

Oct. 1, 1935.

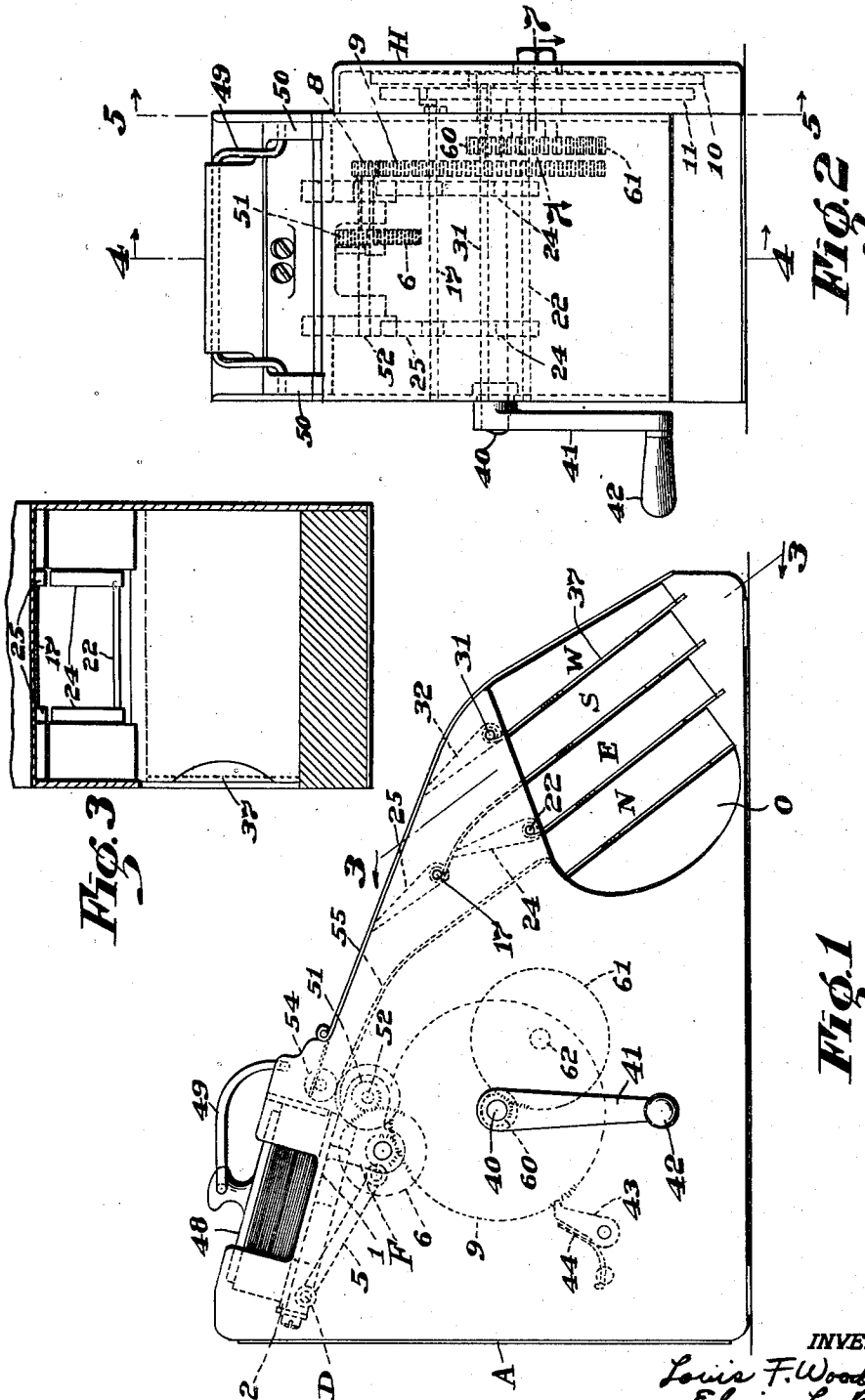
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2,016,030

