

MULTIPLE PASS SHUFFLER/SORTER AND METHOD OF OPERATION THEREOF

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to US Provisional Patent Application Serial Number 63/619,876 filed on January 11, 2024 (AGS_TABLE-P0003P); US Provisional Patent Application Serial Number 63/698,448 filed on September 24, 2024 (AGS_TABLE-P0004P); US Provisional Patent Application Serial Number 63/698,939 filed on September 25, 2024 (AGS_TABLE-P0005P), the entire disclosures of which are hereby incorporated by reference and relied upon.

Field of the Invention.

[0002] The present invention relates generally to methods and devices for shuffling cards, and more particularly, multiple pass methods and devices.

Background of the Invention

[0003] Numerous mechanical and electro-mechanical devices have been designed for use in shuffling cards, such as one or more decks of playing cards. Generally, such devices may be referred to as a card shuffler or shuffler. Such devices may be used in the randomization (shuffling) of a deck of playing cards. The resultant deck, having undergone the necessary gyrations, will be sufficiently randomized for reliable statistical outcomes in subsequent gameplay. Upon fully utilizing the deck, or according to the rules of the game, the deck is again shuffled to prepare for each round. Alternatively, or in addition, such devices may be used in the ordering of the cards in the deck of cards in a predetermined order (which may be random).

[0004] Typically, shufflers are suitable for either single or multi-deck use. Those shufflers optimized for single deck games are rarely capable of accommodating additional decks. Whilst those shufflers optimized for a plurality of decks (a shoe) typically lack game specific characteristics and simply randomize the shoe sufficiently for any randomized game scenario.

[0005] In a modern digital device, randomness is typically the function of a Random Number Generator or RNG which provides reliable pseudorandom values used to determine how the cards should be shuffled. Typically, each incoming card is mapped to a slot. Each card will be sent to a predetermined slot to ensure that the final sequence of cards is consistent with that requested by the RNG.

[0006] As the number of decks increases, the required mechanisms internal to the shuffler become necessarily more complex and larger. As size increases, so also do mass and momentum of the internal moving parts. As one approaches 8 decks of cards (a typical scenario

in blackjack), the scale and forces involved become significant factors in overall product design.

[0007] The present invention is aimed to one or more of the problems identified above.

BRIEF SUMMARY OF THE INVENTION

Multi-Pass Shufflers

[0008] In example, a scenario where 8 decks (416 cards) are to be randomized (shuffled). All of the cards to be shuffled are loaded into the machine in the first step. The cards are drawn inside the shuffler, where they are processed and ultimately ejected once finally randomized. The cards in this scenario can be envisioned arrayed in several ways. One possible arrangement is a single stack of 416 cards. This arrangement is a straightforward approach and precisely what leads to the scaling issues described above. However, the arrangement of cards can also be viewed as a matrix (multi-dimensional array of numbers) rather than a single column of numbers.

[0009] If one envisions using a plurality of stacks for the cards, the height of each stack decreases rapidly as the number of stacks grows. Two stacks, 208 cards high, four stacks, 104 cards high, etc. An optimal value can be determined for a given number of cards and passes.

[0010] In the case of 8 decks in 2 passes, this optimal value is 21. Basically, a size which, when squared, is equal to or greater than the number of cards to be shuffled. Simply take the n th root of the number of cards, where n is the number of passes, and round up to the nearest whole number if the n th root is not an integer.

[0011] This value represents both the required X dimension (# columns) and the Y dimension (# rows) in the square array. This maximum dimension is used to determine the number of slots or shelves which will be required to properly sequence the cards.

[0012] So, in our example, the physical shuttle would have at least 21 shelves for cards with each shelf being capable of holding at least 21 cards each.

[0013] To begin the shuffle, the RNG delivers the desired card sequence as a series of numbers. This numeric series is placed into an array sized as determined previously (e.g., 21 columns across x 21 rows tall).

Multi-Pass Shuffling

[0014] The number of passes required to fully sequence a plurality of cards is determined by the number of dimensions associated with the matrix used. In our example, we are using a 2-

dimensional array (columns & rows), thus we will require two passes to fully sequence the cards.

[0015] For reference, this is why shufflers to date are single pass, as they generally all use single dimension arrays. In some cases, the internal card shuttles provide a mechanism for sequencing inserted cards, thereby reducing the number of slots required, but the process utilized is still a single dimensional sort.

[0016] "Multiple passes" means that every card is processed multiple times before the sequencing is completed. Internally, having processed each card once, the stack of processed cards is repositioned back to the infeed to be processed again for any additional passes. Alternatively, if no further passes are required, the cards are ejected having been sequenced as in accordance with the RNG.

[0017] The advantage of a multi-pass approach is smaller scale of design, requiring fewer slots or shelves and experiencing less mass-based kinetic challenge. The disadvantage is equally obvious, each card must be processed more than once. A process which may take 2 seconds per card, may require at least 4 seconds per card in a two-pass scenario.

[0018] Thus, a balance between scale and number of passes is sought. This balance is typically determined using the comparison of concept models, seeking the smallest size whilst achieving the quickest processing time.

[0019] The process for each pass first is straight forward: identify each card (either by sequence or markings), and then direct it toward an appropriate slot or shelf. Continue until all cards are shelved, then if required perform additional passes.

Matrix Transformation

[0020] The overall process of repositioning each card, resulting in a target arrangement, can be viewed as a transformation from one matrix sequence to another.

[0021] The cards being fed into the shuffler are in no particular order. Previous game outcomes and shuffles play a role in the incoming sequence of cards. Just as the RNG sequence was reformatted into a matrix, so also the infeed sequence. The operations undertaken are then to take the infeed matrix arrangement and reorganize the cards so as to result in the desired RNG outfeed sequence.

[0022] This transformation can take place using a sorting process in each pass, where the first pass organizes the cards into the desired columns (1st dimension) and the second pass organizes the cards into the target rows (2nd dimension), resulting in the final target matrix arrangement.

[0023] In one aspect of the present invention, a shuffling device including a frame, a first card receiving area, a shuffling mechanism, a card reader, and a controller is provided. The first card receiving area receives a set of cards. The shuffling mechanism is coupled to the frame and is associated with the first card receiving area. The shuffling mechanism is configured to receive cards from the cards receiving area and to controllably place the cards into respective card receiving pockets. The card reader is coupled to the frame and is associated with the shuffling mechanism, the card reader configured to read card information from the cards as the cards pass through the shuffling mechanism. The controller is connected to the card reader and the shuffling mechanism. The controller configured to perform the steps of establishing a virtual deck structure and performing first and second passes. The virtual deck structure defines a virtual card assignment for a plurality of cards. The virtual deck structure is a matrix having a plurality of cells organized in a predetermined number of rows and a predetermined number of columns. Each card of the plurality of cards is associated with one of plurality of cells within the matrix. The number of card receiving card receiving pockets being equal to or greater than the predetermined number of rows and columns in the matrix. The first pass includes the steps of using the shuffling mechanism, feeding cards one at a time from the set of cards in the first card receiving area of the shuffling device into the shuffling mechanism, using the card reader, reading card information from each of the cards fed from the first card receiving area, generating information regarding a first assigned card receiving pocket for each of the cards fed from the first card receiving area based on the associated card information and the virtual deck structure, and using the shuffling mechanism, delivering the cards, into the associated first assigned card receiving pockets forming a partially shuffled set of cards. The second pass includes the steps of performing using the shuffling mechanism, placing the partially shuffled set of cards into the first card receiving area of the shuffling device, using the shuffling mechanism, feeding cards one at a time from the partially shuffled set of cards in the first card receiving area into the shuffling device, using the card reader, establishing card information for each of the cards fed from the first card receiving area, generating information regarding a second assigned card receiving pocket for each of the cards fed from the first card receiving area based on the associated card information, and using the shuffling mechanism, delivering the cards, into the associated second assigned card receiving pockets forming a shuffled set of cards.

[0024] In a second aspect of the present invention, a shuffling device including a frame, a first card receiving area, a shuffling mechanism, a card reader, a controller, an infeed elevator,

a transport mechanism, a pusher mechanism, and a card stack moving mechanism is provided is provided. The first card receiving area receives a set of cards. The card receiver is movably coupled to the frame and has a plurality of card receiving pockets. The shuffling mechanism is coupled to the frame and is associated with the first card receiving area. The shuffling mechanism is configured to receive cards from the cards receiving area and to controllably place the cards into respective card receiving pockets. The card reader is coupled to the frame and is associated with the shuffling mechanism. The card reader is configured to read card information from the cards as the cards pass through the shuffling mechanism. The controller is connected to the card reader and the shuffling mechanism and configured to perform first and second passes on the set of cards.

[0025] The infeed elevator defines the first card receiving area and is connected to the controller. The controller is configured to controllably raise and lower the infeed elevator relative to a top of the shuffling device. The transport mechanism controllably moves cards from the first card receiving area into the shuffling mechanism. The transport mechanism includes a first set of rollers and a second set of rollers. The first set of rollers are configured to transport cards from the first card receiving area to an intermediate position. The card reader is positioned adjacent the intermediate position. The second set of rollers are configured to transport cards from the intermediate position into the card receiver. The first and second set of rollers are controllably driven by respective motors controlled by the controller. The first set of rollers are driven at a first speed and the second set of rollers are driven at a second speed. The second speed is greater than the first speed. The pusher mechanism configured to push cards from each of the pockets of the card receiver into a second card receiving area at the end of the first pass. The card stack moving mechanism is configured to move the cards in the second card receiving area to the first card receiving area after the pusher mechanism pushes the cards from the card receiver into the second card receiving area.

[0026] The controller configured to perform the steps of establishing a virtual deck structure and performing first and second passes. The virtual deck structure defines a virtual card assignment for a plurality of cards. The virtual deck structure is a matrix having a plurality of cells organized in a predetermined number of rows and a predetermined number of columns. Each card of the plurality of cards is associated with one of plurality of cells within the matrix. The number of card receiving pockets being equal to or greater than the predetermined number of rows and columns in the matrix. The first pass includes the steps of using the shuffling mechanism, feeding cards one at a time from the set of cards in the first card receiving area of

the shuffling device into the shuffling mechanism, using the card reader, reading card information from each of the cards fed from the first card receiving area, generating information regarding a first assigned card receiving pocket for each of the cards fed from the first card receiving area based on the associated card information and the virtual deck structure, and using the shuffling mechanism, delivering the cards, into the associated first assigned card receiving pockets forming a partially shuffled set of cards. The second pass includes the steps of performing using the shuffling mechanism, placing the partially shuffled set of cards into the first card receiving area of the shuffling device, using the shuffling mechanism, feeding cards one at a time from the partially shuffled set of cards in the first card receiving area into the shuffling device, using the card reader, establishing card information for each of the cards fed from the first card receiving area, generating information regarding a second assigned card receiving pocket for each of the cards fed from the first card receiving area based on the associated card information, and using the shuffling mechanism, delivering the cards, into the associated second assigned card receiving pockets forming a shuffled set of cards.

[0027] In a third aspect of the present invention, a method of shuffling cards using a shuffling device is provided. The shuffling device includes a card receiving area, a shuffling mechanism, and a card receiver having a plurality of card receiving pockets. The method includes the steps of establishing a virtual deck structure. The virtual deck structure defines a virtual card assignment for a plurality of cards. The virtual deck structure is a matrix having a plurality of cells organized in a predetermined number of rows and a predetermined number of columns. Each card of the plurality of cards being associated with one of plurality of cells within the matrix. The number of card receiving card receiving pockets being equal to or greater than the predetermined number of rows and columns in the matrix. The method includes a first pass and a second passes. The first pass includes the steps of placing a set of cards into the card receiving area of the shuffling device. feeding cards one at a time from the card receiving area of the shuffling device into the shuffling mechanism, reading card information from each of the cards fed from the card receiving area, generating information regarding a first assigned card receiving pocket for each of the cards fed from the card receiving area based on the associated card information and the virtual deck structure, and delivering the cards, using the shuffling device, into the associated first assigned card receiving pockets forming a partially shuffled set of cards. The second pass includes the steps of placing the partially shuffled set of cards into the card receiving area of the shuffling device, feeding cards one at a time from partially

shuffled set of cards in the card receiving area of the shuffling device, reading card information from each of the cards fed from the card receiving area;
generating information regarding a second assigned card receiving pocket for each of the cards fed from the card receiving area based on the associated card information, and delivering the cards, using the shuffling device, into the associated second assigned card receiving pockets forming a shuffled set of cards.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0028] These and other features and advantages of the present invention will become more readily appreciated when considered in connection with the following detailed description and appended drawings.

[0029] FIG. 1A is a block diagram of a multi-pass shuffler according to an embodiment of the present invention.

[0030] FIG. 1B is a first flow diagram associated with the multi-pass shuffler of FIG. 1A.

[0031] FIG. 1C is a second flow diagram associated with the multi-pass shuffler of FIG. 1A.

[0032] FIG. 1D is a third flow diagram associated with the multi-pass shuffler of FIG. 1A.

[0033] FIG. 1E is an exemplary virtual deck structure in the form of a two-dimensional matrix according to an embodiment of the present invention.

[0034] FIG. 2A is a front perspective view of a shuffler in accordance with examples of the subject disclosure.

[0035] FIG. 2B is a rear perspective view of the shuffler illustrated in FIG. 2A.

[0036] FIG. 3 is a front plan view of the shuffler illustrated in FIG. 2A.

[0037] FIG. 4 is a top plan view of the shuffler illustrated in FIG. 2A, with portions of a top cover thereof removed.

[0038] FIG. 5 is a first plan side view of the shuffler illustrated in FIG. 2A.

[0039] FIG. 6 is a rear plan view of the shuffler illustrated in FIG. 2A.

[0040] FIG. 7 is a perspective rear view of the shuffler illustrated in FIG. 2A.

[0041] FIG. 8A longitudinal cross-sectional side view of the shuffler illustrated in FIG. 4 taken in the direction of line 8A/8A therein and with portions of a housing thereof not illustrated.

[0042] FIG. 8B is an enlarged view of the indicated portion of FIG. 8A.

[0043] FIG. 8C illustrates the portion of FIG. 8A as viewed from the perspective indicated in FIG. 8A.

[0044] FIG. 9 is a transverse cross-sectional view of the shuffler illustrated in FIG. 4 taken in the direction of line 9/9 therein.

[0045] FIG. 10 is a second longitudinal cross-sectional side view of the shuffler illustrated in FIG. 4 taken in the direction of line 10/10 therein and with portions of a housing thereof not illustrated.

[0046] FIG. 11A is a longitudinal cross-sectional side view of the shuffler illustrated in FIG. 4 taken in the direction of line 11A/11A therein and with portions of a housing thereof not illustrated.

[0047] FIG. 11B is an enlarged view of the indicated portion of FIG. 11A.

[0048] FIG. 11C is an enlarged view of the indicated portion of FIG. 11A.

