating members **95** in the opposite direction.

Slots **99** of members **95** individually engage operating pins **32** of respective ones of card engaging elements **30** such that longitudinal movement of element operating members **95** is transmitted into rotational movement of elements **30**. The distance members **95** move, and thus the angle through which elements **30** rotate, is determined by an individual stop **96** rigidly affixed to each of members **95** acting in conjunction with abutting surfaces **98E** and **98R** of bearing blocks **97**. When members **95** are moved to the right such that stop **96** abuts surface **98E**, as shown in FIG. 2, card engaging members **30** are rotated to the "ENGAGE" position shown in FIG. 4A. Conversely, when lever **80** is moved to the right toward its "RELEASE" position, imparting clockwise rotation to shaft **82** in FIG. 2, connecting member **84** moves to the right and, via yoke **90**, urges members **95** toward the left. Movement of members **95** to the left is stopped when stop **96** abuts surface **98R**, elements **30** being thus rotated to the "RELEASE" position shown in FIG. 4B. Stops **96** and abutting surfaces **98E** and **98R** further function advantageously to limit rotation of elements **30** so that operating pins **32** thereof are not disengaged from slots **99** of elements **95**.

Card engaging elements **30** are operable to engage and

to release cards 50 regardless of the location of carriage assembly 20 within housing 10. For this purpose a guide bearing 86 and a journal bearing 87 are employed in conjunction with arm 83. Journal bearing 87 is rigidly connected to carriage assembly 20; and guide bearing 86 is rigidly connected to arm 83 and is slidably mounted on shaft 82. Guide bearing 86, and thus arm 83, is prevented from rotational movement relative to shaft 82 by a key thereof engaging a keyway in shaft 82 or by the use of a noncircular shaft. The latter method is illustrated herein, shaft 82 being square in cross-section and engaging a similarly-shaped opening through bearing 86. Guide bearing 86, and thus arm 83, is rotatably coupled to carriage assembly 20 via journal bearing 87, and is prevented from longitudinal movement relative thereto by retaining element 88. Accordingly, all of the above-described apparatus for rotating card engaging elements 30, except operating lever 80, arm 81 and shaft 82, are coupled to and are transported by carriage assembly 20.

Further, overload apparatus comprising overload bar 70, coupling arms 72 and overload switch OLS is coupled to and transported by carriage assembly 20. Arms 72 are rigidly connected to bar 70 and are pivotally disposed relative to assembly 20 on shaft 73. Overload 70 is disposed relative to card engaging elements 30 such that movement of any one of elements 30 in a direction toward carriage assembly 20, compressing its respective spring 35, causes overload pin 33 thereof to impinge upon bar 70. Switch OLS is rigidly coupled to carriage assembly 20 and arranged to be operated by movement of one of arms 72. Therefore, force exerted on bar 70 in a direction toward carriage assembly 20, such as when overload pin 33 of one of elements 30 impinges thereon, is transmitted via movement of one of arms 72 to operate switch OLS.

The operation of the card handling apparatus described above and shown in FIGS. 2 through 4B will now be described with reference to the illustrative circuit in FIG. 5. In addition to motor 2DM, pushbutton switches IN–SW, OUT–SW and CO–SW, and overload switch OLS, the illustrative operating circuit shown in FIG. 5 comprises switches ED–SW, OS, FF and FB. For purposes of clarity these additional switches are not shown in FIGS. 2 through 4B; however, their function and operation will be fully apprehended from the description hereinbelow. Specifically, switch ED–SW is operated by operating lever 80, position "RELEASE" of lever 80 operating switch ED–SW to contact 1 thereof and position "ENGAGE" operating switch ED–SW to its contact 2; switch FB closes when carriage assembly 20 is in its home position; and switch FF closes and switch OS opens when carriage assembly 20 is positioned at the front of housing 10 such that pins 31 of elements 30 are adjacent apertures 52 of cards 50 in a memory module, switch FF being employed during withdrawal of cards 50 and switch OS being employed during insertion of cards 50 into a module. The various switches are normally in the positions shown in FIG. 5 when the card handling apparatus is not in use, lever 80 being in the "RELEASE" position operating switch ED–SW to contact 1 thereof, switch FF being open and switch OS being closed, pushbutton switches IN–SW, OUT–SW and CO–SW being released to their back contacts 1 and carriage assembly 20 being in its home position closing switch FB.