[0049] FIG. 11D is a cross-sectional view of the indicated portion of FIG. 11C.

[0050] FIG. 12 is a view of the shuffler illustrated in FIG. 2B shown with portions of a housing removed.

[0051] FIG. 13 is a longitudinal perspective cross-sectional view of the shuffler illustrated in FIG. 1 taken in the direction of line 13/13 therein;

[0052] FIG. 14 is a cross-sectional view of the shuffler illustrated in FIG. 2A taken in the direction of line 14-14 therein.

[0053] FIG. 15 is a schematic diagram of a controller and associated components of the shuffler illustrated in FIG. 2A.

[0054] FIG. 16 is a flow diagram of a method of operation of the shuffler illustrated in FIG. 2A.

[0055] FIG. 17 illustrates aspects of a method of operation of the shuffler illustrated in FIG. 2A including creation of data sets by different controllers thereof.

[0056] FIG. 18A is graphic representation of a multi-pass card shuffler or shuffler device, including an infeed elevator, according to a second embodiment of the present invention.

[0057] FIG. 18B is a first perspective view of the multi-pass card shuffler of FIG. 18A.

[0058] FIG. 18C is a second perspective view of the multi-pass card shuffler of FIG. 18A.

[0059] FIG. 18D is a perspective view of a portion of a multi-pass card shuffler or shuffler device, including an infeed elevator, according to a second embodiment of the present invention.

[0060] FIG. 19 is a first interior view of the multi-pass card shuffler of FIG. 18A.

[0061] FIG. 20A is a first partial interior view of the multi-pass card shuffler of FIG. 18A illustrating a shuffling mechanism having a set of infeed rollers and a shuttle, according to an embodiment of the present invention.

[0062] FIG. 20B is a second partial interior view of the multi-pass card shuffler of FIG. 18A.

[0063] FIG. 21 is a second partial interior view of the multi-pass card shuffler of FIG. 18A illustrating a card ejector mechanism.

[0064] FIG. 22 is a third partial interior view of the multi-pass card shuffler of FIG. 18A illustrating a card stack moving mechanism.

[0065] FIG. 23A is a fourth partial interior view of the multi-pass car shuffler including the card stack moving mechanism of FIG. 22. card shuffler of FIG. 18A.

[0066] FIG. 23B is a fifth partial interior view of the multi-pass car shuffler including the card stack moving mechanism of FIG. 22. card shuffler of FIG. 18A.

[0067] FIG. 24 is a sixth partial interior view of the multi-pass card shuffler of FIG. 18A.

[0068] FIG. 25 is a seventh partial interior view of the multi-pass card shuffler of FIG. 18A.

[0069] FIG. 26 is a second interior view of the multi-pass card shuffler of FIG. 18A including an outfeed elevator.

[0070] FIG. 27 is a second perspective of the multi-pass card shuffler of FIG. 18A illustrating the outfeed elevator of FIG. 26 in a raised position.

[0071] FIG. 28A is a front view of a card receiver or shuttle of the multi-pass card shuffler of FIG. 18, according to an embodiment of the present invention.

[0072] FIG. 28B is a perspective view of the card receiver of FIG. 28A.

[0073] FIG. 29A is a first side view of the multi-pass card shuffler of FIG. 18, including the shuttle and card ejector mechanism.

[0074] FIG. 29B is a second view of the multi-pass card shuffler of FIG. 18, including the shuttle and card ejector mechanism.

[0075] FIG. 30A is first perspective view of the card stacking moving mechanism of FIG. 22.

[0076] FIG. 30B is a second perspective view of the card stacking moving mechanism of FIG. 22.

[0077] FIG. 31A is a first opposite side view of the multi-pass card shuffler of FIG. 18, including the shuttle and card ejector mechanism.

[0078] FIG. 31B is a second opposite side view of the multi-pass card shuffler of FIG. 18, including the shuttle and card ejector mechanism.

[0079] FIG. 32A is a first perspective view of the multi-pass card shuffler of FIG. 18 illustrating the infeed and outfeed elevators.

[0080] FIG. 32B is a second perspective view of the multi-pass card shuffler of FIG. 18 illustrating the infeed and outfeed elevators.

[0081] FIG. 33A is a first side view of the shuttle and the card ejector mechanism.

[0082] FIG. 33B is a second side view of the shuttle and the card ejector mechanism.

[0083] FIGS. 34A-34H are diagrammatic illustrations associated with an exemplary shuffling or sorting operation, according to an embodiment of the present invention.

[0084] FIGS. 35A-35B and 36 are perspective views of a card stack pusher mechanism, according to an embodiment of the present invention.

[0085] FIGS. 37A is a side view of a card shuttle lifting mechanism with a counterweight in a first position, according to an embodiment of the present invention.

[0086] FIG. 37B is a second side view of the card shuttle lifting mechanism of FIG. 35A with the counterweight in a second position.

[0087] FIG. 37C is a third side view of the card shuttle lifting mechanism of FIG. 35A with the counterweight in a third position.

[0088] FIG. 37D is an enlarged perspective view of the counterweight of FIG. 35A.

[0089] FIG. 37E is a second enlarged perspective view of the counterweight of FIG. 35A.

DETAILED DESCRIPTION OF THE INVENTION

[0090] With reference to the drawings, and in operation, devices **10** and methods for shuffling cards, such as multiple decks of standard playing cards, are provided. In particular, the present invention relates to devices **10** and methods for shuffling a set of playing cards into a desired order. Generally, the desired order is randomly determined prior to the shuffling operation. However, it should be noted that the desired order may be any desired order, e.g., not necessarily randomly determined.

[0091] As discussed below, the desired order may be randomly determined using a random number generator (RNG). The present invention may be configured, for example, to shuffle eight decks of a playing cards. Each deck of cards may or typically include 52 cards consisting of an Ace card, cards 2-10, and three face cards (Jack, Queen, and King) each in four suits (hearts, diamonds, spades and clubs). This results in a total of 416 cards. The desired order places each card from the set of 416 cards in an order from 1 to 416 defining a set of shuffled cards.

[0092] As discussed in more detail below, the device **10** and methods of the present invention provides a two-pass shuffling operation to place a set of cards consisting of 8 decks of cards in which the cards are in any order into the desired order. To facilitate the two-pass shuffling operation, the desired order is converted into a two-dimension matrix having a predetermined number of rows and columns.

[0093] In the illustrated embodiment, the predetermined number of rows is equal to the predetermined number of columns. The predetermined number of rows and columns may be calculated by taking the square root of the total number of cards (416) and rounding up to the next whole number. The square root of 416 is ~20.40, so in the illustrated the matrix has 21 rows and columns.

[0094] An exemplary matrix **9** is shown in FIG. 1E. The exemplary matrix **9** includes 441 cells arranged in 21 rows and 21 columns. Each of the cards in the desired order is assigned to a respective cell in the matrix. In FIG. 1E, each card is presented by a two-character code. The first character represents the value of the card, and the second character represents the suit of the card (h=hearts, d=diamonds, s=spades and c=clubs). The matrix **9** represents the desired order when stacked together.

[0095] For example, in the illustrated embodiment, each row represents a sub-stack of cards with the card in the first column on top of the sub-stack and the card in the twenty-first column on the bottom of the sub-stack. When the sub-stacks are stacked together with the sub-stack represented by the first row on top of the sub-stack represented by the second row, and so forth, the sub-stacks represent the set of cards in the desired order.

[0096] With reference to FIG. 1A, the device, or shuffling device, **10** includes a card receiving area **4**, a card reader **5**, a shuffling mechanism **6**, a card receiver or shuttle **8**, and a controller **7**. The card receiving area **4** is configured to receive an unshuffled set of physical playing cards. The card receiver **8** includes a plurality of card receiving pockets **8A**. In the illustrated embodiment, the number of card receiving pockets **8A** is equal to or greater than the number of rows or columns in the matrix **9**.

[0097] The shuffling mechanism **6** is associated with the card receiving area **4** for receiving physical cards from the cards receiving area **4** and controllably placing the cards into respective card receiving pockets **8A** of the card receiver **8**. The card reader **5** is associated with the shuffling mechanism **6** for reading card information from the cards as the cards pass through the shuffling mechanism **6**. In one embodiment, the card reader **5** may be a camera. The controller **7** is connected to the card reader **5** and the shuffling mechanism **6**.

[0098] With reference to FIGS. 1B, 1C and 1D, in one embodiment, the controller **7** implements and is configured to perform a method **M10** for shuffling the cards received in the card receiving area **4** by placing the cards into the desired order defined by the matrix **9**. With specific reference to FIG. 1B, in a first step **S10A**, a virtual deck structure is established. In the illustrated embodiment, the virtual deck structure is defined by the matrix **9**. As discussed above, the matrix **9** defines or provides a virtual card assignment for a plurality of cards. In the illustrated embodiment, the plurality of cards includes the cards in a predetermined number, for example, 8, of decks of cards. The matrix **9** has a plurality of cells organized in a predetermined number of rows and a predetermined number of columns. Each card of the plurality of cards is associated with one of plurality of cells within the matrix **9**. The step of establishing the virtual deck structure may include randomly assigned a virtual card to each cell matrix **9**. Alternatively, step of establishing the virtual deck structure may include the step of reading a pre-established or predetermined virtual deck structure from a set of stored virtual deck structures.

[0099] In a second step **S10B**, a first pass or first shuffling pass operation is performed on the set of cards received in the card receiving area **4** to form a partially shuffled set of cards (see below). In a third step **S10C**, a second pass or first shuffling pass operation is performed on the set of partially shuffled set of cards to form a shuffled set of cards.

[0100] With reference to FIG. 1C, a method **M20** associated with the first pass or first shuffling pass operation according to an embodiment of the present invention. In a first step **S20A**, a set of physical playing cards are received into the card receiving area **4**. In one embodiment, the set of physical playing cards may be placed into the card receiving area **4** by a user. In a second step **S20B**, the cards are fed, for example, one by one, from the card receiving area **4** into the card shuffling mechanism **6**. In a third step **S20C**, as the cards are transported by, and within, the card shuffling mechanism, the card reader **5** is used to capture card information from each card. For example, the card reader **5** may be a camera that captures an image of each card which is then used by the controller **7** to identify the card. In another example, card reader **5** may be a radio frequency identification (RFID) reader configured to read RFID tags within playing cards. In a further example, card reader **5** may be a bard code reader configured to read specialized bar codes displayed on plying cards.

[0101] In a fourth step **S20D**, the card information from the card reader **5** and the matrix **9** (or virtual deck structure) is used to generate information regarding a first assigned card receiving pocket **8A** for each of the cards fed from the card receiving area **4**.

[0102] In the illustrated embodiment, each pocket **8A** of the card receiver **8** is able to hold or accommodate at least the number of cards in each row or column of the matrix **9**, for example 21 cards. In the first pass, once each card is identified, the column of the matrix **9** in which the identified card belongs is established. In the illustrated embodiment, the cards in each column represent the *i*/*h* card in each sub-stack which corresponds to the position of each card in the associated sub-stack. In other words, during the first pass the set of cards are organized or shuffled such that each card is placed in a pocket **8A** corresponding to the associated column in the matrix **9** which corresponds to the position of each card in the associated sub-stack. Thus, at the end of the first pass, each card is in the pocket **8A** corresponding the associated column in the matrix **9** which corresponds to the position in the sub-stack. It should be noted after the first pass, the order of the cards in each pocket **8A** does not necessarily correspond to the associated row in the matrix **9**.

[0103] Returning to FIG. 1C in a fifth step **S20E**, the cards are delivered, via the shuffling mechanism **6**, into the associated first assigned card receiving pockets forming a partially shuffled set of cards.

[0104] In the illustrated embodiment, each pocket **8A** of the card receiver **8** is able to hold or accommodate at least the number of cards in each row or column of the matrix **9**, for example 21 cards. In the first pass, once each card is identified, the column of the matrix **9** in which the identified card belongs is established. In the illustrated embodiment, the cards in each column represent the *i*/*h* card in each sub-stack which corresponds to the position of each card in the associated sub-stack. In other words, during the first pass the set of cards are organized or shuffled such that each card is placed in a pocket **8A** corresponding to the associated column in the matrix **9** which corresponds to the position of each card in the associated sub-stack. Thus, at the end of the first pass, each card is in the pocket **8A** corresponding the associated column in the matrix **9** which corresponds to the position in the sub-stack. It should be noted after the first pass, the order of the cards in each pocket **8A** does not necessarily correspond to the associated row in the matrix **9**.

[0105] When the partially shuffled cards are removed from the card receiver **8** and received back into the card receiving area, the cards in each pocket **8A** (or sub-stack) are placed on top of each other. In the illustrated embodiment, the cards in the twenty-first pocket **8A** are at the bottom of the partially shuffled set of cards and the cards in the first pocket **8A** are at the top of the partially shuffled set of cards.

[0106] With reference to FIG. 1D, a method **M30** associated with the second pass or

second shuffling pass operation according to an embodiment of the present invention is shown. In a first step **S30A**, the partially shuffled set of cards are received into the card receiving area **4** of the shuffling device **10**. As discussed above, in one embodiment a user may remove the partially shuffled set of cards from the shuffling mechanism **6** and place the card back into the card receiving area **4**. Alternatively, the shuffling mechanism **6** may be configured to automatically place the partially shuffled set of cards back into the card receiving area **4**.

[0107] In a second step **S30B**, the cards are fed back, one at a time, into the shuffling mechanism **6** from the card receive area. In a third step **S30C**, the card information, e.g., value and suit, are established for each of the cards fed from the card receiving area **4**. In one embodiment, the card information may be established using the card reader **5**. Alternatively, the card information and position in the set of partially shuffled cards after the first pass may be stored in memory associated with or otherwise in communication with controller **7**.

[0108] In a fourth step **S30D**, information regarding a second assigned card receiving pocket for each of the cards fed from the card receiving area based on the associated card information and the matrix **9** is established. After the first pass, the card information for each of the cards in each pocket may be stored in memory. Alternatively, the card information for each of the cards may be read again by the card reader **5** as the card passes through the shuffling mechanism **6**.

[0109] In a fifth step **S30E**, the cards are delivered, using the shuffling mechanism, into the associated second assigned card receiving pockets forming a shuffled set of cards. As mentioned above, in the partially shuffled set of card, each sub-stack of cards (from the first pass) consists of cards in the same (*ith*) position in the desired order. In the second pass, the cards may then be delivered into the correct pocket **8A** based on the matrix **9**. In other words, in the partially shuffled set of cards, the twenty-first cards at the bottom all belong in the twenty-first position of each sub-stack in the desired order. As these cards are fed into the shuffling mechanism **6**, the cards are identified and delivered into the (now-empty) pockets **8A** of the card receiver **8**. After the first twenty-one cards are sorted, the next twenty-one cards are sorted and delivered. These cards are the twentieth cards in the sub-stacks of the desired order and are delivered into the correct pocket **8A** on top of the twenty-first card. Once all cards from the set of partially shuffled cards in the card receiving area **4** have been identified and sorted into the correct pocket **8A**, the set of shuffled cards may be assembled by removing the cards from the pockets **8A** and stacked on top of each other.

[0110] It should be noted that the steps in the methods FIGS. 1B-1D may be performed in any order. Further, as stated above, the present invention may be used to shuffle a set of playing cards into a desired order which may be random or predetermined. For instance, the desired order may form sets of predetermined hands of cards for use in a specific game of cards.

First Embodiment of a Shuffler

[0111] One example of a card shuffler of the disclosure will be described first with reference to FIGS. 2A-15. Generally, the card shuffler **20** is designed to sort or shuffle a single deck of cards into a predetermined order (which may be a predetermined random order). However, the card shuffler **20** may be adapted to, and operated, in a manner to shuffle into a predetermined order (which may be random) using two passes (see above).

[0112] As illustrated, the shuffler **20** may comprise a housing **22** which contains, supports or otherwise defines one or more features of the shuffler **20**. As illustrated, the housing **22** generally has an upper portion **24** and a lower portion **26**. As further illustrated, the shuffler **20** has a front or first end **28**, a rear or second end **30**, a first side **32**, a second side **34**, a top **36** which is defined by the upper portion **24** of the housing **22** and a bottom **38** which is defined by the lower portion **26** of the housing **22**. In the illustrated example, the housing **22** has a length along a line extending through the front or first end **28** and the rear or second end **30**, and width along a line extending through the first and second sides **32,34**, wherein the length is greater than the width.

[0113] In certain examples, the lower portion **26** of the housing **22** comprises a generally closed space or enclosure for various components of the shuffler **20**. The lower portion **26** may, as illustrated in FIG. 7, have a base portion that generally defines the bottom **38** of the shuffler **20**, and then an upwardly extending wall that defines a portion of each side **32,34** and the front **28** and rear **30** of the shuffler **20**. The upper portion **24** is positioned above the lower portion **26** of the housing **22**. In certain examples, as better illustrated in FIGS. 1 and 2, the upper portion **24** defines a card receiving and dispensing area **40** and a raised containment area or console **42** which also defines or supports a control panel **44**.

[0114] As illustrated in FIG. 7, the bottom **38** of the shuffler **20** may be generally planar. In certain examples, one or more feet **46** may extend downwardly therefrom, such as to support the shuffler **20** when it rests on a surface.

[0115] Referring to FIG 6, In certain examples, the rear **30** of the shuffler **20** may be defined in part by the wall of the lower portion **26** of the housing **22**. As illustrated, one or

more intake vents **48** may be located at the rear **30** of the shuffler **20**. An electrically powered and motor driven fan **50** may be used to draw air through the intake vent **48** into the interior of the shuffler **20**.

[0116] Referring to FIGS. 3 and 7, one or more air exhaust vents **52** may be provided, such as by being located at the front **28** of the shuffler **20**, such as in the lower portion **26** of the housing **22**. Air that is drawn into the interior of the shuffler **20** (via the intake vent **48**) may be exhausted via these exhaust vents **52**. In certain examples, one or more interfaces are provided, such as located at the front **28** of the shuffler **20**. As illustrated, these interfaces may comprise a power cable port **54** (such as defining a male power coupler for receiving the female end of a power cord), a power switch **56** for turning power on and off to the unit, and one or more communication interfaces **58**. Such communication interfaces **58** might comprise one or more of a CAT 6, CAT 5/5e, USB, Firewire, or other communication ports, such as for receiving an associated communication cable.

[0117] In certain examples, as illustrated in FIG. 7, the lower portion **26** of the housing **22** may define an inset **60**. This inset **60** may be configured, along with an adjacent portion of the housing **22**, to form a handle. This handle may be used, for example, by an installer to pick up the shuffler **20**, such as during transport and/or installation.

[0118] As illustrated in FIG. 7, the lower portion **26** of the housing **22** may define an outwardly extending flange **62**, such as an intersection of the lower portion **26** with the upper portion **24** of the housing. The flange **62** may extend around the entire shuffler **20**, or might be in one or more locations. As described in more detail below, the flange **62** may define a mounting location for one or more features of the shuffler **20**, and may also serve as a supporting surface or stop for mounting the shuffler **20**. For example, when the shuffler **20** is mounted to a gaming table, the shuffler **20** may be lowered into an opening in a supporting surface of the table, with the lower portion **26** of the housing **22** located under the gaming table surface and the flange **62** resting upon the surface and thus generally supporting the shuffler **20**.

[0119] Referring to FIGS. 1-4, the raised or console area **42** of the upper portion **24** of the housing **22** extends upwardly at the front **28** of the shuffler **20**. As indicated, a control panel **44** may be associated with the raised area **42**. In certain examples, the control panel **44** generally faces towards the front **28** of the shuffler **20**. The control panel **44** may comprise one or more input and output devices, such as one or more video displays **64** for displaying information, and at least one indicator **170** (as illustrated, two indicators might be provided).

Each indicator **170** might comprise, for example, an LED light.

[0120] The raised area **42** may be defined by a body or cover that is connected to the lower portion **26** of the housing **22**. One or more features of the control panel **44** may be connected to that body or cover. As detailed below, the body or cover may extend over internal features of the shuffler **20**, such as a moving card receiver, a card ejector and the like.

[0121] The card receiving and dispensing area **40** is located rearwardly of the raised area **42**, between the raised area **42** and the rear **30** of the shuffler. In certain examples, the card area **40** comprises a card receiving or infeed area **70** and a card dispensing area **72**. The card receiving area **70** may comprise a recessed or depressed area in the upper portion **24** of the housing **22**. In certain examples, the card receiving area **70** is card shaped, e.g. generally rectangular in shape, such as having first and second opposing side walls and first and second opposing end walls which extend between the side walls, a generally open top and a generally closed bottom. The length of the side walls and the width of the end walls are configured to define a card receiving area **70** which is slightly larger in dimension than the cards of a standard card deck. As illustrated, the card receiving area **70** may be oriented so that its longer sides (corresponding to the height of a playing card from a top end to a bottom end thereof) extend generally parallel to a line through the sides **32,34** of the shuffler **20**, and so that its shorter sides (corresponding to the width of a playing card from side to side thereof) extend generally parallel to a line through the front **28** and rear **30** of the shuffler **20**. As described below, in this orientation, the card receiving area **70** is configured to receive cards and deliver them into the shuffler **20** in a “sideways” orientation. The sidewalls and end walls may extend generally vertically upward from the bottom (at 90 degrees thereto, or in other examples, at angles slightly greater than 90 degrees, whereby the walls generally tilt slightly outward such that a dimension of the open top of the card receiving area **70** is larger than the dimension of the bottom, whereby the slight slope in the walls tends to guide cards placed in the card receiving area **70** towards the bottom thereof).

[0122] In certain examples, as best illustrated in FIG. 4, a finger recess **74** is located at a top and a bottom of (or in other words, at or in the end walls of) the card receiving area **70**. The finger recesses **74** are sized to receive one or more fingers of a user who is gripping the top and bottom ends of one or more stacked cards that are being placed into or being removed from the card receiving area **70**. In certain examples, as best illustrated in FIGS. 10 and 13, the finger recesses **74** may extend downwardly below the card supporting bottom of the card receiving area **70** (e.g. below the plane that the bottom card lies in when cards are located in

the card receiving area **70**). As illustrated, this configuration may be facilitated by the finger recesses **74** being located at both ends of the card receiving area **70** and outside (laterally) of card feed rollers (described below). A particular advantage to this configuration is that in order to securely grip a set of cards a user may place their fingers so that they extend beyond or below the bottom card of a set of cards. In the configuration described, the user's fingers are then accommodated in this position as the cards are being placed into (or removed from) the card receiving area **70**.

[0123] In the illustrated example, the card dispensing area **72** is located between the card receiving area **70** and the raised area **42** of the upper portion **24** of the housing **22**, whereby the card receiving area **70** is located at the rear **30** of the housing, the card dispensing area **72** is located adjacent to the card receiving area **70** towards the front **28**, and the raised area **42** is located adjacent to the card dispensing area **72** towards the front **28**, generally along a longitudinal line through the housing **22** through the front **28** and rear **30**. In this manner, as described in more detail below, the card dispensing area **72** can receive cards which are ejected or dispensed outwardly from the shuffler **20** at the raised area **42** thereof.

[0124] Like the card receiving area **70**, the card dispensing area **72** comprises a recessed or depressed area of the housing **22**. The card dispensing area **72** may similarly comprise a generally rectangular-shaped area which is sized to receive one or more cards in a "sideways" orientation (e.g. with the cards oriented such that a line running through them lengthwise from top to bottom extends generally perpendicular to a line running through the shuffler **20** from the front **28** to the rear **30**). The card dispensing area **72** may also comprise one or more finger recesses **76**, such as at a location corresponding to a top and bottom or the ends of the card dispensing area **72**, and thus the top and bottom of cards located therein.

[0125] As best illustrated in FIG. 8A, in certain examples, a top of the card receiving area **70** is generally coplanar with (e.g. at approximately the same elevation as) the top of the lower portion **26** of the housing **22**, and thus the flange **62** thereof (thus, when the flange **62** is positioned on a supporting surface, the top of the card receiving area **70** is positioned above the supporting surface). On the other hand, a top of the card dispensing area **72** is generally higher than the top of the card receiving area **70**. As illustrated, the top of the card dispensing area **72** is generally defined by a card ramp **158** and the top of a divider **78** (both described in more detail below), which are positioned higher than the flange **62** and the top of the card receiving area **70** (whereby a top of the card dispensing area **72** is in a plane which is higher than a plane containing the top of the card receiving area **70**).

[0126] Both the card receiving area **70** and card dispensing area **72** extend downwardly below the flange **62**, and thus downwardly into the lower portion **26** of the housing **22**. When the flange **62** is resting upon a surface of a gaming table, this means that at least the bottom of the card receiving area **70** and the bottom of the card dispensing area **72** are generally located below the table surface.

[0127] As illustrated, the card receiving area **70** and the card dispensing area **72** are separated, such as by an upwardly extending divider **78**. In certain examples, the divider **78** effectively forms one of the sidewalls of the card receiving area **70** and one of the sides of the card dispensing area **72**. In certain examples, the divider **78** extends upwardly above the card receiving area **70** and the card dispensing area **72**, such as to a height where a top thereof is located above the flange **62** and thus above a gaming table surface when the shuffler **20** is mounted therein. In certain examples, the divider **78** not only serves to divide the card receiving area **70** from the card dispensing area **72**, but also accommodates a moveable side wall **80** which is associated with the card receiving area **70**, and serves as a stop for cards which are ejected onto and sliding down the card ramp **158** of the card dispensing area **72**.

[0128] In one example, the bottom of the card dispensing area **72** slopes, such as downwardly in the direction of the card receiving area **70**. As described below, this allows cards which are ejected from the shuffler **70** and sliding down the card ramp **158** to be directed towards the divider **78** and position where they are easily retrieved for dealing.

[0129] Additional details of the shuffler **20**, including the operation thereof, will now be described, primarily with reference to FIGS. 8A-14.

Card Infeed

[0130] In certain examples, the shuffler **20** includes a card infeed mechanism. The card infeed mechanism is configured to retrieve or take cards from the card receiving area **70** and deliver them to a card shuffling mechanism (which is described below and may comprise a card receiver) in the shuffler **20**. In certain examples, the card infeed mechanism thus comprises means for moving cards from the card receiving area **70** to the card shuffling mechanism.

[0131] As described in more detail below, a user of the shuffler **20** places one or more cards, such as one or more decks of cards, into the card receiving area **70**. In certain examples, the card infeed mechanism is configured to grab or retrieve cards from the bottom of the stack or deck of cards that is located in the card receiving area **70**.

[0132] In certain examples, one wall, or at least a portion thereof, which defines the card

receiving area **70** is movable. The wall may comprise a moveable side wall **80** which comprises a generally planar body that is movable from a first position to a second position. The first position may comprise a raised or retracted position, such as where the moveable side wall **80** is generally vertically extending (and generally extends approximately 90 degrees relative to the bottom of the card receiving area **70** and generally parallel to the other side wall and the end walls). In the first position, the movable side wall **80**, or at least a face or surface thereof, defines part of a peripheral boundary of the card receiving area for cards located therein. The second position may comprise a tilted or extended position where the moveable side wall **80** extends into the card receiving area **70**. In this position the moveable side wall **80** may extend at an angle, such as to a horizontal or other substantially non-vertical position. In the second position, the movable side wall **80** is configured to engage one or more cards in the card receiving area **70**, such as by contacting a top card in the card receiving area **70** (where there may be one or more cards in the card receiving area **70**).

[0133] As best illustrated in FIG. 8C, the card dispensing area **72** may be at least partially defined by a first tray **75**. The first tray **75** may, for example, comprise a molded plastic body that is supported by frame elements (described in more detail below) of the shuffler **20** within the lower portion **26** of the housing **20**. This first tray **75** may define at least part of the divider **78**, such as a front wall or face thereof that faces the card dispensing area **72**. Likewise, the card receiving area **70** may at least partially defined by a second tray **71**. This second tray **71** may again comprise a molded plastic body that is supported by frame elements of the shuffler **20** (as illustrated, the second tray **71** may define one or more openings, such as for the rollers **84** and card sensor **88**, described below). In one embodiment, the first tray **75** and the second tray **71** may be selectively disconnectable from the shuffler **20**, such as to access components adjacent to the trays, such as for service.

[0134] In one example, the side of the second tray **71** at or facing the divider **78** is open. This side or wall of the card receiving area **70** (which essentially comprises the rear face of the divider **78**) may be defined by a base support **73** and the moveable side wall **80**. The base support **73** may comprise a supporting or mounting element, such as a metal plate that is associated with the frame structure in the housing **20**. The movable side wall **80** may be movably mounted to the base support **73** and thus be movable relative to the base support **73** and the divider **78**, such as by pins (such as located at opposing ends of the movable side wall **80** near a bottom portion thereof, whereby the movable side wall **80** is essentially ‘hinged’ so that it rotates about the bottom thereof relative to the base support **73**). The moveable side

wall **80** may thus rotate relative to the base support **73**, such as via or about the pins, where as illustrated, the pivot location may be raised from a bottom of the card receiving area **70**.

When the moveable side wall **80** is moved to its vertical position, it fits within or retracts into a recessed portion of the divider **78**, whereby a face of the moveable side wall **80** becomes one side or boundary of the card receiving area **70** (which thus constrains cards located therein), as best illustrated in FIG. 8C.