Assume then, for example, that it is desired to withdraw a plurality of cards 50 from respective card locations, such as card locations 100 in FIGS. 2 and 3. Initially, housing 10 is supported and positioned adjacent card locations 100 by hanger pins 13 and guide elements 14 and is locked into position by operating locking levers 16. Operation of pushbutton switch IN–SW to its front contact 2 completes a path energizing motor 2DM to drive carriage assembly 20 forward on lead screws 21 toward the front of housing 10. This path may be traced from one terminal of source 115 through front contact 2 of switch IN–SW, the armature of motor 2DM, back contact 1 of switch CO–SW, back contact 1 of switch OUT–SW, and the field winding of motor 2DM to the other terminal of source 115. As carriage assembly 20 moves forward from its home position switch FB opens. Motor 2DM continues to drive carriage assembly 20 forward toward card locations 100 until card engaging pins 31 of elements 30 reach a position adjacent apertures 52 of the respective individual cards 50 in card locations 100, thereby closing switch FF. This is the position in which carriage assembly 20 is shown in dashed lines in FIG. 3.

Closure of switch FF completes a path shorting out the armature of motor 2DM, providing dynamic braking to bring forward movement of carriage assembly 20 quickly to a halt. The shorting connection across the armature of motor 2DM may be traced through closed switch FF, contact 1 of switch ED–SW, back contact 1 of switch OUT–SW and back contact 1 of switch CO–SW. Pushbutton switch IN–SW is then released to its back contact 1, breaking the operating path for motor 2DM. Lever 80 is moved to the "ENGAGE" position, thereby rotating card engaging elements 30 to the position shown in FIG. 4A. Card engaging pin 31 of each element 30 thus pivotally engages aperture 52 of a respective one of cards 50 in card locations 100. Switch ED–SW is operated to its contact 2 when lever 80 is moved to the "ENGAGE" position, removing the shorting connection from the armature of motor 2DM.

Engaged cards 50 are withdrawn from card locations 100 into housing 10 by operating pushbutton switch CO–SW to its front contact 2. This completes a path from the one terminal of source 115 through front contact 2 of switch CO–SW, the armature of motor 2DM, back contact 1 of switch IN–SW and the field winding of motor 2DM to the other terminal of source 115. Motor 2DM is energized in this path in the reverse direction to drive carriage assembly 20 toward its home position at the rear of housing 10. Cards 50 engaged by pins 31 of elements 30 are thus withdrawn into individual slots or card locations within housing 10. When carriage assembly 20 reaches its home position, closing switch FB, a shorting connection is completed across the armature of motor 2DM to bring assembly 20 to a halt in its home position. This shorting connection may be traced through switch FB and back contact 1 of switch IN–SW. Release of switch CO–SW to its back contact 1 removes source 115 from motor 2DM. Housing 10 may now be removed from card locations 100 and manually transported elsewhere, cards 50 being retained therein by card engaging elements 30 in the "ENGAGE" position.

For example, cards 50 may be transported in housing 10 to information recording apparatus for recording information thereon. In the above-identified Ault-Friedman-Granger-Madden patent, for example, a plurality of cards 50 disposed in a magazine such as housing 10 are individually withdrawn therefrom one at a time, information is recorded thereon, and they are reinserted into the magazine. For this purpose, when housing 10 is clamped in position on the information recording apparatus, operating lever 80 is moved to the "RELEASE" position to disengage elements 30 from cards 50 to permit them to be withdrawn individually from housing 10. Detent apparatus 110 is provided to releasably retain the individual cards 50 in position in housing 10 upon disengagement of elements 30 from cards 50. One of apertures 51 on each of cards 50 is engaged by detent apparatus 110. This minimizes possibility of accidentally dislodging cards 50 from their positions within housing 10, yet permits them to be individually withdrawn therefrom and reinserted by the information recording apparatus, or manually if desired.

Assume now that housing 10 containing a plurality of cards 50 engaged therein is positioned and locked adjacent card locations, such as card locations 100, into which cards 50 are to be inserted. Operating lever 80 is

in the "ENGAGE" position with switch ED–SW thus operated to contact **2**, and all other switches are initially in the respective positions shown in FIG. 5. Pushbutton switch IN–SW is operated to its front contact **2** to complete a previously-traced path energizing motor 2DM to drive carriage assembly **20** forward toward the front of housing **10**. Carriage assembly **20** moves forward, releasing switch FB, pins **31** of elements **30** pivotally engaging respective ones of cards **50** via apertures **52** to insert cards **50** into card locations **100**. The pivotal engagement of cards **50** during insertion into locations **100** accommodates random variations which may occur in the relative orientations of each of cards **50** in housing **10** and in card locations **100**.