[0135] Still referring to FIGS. 2 and 8A, the moveable side wall **80** may have a length from its pivot point to its opposing or free end which is relatively short (and preferably, of a length that allows the movable side wall **80** to fit within the divider **78** when the movable side wall is in its vertical position). For example, the length of the movable side wall **80** may be such that when it is tilted into the card receiving area **70**, it only extends about 1/3 of the way across the card receiving area **70** towards the other side (when the movable side wall **80** is tilted to a generally horizontal position), thus only engaging a portion of one side of the top card in the card receiving area **70**. In this regard, in one example, the movable side wall **80** comprises just a portion of one of the sidewalls of the card receiving area **70**. The exact size of the movable side wall **80** might vary.

[0136] Means are also provided for moving the moveable side wall **80**, such as by a motor **M1** which drives a pulley **P1** which is associated with the moveable side wall **80**, via a belt **B1**, as illustrated in FIG 11A. As described in more detail below, operation of the moveable side wall **80** may be controlled by a controller, including based upon input from one or more sensors. In particular, in certain examples, at least one sensor **88** may be provided for sensing one or more cards in the card receiving area **70**. As illustrated in FIGS. 8A and 13, the card sensor **88** may be located at a bottom of the card receiving area **70**, such as where the sensor is located under the bottom of the card receiving area **70** and where the bottom of the card receiving area includes a window or opening. The card sensor **88** may comprise, for example, an IR or other optical sensor which has an emitter which sends a beam of light outwardly through the opening or window and into the card receiving area **70**. If one or more cards are located in the card receiving area **70**, the light will be reflected back and be detected by a detector of the sensor **88** (and which sensor does not detect the light when no cards are located in the receiving area **70**).

[0137] As indicated, the operation of the moveable side wall **80** may be controlled by a controller. The controller may control the motor **M1**, including based upon information obtained by the controller from the card sensor **88**. In certain examples, the motor **M1** may be

configured to drive the moveable side wall **80** with a relatively constant torque (such as by setting the motor to operate at a constant velocity in order to approximate constant torque), thus ensuring constant pressure on the cards in the card receiving area **70**.

[0138] In certain examples, the controller is, after a short time delay from when the card sensor **88** detects cards in the card area, configured to move the moveable side wall **80** so that it tilts and engages the top of the cards in the card receiving area **70**. The moveable side wall **80** is moved back to its vertical position and does not move back into the card area when no cards remain in the card receiving area **70** (as determined by the sensor **88**).

[0139] In some instances, a user may inadvertently place a second set or deck of cards into the card receiving area **70** when a first set or deck is already located in the receiving area **70** under the moveable side wall **80**. In certain examples, the controller is configured to receive information, such as from a card reader/sensor, which allows the controller to determine the number of cards which have been processed by the shuffler. Thus, when the controller determines, based upon a card count, that all cards of a deck have been processed, if the card sensor **88** detects that cards are located in the card receiving area **70**, the controller can determine that cards were inadvertently placed into the card receiving area **70** on top of the moveable side wall **80**. In such instance, the controller is preferably configured to output an error message to the user that instructs the user to remove the cards. Once the cards are removed (as detected by the card sensor **88**), the controller can retract the moveable side wall **80** so that the user can place the cards back into the card receiving area for processing (at which time the moveable side wall **80** is again lowered into position against the top of that next set of cards). The controller will then begin processing (shuffling) that next set of cards, such as instructed by the user.

[0140] The card infeed mechanism also comprises means for moving the cards. In certain examples, as best illustrated in FIG. 4, one or more rollers **84** are associated with the card receiving area **70**, such as by being positioned at the bottom of the card receiving area **70**. One or more, and preferably at least two, of those rollers **84** are preferably driven rollers (e.g. such as driven by a motor **M2** via one or more belts **B2**, as illustrated in FIG. 10). Additional rollers may be provided, such as idler top rollers (not shown). In this manner, one or more of the rollers **84** which are in contact with the bottom-most card in the card receiving area **70**, are configured to draw or drive that card from the card receiving area **70** into the interior of the shuffler **20**, as best illustrated in FIG. 8A. In certain examples, cards are driven or moved from the card receiving area **70** through a slot in the housing **22** into the interior of the

shuffler. In this manner, individual cards are moved, one at a time (e.g. sequentially as they are removed from the bottom of the card receiving area **70**), from the card receiving area **70** into the shuffler **20**.

[0141] As illustrated in FIGS. 8A and 10, one or more additional rollers **84** or other feeding/moving devices are used to move the cards to the card shuffler. For example, as illustrated, multiple pairs of rollers **84** (one or more of which may be driven or idler rollers) may be used to move each card generally horizontally from the card receiving area **70** through the shuffler **20** linearly to the card shuffler.

[0142] As illustrated in FIG. 10, one or more motors **M3** may be used to drive one or more of the rollers, such as the driven (as opposed to idler). The one or more motors **M3** may drive the rollers directly or indirectly, such as by rotating one or more belts **B3** (which belts may be driven by pulley which is driven by the motor and which drives a pulley which is associated with the driven roller, such as where the pulley is mounted on an axle of the roller). Of course various drive mechanisms might be used to drive the rollers (including direct drives, gear drives, etc.). As described below, the motors may be controlled by the controller, such to selectively drive the rollers.

Shuffling mechanism

[0143] In certain examples, cards which are delivered from the card receiving area **70** are delivered to a card handler or shuffling mechanism. The card handler is preferably configured to shuffle, e.g. randomly arrange, the cards, and more preferably, randomly arrange the cards into one or more groups, sets or hands (as used herein the term “hand” may mean a complete set of cards which is dealt or provided to a player or dealer, but may also comprise other groups of cards, such as sets of community cards, replacement cards for discarded cards and the like).

[0144] In certain examples, as best illustrated in FIGS. 8A and 9, the card handler comprises a movable card receiver **90** having a plurality of card slots or pockets **92**, and means for selectively moving the card receiver **90** in order to direct cards into particular pockets **92**.

[0145] As illustrated, the card receiver **90** comprises a plurality of dividers **94**. The dividers **94** are separated from one another, thus defining the plurality of card slots or pockets **92**. In one example, the dividers **94** are arranged or stacked vertically, thus defining a plurality of vertically spaced pockets **92**. The card receiver **90** may comprise a top or a top divider, a bottom or a bottom divider and a plurality of intermediate dividers therebetween.

[0146] For reasons described in more detail below, and as best illustrated in FIG. 9, the card receiver **90** may comprise a first set of dividers and a second set of dividers which are separated by a slot or channel **96**, or where the dividers otherwise simply define such a channel **96**. This slot or channel **96** causes the card receiver **90** to have a reduced weight as compared to one where the dividers **94** do not include such a slot. In addition, as described below, this channel **96** facilitates passage of a card pusher **152** into the card pockets **92** in order to eject the cards.

[0147] As illustrated in FIGS. 8A and B, each card divider **94** preferably defines a generally planar card supporting portion, such as at top thereof, and at least one card receiving ramp **98**. The card ramp **98** comprises a sloping surface which leads from a front of the card divider **94** towards the rear thereof at which the generally planar card supporting portion is defined.

[0148] As described below, certain card dividers **94** may define only a “top” card ramp **98** (e.g. one associated with the top of the divider), while others define top and bottom card ramps **98** (e.g. one associated with the top of the divider and one associated with the bottom of the divider). In certain examples, each card divider **94** that has only a top card ramp may have a nominal thickness (a thickness or height except at the ramped area) of about 0.11 inches. When a thickness of each playing card which is being shuffled by the shuffler **20** is about 0.011 inches, this causes those dividers **94** to have a thickness of about 10 (and preferably more than 10) times the thickness of each card. The card dividers **94** which have top and bottom ramps may have a thickness of about 0.2 inches. When a thickness of each playing card which is being shuffled by the shuffler **20** is about 0.011 inches, this causes those dividers **94** to have a thickness of about 20 times the thickness of each card.

[0149] A height of each card ramp is about 0.08 to 0.09 inches, such that a ratio of the height of each card ramp to the thickness of the cards is about 7- 8 (when the thickness of the cards is about 0.011 inches).

[0150] The card dividers **94** are separated from one another a distance H of about 0.125 – 0.145 inches (between a top surface of one divider and the bottom surface of an adjacent divider), whereby a ratio of the height of each pocket **92** to the thickness of each card is about 11 - 13 (when the cards have a thickness of about 0.011 inches).

[0151] In certain examples, each card ramp **98** slopes at an angle of around 10-11 degrees. When considering the thickness of the card divider **94** noted above, the ramps thus extend rearwardly from the front of each card divider **94** towards the rear thereof a distance of about

0.466 inches.

[0152] The term “about”, with respect to the noted dimensions, in one example comprises a variable amount that accounts for manufacturing tolerances and variations and is an amount which does not affect the intended operation of the feature. In one example, the term may comprise an amount such as +/- 10% of the indicated dimension.

[0153] In certain examples, the card dividers **94** are constructed from metal, such as aluminum, or other material which has a low coefficient of friction, a low wear rate and is not subject to bending or warping (such as plastic), as such characteristics are important in ensuring that the card dividers **94** work properly as described below (including by directing incoming cards into the associated card pockets **92**).

[0154] As indicated above, certain card dividers **94** define only a top card ramp **98** (e.g. one associated with the top of the divider), while others define top and bottom card ramps **98** (e.g. one associated with the top of the divider and one associated with the bottom of the divider). In certain examples, one or more card pockets **92**, those of a first type, are defined between the upper card ramp **98** on one divider **94** and the lower card ramp on another divider. Other card pockets **92**, those of a second type, are defined between the lower card ramp **98** on one divider **94** and the generally planar top surface of another divider. In one example, the top divider **94** may only define a bottom card ramp and the bottom divider **94** may only define a top card ramp.

[0155] In the example illustrated, the card receiver **90** defines fifteen (15) card pockets **92**. In certain examples, twelve (12) of those card pockets **92** are pockets of the first type, and they are located at the top of the card receiver **90**. The remaining three (3) card pockets **92**, those of the second type, are located at the bottom.

[0156] In certain examples, card pockets **92** of the first type are configured to receive cards in a first configuration. In certain examples, this comprises “top stacking” of cards, wherein when more than one card is placed in the pocket, cards are stacked on top of one another (e.g. a first card is delivered to the pocket and then a second card is delivered to the pocket on top of the first card). In certain examples, the card receiver **90** is moved so that the card divider **94** which is above the card pocket **92** to which the card is to be delivered is aligned with the card to be delivered, as illustrated in FIG. 8A. An incoming card is moved horizontally so that it hits the card ramp **98** on the bottom of the divider **94**, as best illustrated in FIG. 8B. If the card being delivered to that card pocket **92** is the first card being delivered to that pocket, that card then falls to the bottom of the pocket **92** (e.g. onto the top of the divider below). If

the card being delivered to that card pocket **92** is the second card being delivered to that pocket, that card impacts the ramp of the divider and then falls on top of the first card already in the pocket **92**. The number of cards which are located in a “top stacking” pocket **92** may vary (such as depending upon the intended use of the cards, such as for discards, etc.).

[0157] In certain examples, card pockets **92** of the second type are configured to receive cards in a second configuration. In certain examples, this comprises “top and bottom stacking”, wherein cards may be stacked from above or below (e.g. cards may be delivered so that they are stacked on top of the cards which are already in the pocket or are placed below the cards that are already in the pocket). In certain examples, if a card is to be delivered to the card pocket **92** from above, the card receiver **90** is moved so that the card divider **94** above the desired pocket **92** is aligned with the card and then the card is delivered in the same manner as described above. If, however, a card is to be delivered to the card pocket **92** from below, the card receiver **90** is moved so that the card divider **94** below the desired pocket **92** is aligned with the card. The card is then delivered, hitting the ramp **98** of the card divider **94** at the bottom of the pocket **92** and then being pressed inwardly under any existing cards in that pocket **92**. Again, the number of cards which are placed into a “top and bottom stacking” pocket **92** may vary, such as based upon the intended use of the cards. In one example, the “top and bottom stacking” pockets **92** may be used for randomizing cards, such as for randomizing two cards relative to one another, but might also be used for larger numbers of discard cards, etc.

[0158] The total number of card pockets **92** and/or the number of card pockets of the first and second types might vary from the configuration described herein, such as depending upon the particular application (such as the particular game or games for which the shuffler **20** supplies cards). For example, the card receiver **90** might have more card pockets **90** of the second type than the first type. In addition, the size of the pockets **92** might vary in other applications, such as depending upon the total number of cards that might be desirably delivered to a particular pocket **90**.

[0159] In certain examples, means are provided for retaining cards which are delivered to the pockets **92** in the pockets to which they are delivered. In particular, to prevent the cards which are being delivered to a pocket **92** from passing therethrough (towards the front of the shuffler in FIG. 8A), the card receiver **90** may include, as illustrated in FIG. 8A, a front wall **95**, or the dividers **94** may include walls, stops or the like. In addition, the means may also comprise means for preventing a card that is being delivered into one of the card pockets **92**

from rebounding back out of the pocket. In particular, the force of a card impacting the front wall or stop may cause the card to rebound and travel back through the pocket (in the direction of the rear of the shuffler **20**). In certain examples, as best illustrated in FIGS. 8A and 13, a card stop **110** is provided for this purpose. In certain examples, the card stop **110** comprises an arm **112** or other body which is movably mounted, such as for pivoting movement, and has a stop portion **114**. As illustrated, the arm **112** may be somewhat “L” shaped, having a first end which is pivotally mounted to the shuffler and a second end which comprises the stop **114**.

[0160] Means are provided for moving the arm **112**, such as from a retracted position (in which it does not block the card pocket **92** to which cards are being delivered) to an extended position (in which it is positioned adjacent the front or open end of a card pocket **92**). As illustrated, this means might comprise a linkage **116** which is driven by a rotating drive **118**, such as a crank mechanism which is driven by a motor. As illustrated, forward and/or reverse rotation of the drive causes the linkage **116** to move, such as back and forth about its pivot. In certain examples, this movement is controlled by the controller of the shuffler **20**.

[0161] As indicated, and as best illustrated in FIGS. 8A and 9, the card receiver **90** is movable, preferably in a vertical linear direction to a plurality of target positions (for delivering the cards to assigned pockets **92**). A means is thus provided for moving the card receiver **90**. In certain examples, the means comprises an elevator (for elevating – e.g. raising and/or lowering). In one example, the elevator comprises a motorized belt drive. As illustrated, a motor **M4** may be configured to rotate belt **B4** which rotates about a pulley **122**. In one example, the card receiver **90** is coupled to the belt **B4**, such as by a connector **123**. In this manner, as the belt **B4** moves up and down, it pulls the card receiver **90** up and down. In one example, the motor **M4** may comprise a stepper motor or motors of other types, and the motor might be configured to drive or move the card receiver **90** in other manners (e.g. direct drive, geared drive, etc.).

[0162] As described below, the controller of the shuffler **20** may be used to control the operation of the motor **M4**, thus controlling movement and position of the card receiver **90**. This control of the card receiver **90** allows for placement of cards into different card pockets **92**.