Subsequent closure of switch FF has no effect on the operation of motor 2DM since switch ED–SW is operated to its contact **2**. Thus drive motor 2DM continues to drive carriage assembly **20** forward, pushing cards **50** against their respective individual positioning stops in card locations **100**, until the bias of spring **35** of at least one of card engaging elements **30** is overcome. Overload bar **70** is accordingly depressed to close switch OLS in the manner described above, thereby completing a shorting connection through back contacts **1** of switches OUT-SW and CO–SW across the armature of motor 2DM. Forward motion of carriage assembly **20** is stopped, and subsequent release of switch IN–SW to its back contact **1** removes power from motor 2DM.

In the position in which carriage assembly **20** is stopped upon insertion of cards **50** into card locations **100**, switch FF is closed and switch OS is released. Operation of pushbutton switch OUT–SW to its front contact **2** completes a path from one terminal of source **115** through back contact **1** of switch CO–SW, the armature of motor 2DM, back contact **1** of switch IN–SW, and the field winding of motor 2DM to the other terminal of source **115**. Motor 2DM is energized in the reverse direction to back carriage assembly **20** away from card locations **100**, thereby releasing the pressure exerted via springs **35** and pins **31** of elements **30** on inserted cards **50**. When carriage assembly **20** has been backed away from cards **50** to a position relative thereto such that pins **31** no longer exert insertion pressure on cards **50**, switch OS closes and switch FF releases. Closure of switch OS completes a shorting connection across the armature of motor 2DM, which may be traced through back contact **1** of switch CO–SW, switch OS, contact **2** of switch ED–SW, and back contact **1** of switch IN–SW. Movement of carriage assembly **20** is stopped in this position which, it will be recalled, is the position of assembly **20** during withdrawal operation when lever **80** is operated to engage cards **50**.

Operating lever **80** is now moved to the "RELEASE" position, rotating elements **30** to the position shown in FIG. 4B to disengage pins **31** from apertures **52** of cards **50**. Switch ED–SW is operated to its contact **1**, removing the shorting connection from the armature of motor 2DM. If switch OUT–SW was released to its back contact **1**, it is now re-operated to front contact **2** to complete the previously-traced reverse operating path for motor 2DM. Motor 2DM is energized and continues to drive carriage assembly **20** toward its home position. When carriage assembly **20** reaches its home position at the rear of housing **10**, switch FB is closed to short out the armature of motor 2DM and stop motion of assembly **20**. Release of switch OUT–SW to its back contact **1** restores the operating circuit to its initial condition shown in FIG. 5.

This manner of inserting cards **50** into card locations **100** advantageously utilizes the forces individually available to each element **30** via its spring **35**, along with the pivotal engagement of cards **50** by elements **30**, to individually position each of cards **50** in their respective correct positions in card locations **100**. There is no requirement that card locations **100** be precisely oriented relative to one another, nor that card locations **100** be precisely oriented relative to the card locations in housing **10**. Random linear and skew variations between these relative card orientations are thus accommodated advantageously by the present card handling apparatus during insertion of cards **50** into card locations **100** and, also, during withdrawal of cards **50** from locations **100**.

Further, each card engaging element **30** is individually sensitive to unusual or excessive resistance to movement during insertion of a respective card **50** engaged thereby. Such unusual resistance to movement may occur, for example, in the case of a damaged card or a damaged card location. If, during the forward movement of carriage assembly **20** sufficient resistance is met by an engaged card **50** to overcome the bias of spring **35** of element **30** engaging that card, spring **35** is compressed by element **30** and pin **33** impinges upon overload bar **70**. Bar **70** is moved toward assembly **20**, this movement being transmitted via arm **72** to close switch OLS. Closure of switch OLS completes a shorting connection across the armature of motor 2DM to stop forward movement of carriage assembly **20**. Portion **38** of the particular card engaging element **30** protrudes from assembly **20** to identify the element **30**, and thus the card **50** engaged thereby, encountering trouble.