Card Eject

[0163] Once the cards are shuffled by associating them with the pockets **92** of the card receiver **90**, they can then be delivered to the card dispensing area **72** for retrieval by the

dealer. In certain examples, the shuffler **20** includes a card ejector **150** for moving cards from the card pockets **92** to the card dispensing area **72**.

[0164] Referring to FIGS. 8A, 12 and 14, in certain examples, the card ejector **150** comprises a pusher **152** and means for moving the pusher **152**. The pusher **152** may comprise a body having a face **154**. The pusher **152** is preferably movable from a retracted position in which it is positioned behind (in the direction of the front of the shuffler **20**) the card receiver **90** so that it does not interfere with movement of the card receiver or placement of cards into the card pockets, and an extended position in which it extends into the channel **96** of the card receiver and can push cards in one of the pockets **92** rearwardly out of that pocket.

[0165] In certain examples, when it is desired to eject cards, the controller moves the card receiver **90** into a position in which the pusher **152** is aligned with the desired card pocket **92**. The pusher **152** is then extended, causing the face **154** to contact the cards in the aligned card pocket **92** and force them rearwardly.

[0166] In certain examples, the face **154** of the pusher **152** has a height which is equal to or greater than a height H of each card pocket **92** (e.g. the distance between the top of one card divider **94** and the bottom of the card divider **94** above it). In certain examples, the height H of each card pocket H is about 0.125-0.145 inches, and the height of the face **154** of the card pusher **152** is about 0.25 inches (whereby the height of the face **154** is greater than the distance between adjacent dividers **94**, ensuring that the face **154** will contact and push all cards in a pocket **92** between two dividers **94** out of the card receiver **90**, but where the height of the face **154** is not greater than the distance between two adjacent dividers **94**, including the thicknesses of the dividers **94**, whereby the pusher **152** will not push cards out of more than one pocket **92**). As noted above, in one example, the card receiver **90** includes a central channel **96**. In certain examples, the width of the pusher **152** is less than the width of the channel **96**, thus allowing the pusher **152** to move into the channel **96**, and thus between opposing portions of each card divider **94**. Thus, when the pusher **152** is in its forward position, it is positioned inside of the card receiver **90**, e.g. between the front and back of the card receiver at one of the card pockets **92**, and thus forces any cards in that pocket rearwardly and out of the pocket. As noted above, because the height of the face **152** of the card pusher **152** is equal to or greater than the height of the card pocket **92**, the card pusher **152** assuredly pushes all of the cards out of the corresponding pocket, no matter how many are in the pocket (e.g. the cards in the pocket cannot ride over the top of the pusher or the stack of cards in the pocket cannot be so high that the pusher does not engage all of them).

[0167] In certain examples, the ejected cards move generally horizontally and pass through a gate or opening **156** to the exterior of the shuffler **20** (behind the raised area **42** of the upper portion **24** of the housing **22**), and onto a sloping card ramp **158** that leads to the card dispensing area **72**. As best illustrated in FIG. 8A, the gate **156** may comprise a hinged or rotating door type structure which opens (to allow cards to pass therethrough) and closes (to obscure the interior of the shuffler from exterior view). The gate **156** may be moved by a means for moving, such as a motor or other drive.

[0168] As indicated, the pusher **152** is moved by a means for moving. In certain examples, this comprises belt **B5** which is mounted on a first driven pulley **160** and a second idler pulley **161**. A motor **M5** drives the driven pulley **160**, which in turn drives a belt **B5**. The pusher **152** is connected to the belt **B5**, such as by a clamp **163**, whereby movement of the pulley **160** effectuates direct movement of the pusher **152**.

[0169] In the example illustrated, and as described above, the cards are ejected at a vertical position of the shuffler **20** which is higher than the elevation or vertical position at which the cards are placed into the card receiving area **70** and delivered from the card receiving area **70** into the shuffler.

[0170] Additional features and benefits of the disclosure will now be described.

[0171] In certain examples, as illustrated in FIG. 8A, the shuffler **20** may include a card reader **180**. The card reader **180** may comprise an image capture device (such as CCD, CMOS or other types now known or later developed), which is configured to capture an image of each card, or in one example, read the card PIPs (the symbols printed on the cards that determine their rank and suit) that is shuffled. In certain examples, the card reader **180** may be configured to read or scan cards as they pass from the card receiving area **70** to the card shuffler, and particularly to capture an image of the bottom or “face” of each card (that bears the card distinguishing indicia, such as rank and suit). In this regard, as noted above, during this process, cards are individually moved in sequence from the card receiving area **70** to the card receiver **90**, allowing each of them to be separately read. In other examples, the device might comprise other types of sensors for sensing, reading or otherwise capturing one or more elements of information about the cards, such as the card rank and/or suit or other identifying information of the card. Further, the location of the card reader **180** may vary.

[0172] In certain examples, the captured card information, such as the captured card images, is not used in the card shuffling process – e.g. is not used to determine the order or placement of the cards. As indicated above, this is done using an RNG and without regarding

to the particular identity of each card. However, by scanning each card, the identity of each card can be matched to its determined location in the card receiver **90** (as determined by the RNG process) and each associated group of cards. In this manner, information is known regarding the cards dealt to each player, the dealer, to the community, etc., which information may be used for a variety of purposes (triggering bonuses, confirming game wins, etc.). In one example, the read card information is stored in association with information regarding the card's location (the assigned pocket), such as in the memory of the shuffler **20**. In one example, the read card information and the card location for each card is generated and stored in the memory before each card reaches the card receiver **90**. In one example, the stored card information may comprise an image of the read card information, while in others, the read card information might be transformed, such as from an image to data regarding the card (such as instead of an image of the card, the image information could be converted to information such as **8♠**).

Card Shield

[0173] As indicated, in certain examples, cards are ejected through the gate **156** onto the ramp **158** that leads to the card dispensing area **72**. As further described, in certain examples, the gate **156** (Figure 8A) and card ramp **158** are elevated, thus allowing the cards to move down the ramp **158** from the gate **156** to the card dispensing area **72**. Because the top of the card dispensing area **72** is generally level with the top of the lower portion **26** of the housing **22**, it is thus at approximately the same level as the surface of a gaming table in which the shuffler **20** is installed. This means that the gate **156** is then located above the height of the table surface, raising the potential for persons to see the face of the cards (which are facing downwardly when ejected).

[0174] Because this is undesirable, in certain examples, a card shield **190** may be provided. As illustrated in FIGS. 1, 2 and 5, the card shield **190** preferably comprises a wall or barrier that extends upwardly around at least a portion of the card area **40**. The card shield **190** may be connected to the flange **62** (see FIG. 7) of the lower portion **26** of the housing **22** and then extend upwardly therefrom. In certain examples, the card shield **190** extends upwardly a sufficient height to prevent viewing of cards being ejected, such as by extending upwardly to approximately the same elevation as the gate **156**, as illustrated in FIG. 8A. In certain examples, the card shield **190** is constructed from aluminum, plastic or a similar material, and is opaque to prevent persons from seeing through it. The card shield **190** may also serve additional functionality, such as a protector against spilled drinks or the like (wherein the

upwardly extending configuration of the card shield 190 also reduces the potential for spilled liquid or the like from getting into the card area 40).

[0175] The card shield 190 may comprise one or more bodies or sections. As illustrated in FIGS. 2A and 2B, in certain examples, the card shield 190 comprises a first barrier 192 which is located at the first side 32 of the shuffler 20 and extends from generally the raised area 42 of the upper portion 24 of the housing 22 to the rear 30 of the shuffler 20, and a second barrier 192 which is located at the second side 34 of the shuffler 20 and extends from generally the raised area 42 of the upper portion 24 of the housing 22 to the rear 30 of the shuffler 20.

[0176] Of course, the card shield 190 might have other configurations, such as comprising a single barrier member or more than two. Further, the card shield 190 may be connected to the flange 62 in manners other than fasteners, such as screws. For example, the card shield 190 might be formed as an integral portion of the housing 20.

[0177] When the card shield 190 includes first and second barriers for location at generally opposing sides of the shuffler 20, in some examples, only one of the barriers might be used at a given time, such as depending upon the orientation of the shuffler 20 relative to the dealer and players. For example, only the first barrier 192 might be used or only the second barrier 192 might be used at a given time.

Belt Tensioner

[0178] As indicated above, in certain examples of the disclosure, a means for moving the card receiver 90 comprises an elevator, such as in the form a belt drive which is comprised of a motor M4 which drives a belt B4 (to which the card receiver 90 is connected, such as with one or more clamps) which is mounted drive element of the motor and an idler pulley 122. It is important to ensure that the card receiver 90 moves and stops quickly and precisely. Therefore, any deflection of belt B4 is problematic.

[0179] In certain examples, the shuffler 20 of the disclosure includes a belt tensioner 200. As illustrated in FIGS. 11A-D, the driven pulley 122 may be movably mounted, such as on a first movable mount 210. The first movable mount 210 is preferably movable linearly towards and away from the motor M4 and/or the element that the motor drives to turn the belt B4 (such as by slidable mounting of the first movable mount 210 to a frame element 312, described in more detail below). In this manner, the tension on the belt B4 may be increased (when the first movable mount 210 is moved upwardly in this example) or decreased (when the first movable mount 210 is moved downwardly in this example). In another examples, the

position of the driving pulley might be movably mounted.

[0180] The belt tensioner **200** may include a tensioning adjuster. As best illustrated in FIG. 11D, a second movable mount **212** may also be provided, where the second movable mount **212** may also be configured for sliding/linear movement relative to the frame element **312**). As illustrated, a resilient element such as a coil spring **214** is preferably positioned between the second movable mount and the first movable mount **210**. Means are provided for adjusting the compression of the coil spring **214**, and thus the force applied to the first movable mount **210**. This means may comprise, for example, a threaded bolt **211** which passes through the movable mount **210** and engages second movable mount **212**.

[0181] In use, the user may adjust the force applied to the first movable mount **210** by turning the bolt **211**, thus compressing or decompressing the spring, thus changing the upward force on the first movable mount **210** via the spring **214**. In order to set the desired tension on the belt, the user may release fasteners **213** which lock the first movable mount **210** in position. The user may then set the desired force on the movable mount **210** by turning the bolt **211** (which changes the distance between the first movable mount **210** and the second movable mount **212**, and thus the biasing force generated by the spring **214** therebetween). When the desired upward force is applied to the first movable mount **210** (and thus the amount of tension on the belt **B4**), the user may lock the first movable mount **210** in position via one or more fasteners **213** (which are associated with the first moveable mount **210** and may move relative to a slot in the frame element **312**). Advantageously, if the belt **B4** stretches, the user can release the fasteners **213**, adjust the force applied to the first movable mount **210**, and then re-lock the first movable mount **210** in the newly adjusted position. This adjustment might be performed during designated maintenance on the shuffler **20**.

Construction and Calibration

[0182] Another aspect of the disclosure comprises a construction of the shuffler **20**, including the design and interconnection thereof to accommodate and maintain tight tolerances. As best illustrated in FIG. 12, various components of the shuffler **20** may be associated with a frame. The frame may be located within the housing **22** and the various portions of the housing **22** may thus cover and/or connect to the frame.

[0183] In certain examples, the frame may comprise a base or base plate **310**, such as a generally planar plate comprising machined aluminum. Elements of the card infeed system, including the motors **M1-M3**, the rollers **84** and associated features (including, as illustrated,

elements of the shuffler **20** that comprise or define the card receiving area **70** and card dispensing area **72**) may be associated with first and second vertical supports **312,314** that extend upwardly from the base plate **310** (and are spaced from one another). Other frame elements, such as an end cap **316** or other elements, may be associated with the base plate **310** and/or first and second vertical supports **312, 314**.

[0184] In certain examples, the movable card receiver **90** is associated with third and fourth vertical supports **318, 320**. The third and fourth vertical supports **318,320** are also connected to the base plate **310**. The first and second vertical supports **312,314** may also be connected to the third and fourth vertical supports **318,320**.

[0185] As illustrated in FIG. 12, the frame may include other elements, such as one or more downwardly extending supports **322,324**, such as for supporting the shuffler **20**.

[0186] The various elements of the frame may be connected to one another in various manners, such as with fasteners. In certain examples, one or more of the frame elements may be interconnected, such as in a tab and slot arrangement. Such a configuration aids in ensuring that the frame elements are maintained in alignment (because of the rigidity of the frame elements themselves and the contact of the frame elements with one another, rather than merely by fasteners alone, which can loosen and also not adequately counter-act bending forces). Secondly, fasteners may be used to join the frame members, such as for further counter-acting bending forces.

[0187] In certain examples, a means may be provided for adjusting the position of one or more components of the shuffler **20**, such as to ensure continued alignment of the components. In certain examples, this means may comprise a means for adjusting the position of the card receiver **90** relative to the card infeed mechanism. As described above, in certain examples, cards are fed in along a generally linear and horizontal path from the card receiving area **70** to the card receiver **90**. It is important to maintain alignment of the card receiver **90** relative to the card infeed mechanism in order to ensure that cards are properly fed to the card receiver **90** – including so that the cards impact the card ramps **98** of the card dividers **94** and are directed to the proper card pockets **92**.

[0188] In certain examples, as illustrated in FIG. 11B, a first calibration mark or indicator **326** may be provided on a portion of the frame which supports the card infeed mechanism, such as the first vertical support **312**. A second calibration mark or indicator **328** may be provided on a portion of the card receiver **90**.

[0189] In one example, a user (such as a technician) may calibrate the shuffler **20** by

aligning the calibration marks (in that over time, the position of the card receiver **90**, etc., may get out of alignment). As one example, the user may access a calibration feature, such as by a menu of the controller (which is described below). The calibration feature may, for example, allow the user to provide up/+ or down/- inputs which the controller uses to cause the motor **M4** to move, thereby adjusting the position of the card receiver **90**, until the technician confirms that the calibration marks are aligned (by visual inspection and continued adjustment inputs). In other examples, the calibration might be manual, such as by providing one or more adjustment screws or bolts which, when turned, cause the position of one or more of the elements of the shuffler **20** to move.

Controller

[0190] As indicated above, operation of the shuffler **20** is preferably controlled by at least one controller. The controller may comprise hardware and/or software, such as a processor which executes machine-readable code (e.g. software) which is stored in a memory. As illustrated in FIG. 8A, one or more of the components of the controller may be associated with a circuit or motherboard.

[0191] In one example, the shuffler **20** has a main controller or CPU **175** and a secondary controller or microcontroller **177**. As illustrated in FIG. 15, the main controller **175** and the secondary controller **177** may be configured to receive information, including inputs or data from external devices and systems via the one or more communication ports or interfaces **58**, one or more buttons **66a,b**, the card sensor **88**, a card reader **180** (as described below) or other input devices of the shuffler **20**. One of the main controller **175** and the secondary controller **177** are also configured to illuminate the indicators **170** and cause information to be displayed on the video display **64**, as well as control other elements of the shuffler **20**, such as the various motors (including motors **M1-M5**) or other drive mechanisms, the fan(s) **50**, etc.

[0192] It will be appreciated that the shuffler **20** may include, and the main controller **175** and/or secondary controller **177** may thus communicate with, a variety of sensors other than those described in detail above. For example, aside from the card infeed sensor **88**, other sensors such as motor, card or other sensors might be provided for enabling and/or confirming operation of the shuffler **20**. For example, various sensors might be used to detect motor positions, the absence or presence of portions of the housing **22**, the presence of one or more cards in the card receiver **90**, the presence of cards in the card dispensing area **72** (such as used to determine when to eject another set of cards) and/or the location or movement of

cards. For example, one or more sensors may be used to determine the flow of cards through one or more portions of the shuffler **20**, such as from the card receiving area **70** to the card receiver **90**. In one example, these sensors might comprise “cut-beam” type sensors (where the presence of a card cuts an emitted light beam), and where the one or more sensors may be positioned so that movement of the cards is detected in manner which can be used to determine if the cards are moving at a target rate or speed (where if the beams emitted by the sensors are not cut or triggered at designated times or time intervals so as to indicate normal flow of cards, a fault condition may be triggered). As indicated, the sensors may be of various types, such as beam sensors, Hall-Effect sensors, pressure, contact or other types.

[0193] In one example of the disclosure which is described in detail below, aspects of the operation of the shuffler **20** may be separately controlled by the main controller **175** and the secondary controller **177**. The main controller **175** and the secondary controller **177** may be in communication with one another, and the secondary controller **177** may be used primarily to generate card pocket information, receive input from the card sensor **88** and buttons **66a**, **66b**, and control the motors **M**, such as the motor **M4** which is used to move the card receiver **90** to cause incoming cards to be associated with particular assigned/designated pockets **92**.

[0194] As detailed below, in certain examples, the main controller **175** is configured to generate one or more groups of cards, such as one or more hands or sets of cards. The number of groups or sets and the number of cards of each group of set might be defined by the game which is being played. For example, in a game of stud poker where each player receives five (5) cards and four (4) players are playing the game, the main controller **175** may generate a virtual deck structure for the particular selected game or operation. This virtual deck structure comprises a randomized virtual deck structure, such as generated using a random number generator (RNG). This virtual deck or virtual deck structure may be stored in a first memory **178** which is associated with the main controller **175**.

[0195] As also detailed below, in one example, the secondary controller **177** is configured to assign physical cards to the pockets **92** of the card receiver **90**, such as based upon information regarding the virtual deck structure. The secondary controller **177** may store the card pocket or location information in a memory, such as a second memory **179** (the second memory **179** might comprise a separate memory or data storage device from the first memory **178** which is associated with the main controller **175**, or might comprise separate portion or area of a common memory device), separate from the virtual deck information which is generated and stored by the main controller **175**. The secondary controller **177** may be

configured to move the card receiver **90** (such as via a control signal to the motor **M4**) for location of each card into its assigned pocket **92**.

[0196] The main controller **175** may store read card information (such as obtained from the card reader) in correlation to the virtual deck, thereby generating “hand” information (e.g. information regarding each card which is associated with each hand of the game). This correlated card or “hand” information may also be stored in the first memory **178** which is associated with the main controller **175**.

[0197] In certain examples, the main controller **175** is configured to only cause information to be displayed on the one or more video displays **64** in response to a user input, such as the one or more buttons **66a,b** or a touch-device or screen (such as associated with the video display **64**) or other input device. In one example, the buttons **66a,b** comprise first and second buttons which are located at or adjacent to the card receiving and dispensing area **40**. For example, as illustrated in FIG. 1, the buttons **66a,b** might be located adjacent to the card receiving area **70**, such as near the flange **62**. The buttons **66a,b** might be of various types which are configured to receive user input, such as via touch or depression. The buttons **66a,b** might comprise one or more visual indicators, such as a light or light ring, wherein the visual indicator might be selectively illuminated, such as in different colors.

[0198] In certain examples, at least one indicator **170** (such as LEDs) may provide information to the user. The indicators **170** might be provided, for example, at the control panel **44** portion of the shuffler **20**. As illustrated, the indicators **170** might be located adjacent to the display **64**. However, it might be located in other positions. In one example, the indicators **170** might be illuminated in different colors (such as green (normal operation), yellow (indicating required input by the user to the shuffler) and red (warning condition, such as requiring technician intervention)). In one example, the visual indicators of the buttons **66a,b**, may be synchronously illuminated to the indicator(s) **170**.

[0199] In certain examples, when the main controller **175** is awaiting instructions or input by a user, it may activate the indicators **170** and buttons **66a,b**, such as by illuminating the LEDs in yellow. The user is then alerted that they need to provide input to the controller, such as to cause the controller to display certain information to the user, including instructions, options or other information. This input might comprise input to a button **66a,b** and/or input to the display **64**.

[0200] In certain examples, the main controller **175** may, in response to such user input, be configured to display various information in response to user input, such as information

regarding options to begin shuffling, create hands for particular games, stop shuffling, display shuffled hand information, or other information. The user may provide input, such as relative to such selections, to cause the shuffler **20** to initiate shuffling, including creating shuffled hands for a particular game.

[0201] As indicated, the shuffler **20** is preferably configured to shuffle cards and create one or more groups of cards, such as hands which are required for the play of a game. The main controller **175** may allow the user to select a particular game being played and/or other parameters, so that the controller can control the shuffler **20** to create the correct number of hands (whether player or dealer hands) and/or community card sets, including with the correct or desired number of cards per hand/set. As indicated, the shuffler **20** may also generate information regarding the identity of each shuffled card, such as in relation to the virtual deck, thus enabling the shuffler **20** to store and display “hand” information (e.g. information regarding each particular card in group of cards formed by the shuffler **20**).

[0202] In some examples, the main controller **175** may be programmable (such as via external connection to another device, such as a laptop or server) in order to reprogram the controller, such as to include information regarding additional or new games, and/or the user may be permitted to similarly program the controller. Game or other information, such as the number of sets of cards, number of cards per set, etc., may be stored in the memory and be used by the processor to generate the required number of sets or hands of cards and/or sets or hands of cards with particular numbers of cards, for different types of games.

[0203] FIG. 16 illustrates one example flow of the general operation of the shuffler **20**. In a step **S1**, the shuffler **20** may be powered on, such as by use of the power switch **56**, if the shuffler is not already powered on. In a step **S2**, the dealer may provide input of a particular operation, such as by selecting an option from a menu or list displayed by the display **64**, such as via the associated touch-screen. The option may comprise, for example, a shuffling and hand-dealing operation associated with a particular game.

[0204] In step **S3**, the secondary controller **177** may be configured to receive the selected operation input and then check for cards in the card receiving area **70**, such as based upon an output of the card sensor **88**. If no cards are detected, the operation may repeat until the dealer places cards into the card receiving area **70**. At this time, the movable side wall **80** is located in its vertical position.

[0205] When cards are detected in the card receiving area **70**, the main controller **175** may, as denoted at step **S4**, generate virtual deck information or a virtual deck structure for the

particular selected game, based upon the particular features of the game – such as based upon the number of player cards, dealer cards, community cards and the like that are needed to present the game. The virtual deck information is created using an RNG which thus “shuffles” the cards of the virtual deck to create a shuffled virtual deck, where the physical cards (each of which is identified by an ordinal number indicative of its position in the physical deck of cards) are each linked to a corresponding virtual deck card (having an associated position for use in the game). This operation may yield, for example, virtual deck information, such as where individual cards of the physical deck which is located in the receiving area **70** are assigned (using respective ordinal numbers indicative of positions in the physical deck which is being shuffled) to virtual deck positions, such as “Physical Deck Card 1: Player Hand 2, Card 1; Physical Deck Card 2: Player Hand 1, Card 1; Physical Deck Card 3: Dealer Hand, Card 1, etc.” In one example, this virtual deck information is created before actual shuffling begins by the main controller **175**, and before the read card information (e.g., actual rank and suit) of each of the physical cards is known. This virtual deck information may be stored in the first memory **178** which is associated with the main controller **175**. FIG. 17 further illustrates this aspect of the invention, wherein the main controller **175** has created a first data set which comprises random assignment of physical cards to a virtual deck, where the virtual deck is defined by the cards and/or card sets which are necessary to implement the selected game.

[0206] In a step S5, the secondary controller **177** receives information about the virtual deck (some or all of the virtual deck information) from the main controller **175** and uses that information to generate card slot or pocket **92** data. For example, upon being provided with information which identifies that the virtual deck provides card sets for 5 player hands, 1 dealer hand and 1 community card set, the processor may elect to route each incoming card that corresponds to a first player hand to slot 2, cards corresponding to the dealer hand to slot 1, the cards corresponding to the community cards to slot 8, etc., and with discards or extra cards routed to other slots. This aspect of the invention is illustrated in FIG. 17, wherein the secondary controller **177** may create a third data set which comprises an assignment of each physical card to one of the card locations (card receiver pockets **92** in this example).

[0207] The secondary controller **177** may then activate the movable sidewall **80**, such as by activating motor **M1**, in order to begin processing of the cards, as at step S6. As indicated above, this activation may cause the movable sidewall **80** to move from a vertical position to a tilted position in which it contacts the cards in the card receiving area **70**. At the same time,

the secondary controller **177** preferably actuates or drives the card infeed mechanism, such as by activating motor **M2** and driving the rollers **84**, thus drawing cards from the bottom of the card receiving area **80**, such as indicated at step **S7**.

[0208] In step **S8**, each in-fed card may be read by the card reader **180** and that read card information is analyzed and is stored in a read card data structure, such as in the first memory **178** (or a memory associated with the card reader, etc.). In one example, this structure associates each read card (using its ordinal number) with its card information, such as “Physical Deck Card 1: A♠; Physical Deck Card 2: 4♥, etc.). This aspect of the invention is illustrated in FIG. 17, wherein a second data set is created, where the second data set comprises card information for each physical card.

[0209] In step **S9**, each card is routed to the card receiver **90** for placement in a slot or pocket **92** – as assigned in step **S5** noted above. Importantly, in one example, the placement process is performed by the secondary controller **177** which operates the card receiver **90**, which processor is, as noted above, separate from the shuffler’s main controller **175**. The secondary controller **177** preferably moves the card receiver **90** (such as by activation of motor **M4**) so that the pocket **92** to which each card is assigned is aligned with the incoming card, allowing each card to be moved to its assigned pocket. In one example, this process of in-feeding cards and directing them to pockets continues (as at step **S10**) until all cards have been processed from the card receiving area **70** (at which point the infeed mechanism may be deactivated, including by moving the movable sidewall **80** back to its vertical position and turning off the motors **M2** and **M3** which drive sets of the rollers **84**).

[0210] In one example, the shuffler **20** is capable of generating information regarding each dealt hand, undealt hand, etc., as in step **S11**. This information is generated by the main controller **175**, which matches the read card information to the virtual deck information. As indicated, because the ordinal number of each card in the physical deck that is being shuffled is mapped to a virtual deck position via the virtual deck information and because the read card information maps the ordinal number of each card to respective read card data via the read card information, mapping of the read card information to the virtual deck information thus accurately maps the read card data to the cards that are dealt in the game, and particularly to each hand or other location. This is done independently of the card receiver or pocket **92** locations where the cards are assigned by the secondary controller **177**. For example, as illustrated in FIG. 17, the hand information may be generated by simply linking the card information for each read card to the corresponding card in the virtual deck – e.g. in

the example provided, “card 2” is known to be the 4♥, and card 2 was assigned to Player Hand 1 in the virtual deck, so it is then known that the 4♥ is one of the cards of Player Hand 1 as formed and outputted by the shuffler (this information may be generated by linking the first and second data sets, including by forming a new combined data set). The correlation of the read card data to the virtual deck may be performed by the main controller 175 prior to the cards being moved from the card receiver 90 to the card dispensing area 72 for dealing. However, to ensure that this information is not available to the dealer or players before the game is complete (such as for recall or display via the display 44), the correlated information is sequestered in a secure memory (such as first memory 178 or a separate memory) and can’t be accessed.

[0211] The cards may then be ejected. As indicated, in step S12, the main controller 175 (either directly or via the secondary controller 177) may cause the card receiver 90 to move vertically up and down so that individual pockets 92 are aligned with the card ejector 150. The main controller 175 (either directly or via the secondary controller 177) may then activate the card ejector 150, causing the pusher 152 to push the cards associated with a pocket 92 out of the card receiver 90, as at step S13, so that the cards are dispensed into the card dispensing area, as reflected at step S14, where they may be retrieved by the dealer. As indicated herein, in one example, the main controller 175 is configured to process the cards into one or more groups, such as hands, whereby the hands (whether player hands, a dealer hand, one or more community cards, etc.) are dispensed to the card dispensing area 72 for retrieval by the dealer.

Advantages and other aspects of the design

[0212] The shuffler 20 may have various advantages and solve various problems over existing shuffling or card handling devices.

[0213] Advantages of the top of the card dispensing area 72 being higher than the top of the card receiving area 70 may be that it facilitates a card receiver 90 (described below) that has numerous card slots or pockets 92, while still permitting the card receiver 90 to have the range of motion (in the vertical direction) which is necessary to both align the pockets thereof with cards being fed into the pockets by the card infeed mechanism of the shuffler, and also to allow the card receiver 90 to move vertically to a position in which the pockets 92 can be aligned with the card ejector 150.

[0214] As indicated, another feature of the disclosure is a shuffler 20 having a card receiving area 70 with a moveable sidewall 80. The moveable sidewall 80 forms a portion of

the card receiving area **70**, such as one sidewall thereof, when in a first or vertical position. At the same time, the movable sidewall **80** can be tilted into the card receiving area **70** to engage the top of the one or more cards therein, thus aiding in forcing the cards downwardly to be drawn from the bottom of the card receiving area **70** into the shuffler **20** by the infeed mechanism. This design is compact and does not require a separate arm or weight that takes up space in the shuffler **20** and requires other components to be relocated.

[0215] In one example of the disclosure, the shuffler **20** generates three different data sets or structures: 1) a virtual deck information; 2) read card information and 3) card receiver location information. In this configuration, the processor (e.g. the secondary controller **177**) which operates the card receiver generates the card receiver or pocket location information for each card, but is not provided with, and thus does not know and does not need or use, the read card information (rank/suit) of any card in the card receiver **90**. Correspondingly, the main controller **175** generates the virtual deck information and is provided with the read card information (rank/suit), but is not provided with, and thus does not know and does not need or use, the card receiver or pocket location information indicating the location where the cards are assigned in the card receiver.