It is understood that the above-described arrangements are merely illustrative of the application of the principles of the invention. Numerous other arrangements may be devised by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. Apparatus for handling a plurality of cards for transferring said cards concurrently between first card locations and second card locations in random orientations with said first card locations, comprising individual card engaging means for pivotally engaging each of said cards independently of one another, said individual card engaging means being movable between said first and second card locations, driving means for concurrently moving said individual engaging means between said first and second card locations, means including said individual card engaging means for detecting predetermined resistance to movement of individual ones of cards between said first card locations and said second card locations, and means responsive to said detecting means for braking said driving means.

2. Card handling apparatus in accordance with claim **1** further comprising means including said individual card engaging means responsive to said predetermined resistance to movement of individual ones of said cards for identifying said individual cards.

3. Apparatus for handling a plurality of cards for transferring said cards concurrently between first card locations and second card locations comprising a movable housing including said first card locations, means for positioning said housing adjacent said second card locations, a plurality of card engaging elements disposed in said housing for movement between said first card locations and said second card locations, driving means coupled to said plurality of card engaging elements, first means for energizing said driving means to drive said elements toward said second card locations, means operable for braking said driving means, means for normally operating said braking means when said card engaging elements are positioned for engaging cards at said second card locations, means for operating said card engaging elements to individually engage respective ones of said cards at said second card locations, second means for energizing said driving means in a reverse direction to transfer said engaged cards from said second card locations to said first card locations, means including said first means for energizing said driving means to transfer said engaged cards from said first card locations to said second card locations, means including said individual card engaging means for detecting predetermined resistance to movement of individual ones of said engaged cards between said first card locations and said second card location, and

means responsive to said detecting means for operating said braking means.

4. Card handling apparatus in accordance with claim 3 wherein said second card locations include respective individual card positioning stops, the combination further comprising means operable during the transfer of engaged cards from said first card locations to said second card locations for preventing the operation of said means for normally operating said braking means, said means responsive to said detecting means operating said braking means when said engaged cards are positioned in said second card locations.

5. Card handling apparatus in accordance with claim 4 further comprising third means for energizing said driving means in a reverse direction, means for operating said braking means when said card engaging elements are positioned for engaging cards at said second card locations, means for operating said card engaging elements to disengage said engaged cards, and means including said third means responsive to the disengagement of said cards for returning said card engaging elements to a starting position.

6. Apparatus for handling a plurality of cards for transferring said cards between first card locations and second card locations comprising a plurality of card engaging elements each rotatably disposed in a movable carriage assembly, means operable at said first and second card locations for rotating each of said card engaging elements to a first position to engage respective ones of said cards and for rotating said card engaging elements to a second position to disengage said cards, driving means coupled to said carriage assembly, first means for energizing said driving means to drive said carriage assembly from said first card locations to said second card locations, second means for energizing said driving means to drive said carriage assembly from said second card locations to said first card locations, means operable for braking said driving means, means for operating said braking means when said carriage assembly is in predetermined positions at said first and second card locations, and means operative when said first energizing means is operated and responsive to a predetermined resistance to movement of said carriage assembly for operating said braking means.

7. Card handling apparatus in accordance with claim 6 wherein said last-mentioned means comprises means for individually biasing each of said card engaging elements in a predetermined position relative to said carriage assembly.

8. Card handling apparatus in accordance with claim 6 further comprising detent means for releasably retaining each of said cards in said first card locations when said card engaging elements are rotated to said second position.

9. Apparatus for handling a plurality of cards, each card having an engagement aperture therein, for transferring said cards concurrently between first card locations and second card locations randomly oriented with said first card locations, comprising a plurality of card engaging elements operable to pivotally engage respective ones of said plurality of cards, each of said card engaging elements having an engagement pin radially disposed thereon, driving means for moving said card engaging elements between said first and said second card locations, and means for operating said card engaging elements at said first and said second card locations, said operating means including means for rotating each of said card engaging elements such that said pin thereon engages said aperture of a respective one of said cards.

10. Card handling apparatus in accordance with claim 9 wherein said rotating means comprises a rotatable shaft extending between first and second card locations, means for rotating said shaft, means coupling said shaft to each of said card engaging elements such that rotation of said shaft effects corresponding rotation of said elements, and means for slidably mounting said coupling means on said shaft for movement between said first and second card locations.

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