[0216] One advantage of such a configuration is that the main controller **175** of the shuffler **20** does not need to be customized to work with a particular shuffling apparatus, such as a particular card receiver. Instead, the main controller **175** only needs to provide a generic virtual deck output, and does not have to generate card location data which is specific to a particular card receiver or be capable of generating specific instructions for moving (e.g., operating) the card receiver. Thus, the main controller **175** could work with various types of card receivers, where the card receiver, including its physical structure and sub-processor, are configured as a “plug and play” unit. Another advantage is that in this configuration, information regarding the compositions of the hands used in the game doesn’t rely on where the cards are placed into a carousel, receiver or other structure. Instead, the read card information is mapped directly to the virtual deck, and thus to the actual card hands which are dealt by the dealer.

Second Embodiment of a Shuffler

[0217] With reference to FIGS. 18A-18D, 19, 20A-20B, 21, 22, 23A-23B, 24-27, 28A-28B, 29A-29B, 30A-30B, 31A-31B, 32A, 32B, and 33A-33B, a shuffling device or card shuffler **400** according to a second embodiment is shown. The card shuffler **400** is a multi-pass shuffler that automatically performs two pass or two shuffling operations (see above).

[0218] With specific reference to FIG. 18A, the card shuffler **400** includes the controller **7**, an infeed elevator **410**, an outfeed elevator **412**, the card shuffling mechanism **6**, the card reader **5**, the card receiver **8**, and a pusher mechanism **14**. In the illustrated embodiment, the card shuffling mechanism **6** includes a transport mechanism **18**, a card stack moving mechanism **430**, and a card receiver lifting mechanism **450**.

[0219] As shown in FIGS. 18B-D, the card shuffler **400** includes a top **402** with a top surface **404**. The card shuffler **400** may be configured to be installed within a cabinet or a table (such as a gaming table) (not shown). The top surface **404** of the top **302** may be configured to be flush with a top of the cabinet or table in which the card shuffler **400** is installed.

[0220] The card shuffler **400** may include a user interface **406** with a display **408**, an infeed elevator **410** and an outfeed elevator **412**. In general, the infeed elevator **410** may rise to the top of the table so that unshuffled cards may be loaded into the infeed elevator **410** and lower the cards to the shuffling mechanism **6** (see below). The outfeed elevator **412** catches or receives ejected cards from the card receiver **8** (see below). The user interface **406** may also include a plurality of user inputs (not shown) which may include a number of mechanical switches, buttons and/or touchscreen buttons (not shown) implemented on the display **408**. The user interface **406** is coupled to the controller **7** and allows a user to control the card shuffler **400**.

[0221] In the illustrated device, the card receiving area **4** is implemented or embodied in the infeed elevator **410**. The infeed elevator **410**, under the control of the controller **7**, may rise, in response to user actuation of the user interface **406** (see FIG. 18). This allows the user to place or insert, in the direction of arrow **414**, a set of unshuffled cards into the infeed elevator **410**. In the illustrated embodiment, the infeed elevator **410** may accommodate up to eight decks of playing cards.

[0222] Once the user has inserted the cards, the infeed elevator **410** may be lowered through the user interface **406**. As shown in FIG. 19, card shuffling device **400** includes a frame **416**, located below the top **402**, in which the other components of the card shuffling device **400** are mounted. With reference to FIG. 19, the infeed elevator **410** may be raised and lowered in directions along arrow **418**. In the illustrated embodiment, the infeed elevator **410** may be raised and lowered via a motor (and series of belts and rollers (see below) under control of the controller **7**.

[0223] The shuffling mechanism **6** may include a serial of infeed rollers **420** for

transporting individual cards from the bottom of the infeed elevator **410** towards the card receiver **8**. With reference to FIGS. 28A-28B, the card receiver **8** may include a shuttle **422**. In the illustrated embodiment, the shuttle **322** includes twenty-two pockets or shelves **424**. Twenty-one of the pockets **424** are used in the shuffling process (see above) and one of the pockets **424** may be used for discards. Further, in the illustrated embodiment, each pocket **424** may hold at least twenty-one cards.

[0224] The controller **7** controllably moves the shuttle **422**, via an appropriate motor (see below) relative to the shuffling mechanism **6** and the infeed rollers **420** to align a respective one of the pockets **424** with the infeed rollers **420**. As discussed above, as the physical cards are fed through the shuffling mechanism **6** (in the direction of arrow **444**) by the infeed rollers **420**, the card reader **5** establishes card information, including value and suit, and the controller determines which pocket **324** in which the card should be deposited. The controller **7** moves the shuttle **422** up or down accordingly such that each card may be deposited into the correct or desired pocket **424**.

[0225] With specific reference to FIG. 21, the card shuffler **400** may further include a card ejector mechanism **426**. As shown, the card ejector **426** may include a pusher **428** for ejecting cards from each pocket **424**. The pusher **428** of the card ejector **426** may be configured to push the cards in each pocket **424** into the outfeed elevator **412**. In the illustrated embodiment, the cards are ejected into the outfeed elevator **412** at the end of each pass. At the end of each pass, the shuttle **422** is moved to align the shuttle **422** with the card ejector **426** such that each of the pockets **424** of the shuttle **422** is aligned with the pusher **428** in turn. For example, first the twenty-first pocket **424** may be aligned with the pusher **428** and the pusher extended (as shown in FIG. 21) to push the cards in the twenty-first pocket **424** into the bottom of the outfeed elevator **412**. Then the shuttle **422** may be moved to align the twentieth pocket **424** with the pusher **428** and the pusher extended to push the cards in the twentieth pocket **424** into the outfeed elevator **412** on top of the cards from twenty-first pocket. This is repeated until all of the pockets **424** have been emptied. In this manner, a set of partially shuffled card is formed at the end of the first pass and a set of shuffled cards is formed at the end of the second pass (see above).

[0226] With specific reference to FIGS. 22-23 and FIGS. 30A-30B, in the illustrated embodiment the card shuffler **400** may further include a card stack moving mechanism **430** configured to move (in the direction of arrow **432**) the cards in the outfeed elevator **412** back into the infeed elevator **410** at the end of the first pass. In the illustrated embodiment, the card

stack moving mechanism **430** constrains the cards on at least three sides and moves the entire stack of cards in the outfeed elevator **412** to the infeed elevator **410** along a set of tracks (not shown). As shown in FIGS. 30A-30B, the card stacking moving mechanism **430** may include a motor (not shown) and one or more bands **429**, under control of the controller **7** to controllably move the card stacking mechanism **430**.

[0227] Once the cards are back into the infeed elevator **410**, the cards may be fed through the shuffling mechanism **6** during the second pass and sorted into the pockets **424** of the shuttle **422** (FIG. 24). Once the second pass has been completed, the cards in the pockets **424** of the shuttle **422** may again be ejected into the outfeed elevator **412** using the card ejector **426** and the pusher **428** (FIG. 25).

[0228] Once the cards have been ejected from the shuttle **422**, the set of shuffled cards is located within the outfeed elevator **412** and the outfeed elevator **412** may be raised in the direction of arrow **434** (see FIG. 26) such that the shuffled card may be removed (by a user) in the direction of arrow **436** (see FIG. 27).

[0229] Generally, with reference to the drawings and in operation, the shuttle **422**, card ejector **426**, and card stack moving mechanism **430**, are moveable under control of the controller **7** using a series of motors and belts.

[0230] With specific reference to FIGS. 20A and 20B, in one embodiment, the set of rollers **420** of the transport mechanism **18** includes a first set of rollers **340** and a second set of rollers **342**. The first set of rollers **340**, under control of the controller **7**, controllably moves the cards from the first card receiving area **4** into the shuffling mechanism **6**. The second set of rollers **342**, under control of the controller **7**, controllably moves the cards from intermediate area **344** into the card receiver **8**.

[0231] With specific reference to FIG. 20A, the first set of rollers **340** are driven by a first motor **346** and a set of belts **348** and the second set of rollers **342** are driven by a second motor **350** and a set of belts **352**. The card reader **5** is positioned adjacent the intermediate position **344**.

[0232] Under control of the controller **7**, the first motor **346** drives the first set of rollers **342** at a first speed to grab the bottom-most card in the first card receiving area **4** and transporting the card towards the intermediate position **344**. Once the card reaches the intermediate position **344**, the first motor **346** and the first set of rollers **340** are paused, allowing the card reader **5** to obtain card information from the card. Thereafter, the second motor **350** drives the second set of rollers **342** at a second speed to transport the card from the

intermediate position **344** to, and into, the card receiver **8**. The second speed may be greater than the first speed to ensure the card has been moved out of the intermediate area **344** before the next card is transported by the first set of rollers **340** into the intermediate area **344**.

[0233] With reference to FIGS. 18A, 19, and 21, the card receiver lifting mechanism **450** includes a third motor **354** and a band **356**. The third motor **354**, under control of the controller **7** raises and lowers the card reader **5**.

Card Stack Pusher

[0234] As discussed above, in the second embodiment, the card shuffler **400** may include a card stacking moving mechanism or card stack pusher **430** configured to move the partially shuffled cards (after the first pass) from the outfeed elevator **412** back to the infeed elevator **410** (in the direction of arrow **429**). With particular reference to FIGS. 35A-35B, in one embodiment the card stack moving mechanism **430** may include a card retention structure **438** configured to surround a stack of cards (represented by box **440** in FIG. 35A).

[0235] The card retention structure **438** includes two side plates **442**, a rear plate **444**, and a bracket **448**. The two side plates **442** and rear plate **444** may be machined from any suitable metal or made from any suitable material. In the illustrated embodiment, the side plates **442** are connected to the rear plate **444** by suitable fasteners **446**. The bottom of the stack of cards **440** may be supported by, and slid over, a plate (not shown).

[0236] The card stack moving mechanism **430** allows the card shuffler device **400** to move the partially shuffled cards from the outfeed elevator **412** back to the infeed elevator **410** to complete the dual pass shuffling process (without requiring the dealer to remove the partially shuffled cards from the outfeed elevator **412** and insert the cards back into the infeed elevator **410**).

[0237] The bracket **448** may be connected to the stepper motor **431** by a band or belt **429** (see above). The card stacking moving mechanism **430** may be configured to move the stack of cards **440** a predetermined stroke distance, e.g., 7", from the outfeed elevator to the infeed elevator.

[0238] In the illustrated embodiment, the card stack moving mechanism **30** may be configured to move all of the cards being shuffled, for example, up to 8 decks of cards. In alternative embodiments, the card stack moving mechanism **30** may be configured to move less than all of the cards being shuffled in a single stroke, thus requiring multiple strokes or pushes to move all of the cards.

Card Receiver Lifting Mechanism with Counterweight

[0239] As discussed above, the card shuffler device **400** may include a card receiver lifting mechanism **450** coupled to the card receiver **8** or shuttle **422** and configured to controllably raise and lower the shuttle **422** relative to the shuffling mechanism **6**. With reference to FIGS. 18A, 19, 21, 37A-37E, the card receiver lifting mechanism **450** may include a frame **452**, an upper roller **454**, a lower roller **456**, a belt **458**, and a third motor **460**.

[0240] In the illustrated embodiment, the frame **452** is formed by the card shuffler device **400** and includes an upper end **452A** adjacent the top **402** of the card shuffler device **400** and a lower end **452B** adjacent or near the bottom of the card shuffler device **400**. As shown, the upper roller **454** is positioned or mounted near the top end **452A** of the frame **452**. The lower roller **456** is positioned or mounted near the bottom end **452B** of the frame **452**. The belt **458** is suspended between the upper and lower rollers **454**, **456**. In other words, the belt **458** is positioned around the outer surface of the rollers **454**, **456**. In one embodiment, the belt **458** is under tension providing a friction interface between the belt **458** and the rollers **454**, **456**.

[0241] In an other embodiment, the rollers **454**, **456** may be gears, i.e., or have teeth or ridges and the belt **458** may be complimentary teeth or ridges along an inner surface of the belt **458** forming a friction interface therebetween.

[0242] The motor **460** is coupled to one of the upper and lower rollers **454**, **456** and is configured to controllably rotate the one of the upper and lower rollers **454**, **456**. In the illustrated embodiment, the motor **460** is coupled lower roller **456**.

[0243] As shown, the shuttle **422** is mounted to, or connected to one side of the belt **458**. During operation, the shuttle **422** exerts forces due to the weight and inertia of the shuttle **422** upon the motor **460**, the belt **458**, the interface therebetween, and associated mechanisms. In the illustrated embodiment a counterweight **462** is coupled to an opposite side of the belt **458**. In operation, when the shuttle **422** goes up, the counterweight **462** goes down, and vice versa.

[0244] In FIG. 37A, the counterweight **462** is located adjacent the top end **452A** of the frame and the shuttle **422** is located adjacent the bottom end **452B** of the frame **452**. In FIG. 35B, the counterweight **462** is located adjacent the bottom end **452B** of the frame and the shuttle **422** is located adjacent the top end **45A** of the frame **452**. In FIG. 35C, the counterweight **462** and the shuttle **422** are located at or near a mid-point between the top end **452A** of the frame and the bottom end **452B** of the frame **452**.

[0245] With reference to FIGS. 37D-37E, in one embodiment the counterweight **462** is connected to the belt **458** via a bracket **464**. In the illustrated embodiment, the bracket **464** may be connected to the counterweight **462** via a plurality of fasteners **466**.

[0246] In one embodiment, the bracket 464 includes a first bracket member 464A and a second bracket member 464B. The first and second bracket members 464A, 464B are fastened together via a plurality of fasteners 468. In the illustrated embodiment, the belt 458 is sandwiched between the first and second bracket members 464A, 464B, creating a friction interface therebetween.

Dual-Pass Shuffling or Sorting Example

[0247] With reference to FIGS. 34A-34H, a dual-pass or shuffling or sorting example will now be explained. In this example, a deck of 25 cards will be sorted into a desired card sequence. The desired card sequence may be a random sequence that is predetermined or some other predetermined sequence. In this example, the cards are represented by a double digit using only the digits 1-5, which in this example correlates to five separate shelves. With reference to FIG. 34A, a representation of the entire deck of cards using two digits is shown. In this example, the representation in FIG. 34A represents the desired card sequence, with the left most card in the representation, "11" being the bottom card and the right most card, "55" being the top card in a vertically stacked deck of cards.

[0248] A representation of the input or scrambled sequence of cards is shown in FIG. 34B. This scrambled sequence of cards could represent the state of the deck of the cards after having been used. In FIG. 34B, in the illustrated embodiment, the left most card, "52", represents the first card to be initially sorted by the dual pass shuffler and the right most card, "32" represents the last card to be initially sorted.

[0249] As discussed above, the input or scrambled sequence of cards may be fed one at a time into the dual pass card shuffler 400. In this example, in the first pass the cards are sorted or placed into the shelves based on or otherwise correlate to the second digit. Thus with reference to FIG. 34C, the first card from the input sequence, i.e., the "52" card is inserted into the second shelf (sh2). The second card, "33", is inserted into the third shelf (sh3), and the third card, "24" is inserted into the fourth shelf (sh4).

[0250] With reference to FIG. 34D, the rest of the cards are sorted or inserted into one of the shelves (sh1-sh5) accordingly. It should be noted that in the illustrated embodiment, the cards are inserted into the shelves at the top of the shelf. In other words, if the card is the first card inserted into a shelf, it is on the bottom of the shelf. Subsequent cards are inserted on top of the card(s) already in the shelf. This, in the illustrated embodiment, the cards in the first column of each shelf represent the bottom most card in the shelf.

[0251] As discussed above, the cards may then be ejected from the shelves. In the

illustrated embodiment, the cards in the first shelf, sh1, are ejected first. Then the cards in the second shelf, sh2, are ejected on top of the cards from the first shelf, and so on, resulting in an interim or partially shuffled or sort deck of cards.

[0252] With reference to FIG. 34E, a representation of the sequence of the partially shuffled or sorted deck of cards is shown, with the left most card, “11” being the bottom card and the right most card in the sequence, “25” being the top card.

[0253] The cards may then be fed one at a time (from the bottom of the stack of cards) back into the dual pass card shuffler 400. In this example, in the second pass the cards are sorted or placed into the shelves based on or otherwise correlate to the first digit. Thus with reference to FIG. 34F, the first card from the bottom of the input sequence, i.e., the “11” card is inserted into the first shelf (sh2). The second card, “31”, is inserted into the third shelf (sh3), and the third card, “41” is inserted into the fourth shelf (sh4). With reference to FIG. 34G, the rest of the cards are sorted or inserted into one of the shelves (sh1-sh5) accordingly.

[0254] The cards may then be ejected from the shelves. In the illustrated embodiment, the cards in the first shelf, sh1, are ejected first. Then the cards in the second shelf, sh2, are ejected on top of the cards from the first shelf, and so on, resulting in the desired sequence of cards (see FIG. 34H).

[0255] From the example illustrated in FIGS 34A – 34H, and with further reference to FIGS. 1B – 1D and FIG. 16, it is illustrated how a typical deck of playing cards can be shuffled by a dual pass shuffler 400. In one embodiment of the present example, a controller assigns an individual card rank to each of the referenced card numbers above, “11” through “55”. In such an example, it could be that the controller determines that the Ace of Hearts (which in this example is included within the twenty-five cards being shuffled) should, at the end of the dual pass shuffling, be positioned in the seventh card position, so the controller assigns card number “22” to the Ace of Hearts, and then proceeds through the shuffling as disclosed in FIGS. 34A – 34H.

[0256] In another example, where the sample deck has multiple Aces of Hearts, the Controller can assign the first Ace of Hearts sorted to card number “22” and the subsequent Ace of Hearts sorted to the subsequent card number assigned. For instance, if the stack cards to be sorted includes several decks of cards (having the same number of cards with the same face values), the stack of cards will include multiple instances of a card with the same face value. Each of these multiple instances will have a unique card number assigned and can then be sorted or shuffled into the correct location in the desired card sequence.

[0257] FIGS 34A – 34H further help illustrate the benefits of the present disclosure, including a reduced number of shelves required to adequately shuffle a number of playing cards. A further benefit is that by utilizing a dual sorting methodology, the first sorting of cards according to the illustrated example (e.g., by correlating the second number to the shelf) ensures that the second sorting of cards according to the illustrated example (e.g., by correlating the first number to the shelf) will result in the desired order of the finally shuffled cars, as determined by the controller. This is managed, in the present example, through the controller mandating that after the first pass the first shelf (s1) (FIG. 24D) is the first shelf to eventually be sorted in the second pass, so that each of the cards assigned with a “1” as the second digit will be the first cards allocated to shelves in the second pass, as illustrated in FIGS. 34F – 34G.

[0258] It will be understood that the above-described arrangements of apparatus and the method there from are merely illustrative of applications of the principles of this disclosure and many other embodiments and modifications may be made without departing from the spirit and scope of the disclosure as defined in the claims.

[0259] The foregoing invention has been described in accordance with the relevant legal standards, thus the description is exemplary rather than limiting in nature. Variations and modifications to the disclosed embodiment may become apparent to those skilled in the art and fall within the scope of the invention.

What is claimed is:

1. A shuffling device, comprising:

a frame;

a first card receiving area for receiving a set of cards;

a card receiver movably coupled to the frame and having a plurality of card receiving pockets;

a shuffling mechanism coupled to the frame and being associated with the first card receiving area, the shuffling mechanism configured to receive cards from the cards receiving area and to controllably place the cards into respective card receiving pockets;

a card reader coupled to the frame and being associated with the shuffling mechanism, the card reader configured to read card information from the cards as the cards pass through the shuffling mechanism;

a controller connected to the card reader and the shuffling mechanism, the controller configured to perform the steps of:

establishing a virtual deck structure, the virtual deck structure defining a virtual card assignment for a plurality of cards, the virtual deck structure being a matrix having a plurality of cells organized in a predetermined number of rows and a predetermined number of columns, each card of the plurality of cards being associated with one of plurality of cells within the matrix, the number of card receiving card receiving pockets being equal to or greater than the predetermined number of rows and columns in the matrix;

performing a first pass including the steps of:

using the shuffling mechanism, feeding cards one at a time from the set of cards in the first card receiving area of the shuffling device into the shuffling mechanism;

using the card reader, reading card information from each of the cards fed from the first card receiving area;

generating information regarding a first assigned card receiving pocket for each of the cards fed from the first card receiving area based on the associated card information and the virtual deck structure;

using the shuffling mechanism, delivering the cards, into the associated first assigned card receiving pockets forming a partially shuffled set of cards; and

performing a second pass including the steps of:

using the shuffling mechanism, placing the partially shuffled set of cards into the first card receiving area of the shuffling device;

using the shuffling mechanism, feeding cards one at a time from the partially shuffled set of cards in the first card receiving area into the shuffling device;

using the card reader, establishing card information for each of the cards fed from the first card receiving area;

generating information regarding a second assigned card receiving pocket for each of the cards fed from the first card receiving area based on the associated card information;

using the shuffling mechanism, delivering the cards, into the associated second assigned card receiving pockets forming a shuffled set of cards.

2. The shuffling device, as set forth in claim 1, further comprising an infeed elevator defining the first card receiving area, the first infeed elevator being connected to the controller, the controller being configured to controllably raise and lower the infeed elevator relative to a top of the shuffling device.

3. The shuffling device, as set forth in claim 1, the shuffling mechanism including a transport mechanism for controllably moving cards from the first card receiving area into the shuffling mechanism.

4. The shuffling device, as set forth in claim 3, the transport mechanism including a first set of rollers configured to transport cards from the first card receiving area to an intermediate position, the card reader being positioned adjacent the intermediate position.

5. The shuffling device, as set forth in claim 4, the transport mechanism including a second set of rollers configured to transport cards from the intermediate position into the card receiver.

6. The shuffling device, as set forth in claim 5, wherein the first and second set of rollers are controllably driven by respective motors controlled by the controller.

7. The shuffling device, as set forth in claim 6, wherein the first set of rollers are driven at a first speed and the second set of rollers are driven at a second speed, the second speed being greater than the first speed.

8. The shuffling device, as set forth in claim 1, including a pusher mechanism configured to push cards from each of the pockets of the card receiver into a second card receiving area at the end of the first pass.

9. The shuffling device, as set forth in claim 8, including a card stack moving mechanism configured to move the cards in the second card receiving area to the first card

receiving area after the pusher mechanism pushes the cards from the card receiver into the second card receiving area.

10. The shuffling device, as set forth in claim 9, wherein the card stack moving mechanism includes a card retention structure configured to surround a stack of cards around three sides.

11. The shuffling device, as set forth in claim 10, wherein the card retention structure includes three plates and a bracket.

12. The shuffling device, as set forth in claim 11, wherein the card stack moving mechanism further includes a stepper motor and a belt, the belt being connected between the bracket and the motor, the card stacking moving mechanism configured to move the stack of cards a predetermined stroke distance between the outfeed elevator to the infeed elevator.

13. The shuffling device, as set forth in claim 9, including an outfeed elevator defining the second card receiving area, the outfeed elevator being connected to the controller, the controller being configured to controllably raise and lower the outfeed elevator relative to a top of the shuffling device.

14. The shuffling device, as set forth in claim 1, including a card receiver lifting mechanism coupled to the card receiver and configured to controllably raise and lower the card receiver.

15. The shuffling device, as set forth in claim 14, the card receiver lifting mechanism including:

a lifting mechanism frame having an upper end and a lower end;

an upper roller coupled to the upper end of the lifting mechanism frame;

a lower roller coupled to the lower end of the lifting mechanism frame;

a belt suspended between the upper and lower rollers;

a motor coupled to one of the upper and lower rollers configured to controllably rotate the one of the upper and lower rollers, wherein the card receiver is coupled to one side of the belt; and,

a counterweight coupled to another side of the belt.

16. A shuffling device, comprising:

a frame;

a first card receiving area for receiving a set of cards;

a card receiver movably coupled to the frame and having a plurality of card receiving pockets;

a shuffling mechanism coupled to the frame and being associated with the first card receiving area, the shuffling mechanism configured to receive cards from the cards receiving area and to controllably place the cards into respective card receiving pockets;

a card reader coupled to the frame and being associated with the shuffling mechanism, the card reader configured to read card information from the cards as the cards pass through the shuffling mechanism;

a controller connected to the card reader and the shuffling mechanism, the controller configured to perform first and second passes on the set of cards;

an infeed elevator defining the first card receiving area, the first infeed elevator being connected to the controller, the controller being configured to controllably raise and lower the infeed elevator relative to a top of the shuffling device;

a transport mechanism for controllably moving cards from the first card receiving area into the shuffling mechanism, the transport mechanism including a first set of rollers and a second set of rollers, the first set of rollers configured to transport cards from the first card receiving area to an intermediate position, the card reader being positioned adjacent the intermediate position, the second set of rollers configured to transport cards from the intermediate position into the card receiver, the first and second set of rollers are controllably driven by respective motors controlled by the controller, wherein the first set of rollers are driven at a first speed and the second set of rollers are driven at a second speed, the second speed being greater than the first speed;

a pusher mechanism configured to push cards from each of the pockets of the card receiver into a second card receiving area at the end of the first pass; and

a card stack moving mechanism configured to move the cards in the second card receiving area to the first card receiving area after the pusher mechanism pushes the cards from the card receiver into the second card receiving area, the controller configured to perform the steps of:

establishing a virtual deck structure, the virtual deck structure defining a virtual card assignment for a plurality of cards, the virtual deck structure being a matrix having a plurality of cells organized in a predetermined number of rows and a predetermined number of columns, each card of the plurality of cards being associated with one of plurality of cells within the matrix, the number of card receiving card receiving pockets being equal to or greater than the predetermined number of rows and columns in the matrix;

performing the first pass including the steps of:

using the shuffling mechanism, feeding cards one at a time from the set of cards in the first card receiving area of the shuffling device into the shuffling mechanism;

using the card reader, reading card information from each of the cards fed from the first card receiving area;

generating information regarding a first assigned card receiving pocket for each of the cards fed from the first card receiving area based on the associated card information and the virtual deck structure;

using the shuffling mechanism, delivering the cards, into the associated first assigned card receiving pockets forming a partially shuffled set of cards; and

performing the second pass including the steps of:

using the shuffling mechanism, placing the partially shuffled set of cards into the first card receiving area of the shuffling device;

using the shuffling mechanism, feeding cards one at a time from the partially shuffled set of cards in the first card receiving area into the shuffling device;

using the card reader, establishing card information for each of the cards fed from the first card receiving area;

generating information regarding a second assigned card receiving pocket for each of the cards fed from the first card receiving area based on the associated card information;

using the shuffling mechanism, delivering the cards, into the associated second assigned card receiving pockets forming a shuffled set of cards.

17. The shuffling device, as set forth in claim 16, wherein the card stack moving mechanism includes a card retention structure configured to surround a stack of cards around three sides.

18. The shuffling device, as set forth in claim 17, wherein the card retention structure includes three plates and a bracket.

19. The shuffling device, as set forth in claim 18, wherein the card stack moving mechanism further includes a stepper motor and a belt, the belt being connected between the bracket and the motor, the card stacking moving mechanism configured to move the stack of cards a predetermined stroke distance between the outfeed elevator to the infeed elevator.

20. The shuffling device, as set forth in claim 16, including an outfeed elevator defining the second card receiving area, the outfeed elevator being connected to the controller,

the controller being configured to controllably raise and lower the outfeed elevator relative to a top of the shuffling device.

21. The shuffling device, as set forth in claim 16, including a card receiver lifting mechanism coupled to the card receiver and configured to controllably raise and lower the card receiver.

22. The shuffling device, as set forth in claim 21, the card receiver lifting mechanism including:

- a lifting mechanism frame having an upper end and a lower end;

- an upper roller coupled to the upper end of the lifting mechanism frame;

- a lower roller coupled to the lower end of the lifting mechanism frame;

- a belt suspended between the upper and lower rollers;

- a motor coupled to one of the upper and lower rollers configured to controllably rotate the one of the upper and lower rollers, wherein the card receiver is coupled to one side of the belt; and,

- a counterweight coupled to another side of the belt.

23. A method of shuffling cards using a shuffling device, the shuffling device including a card receiving area, a shuffling mechanism, and a card receiver having a plurality of card receiving pockets, comprising:

- establishing a virtual deck structure, the virtual deck structure defining a virtual card assignment for a plurality of cards, the virtual deck structure being a matrix having a plurality of cells organized in a predetermined number of rows and a predetermined number of columns, each card of the plurality of cards being associated with one of plurality of cells within the matrix, the number of card receiving card receiving pockets being equal to or greater than the predetermined number of rows and columns in the matrix;

- performing a first pass including the steps of:

 - placing a set of cards into the card receiving area of the shuffling device;

 - feeding cards one at a time from the card receiving area of the shuffling device into the shuffling mechanism;

 - reading card information from each of the cards fed from the card receiving area;

 - generating information regarding a first assigned card receiving pocket for each of the cards fed from the card receiving area based on the associated card information and the virtual deck structure;

delivering the cards, using the shuffling device, into the associated first assigned card receiving pockets forming a partially shuffled set of cards; and
performing a second pass including the steps of:

placing the partially shuffled set of cards into the card receiving area of the shuffling device;

feeding cards one at a time from partially shuffled set of cards in the card receiving area of the shuffling device;

reading card information from each of the cards fed from the card receiving area;

generating information regarding a second assigned card receiving pocket for each of the cards fed from the card receiving area based on the associated card information;

delivering the cards, using the shuffling device, into the associated second assigned card receiving pockets forming a shuffled set of cards.