CARD SHUFFLING AND DEALING DEVICE

Filed June 30, 1931

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

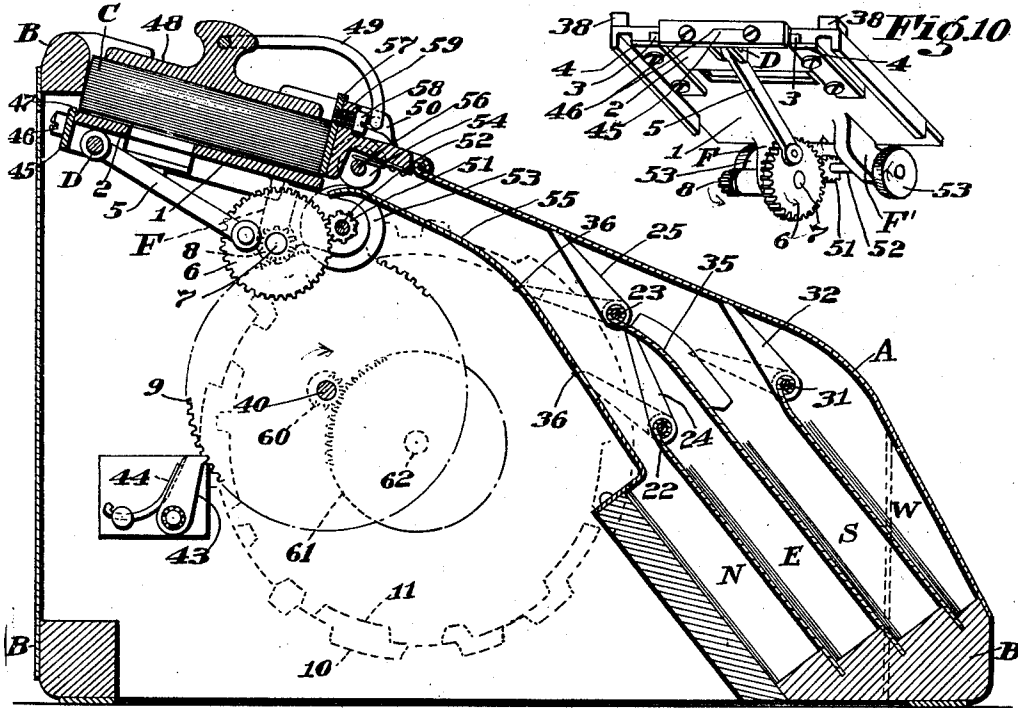


FIG. 4

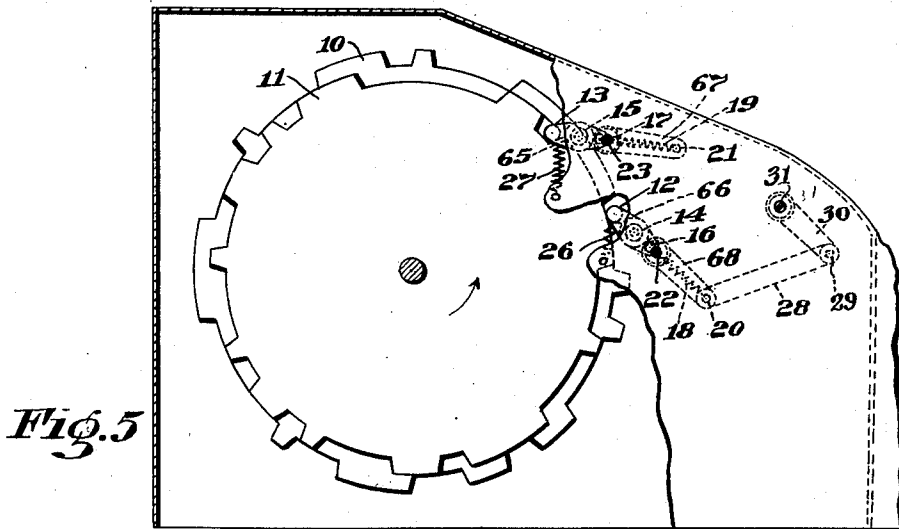


FIG. 5

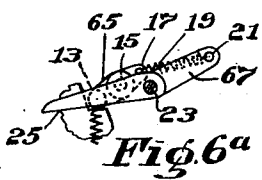


FIG. 6^a

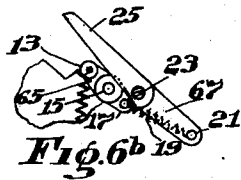


FIG. 6^b

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3 Sheets-Sheet 3

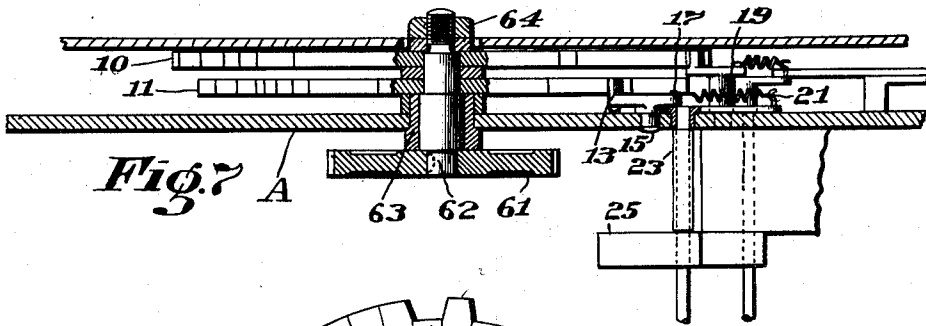


Fig. 7 A

Fig. 8

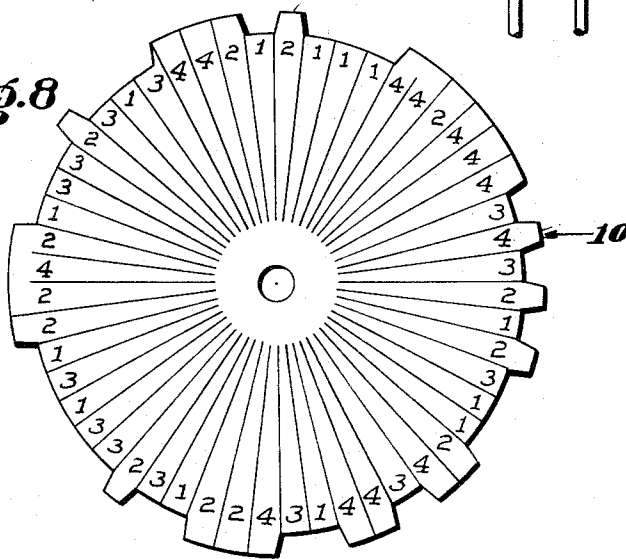
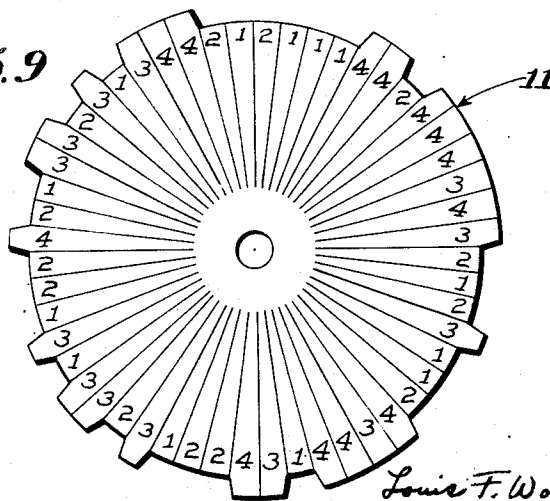


Fig. 9



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2,016,030

CARD SHUFFLING AND DEALING DEVICE

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Application June 30, 1931, Serial No. 547,848

19 Claims. (Cl. 273-149)

This invention relates to devices for shuffling and dealing playing cards.

In games which are played with cards in which an equal number of cards are distributed in rotation to each player around the board and in which a random distribution of the cards is desirable it has been customary to shuffle, cut and distribute the cards by hand. This practice has had several disadvantages. It usually requires that a plurality of decks of cards be used. It slows up the play of the game. It frequently results in a "misdeal", when the whole process has to be repeated. It leaves each player's hand in an untidy pile on the board, which results in more waste of time while the players put the hands in order, to be assorted properly for the play of the game.

The objects of our invention are to provide a simple, attractive, compact device which will eliminate all these disadvantages; to provide a device of such mechanical perfection and accuracy that any chance of misdeal is eliminated; and to provide a device so designed that it inevitably produces a normal random distribution of the cards.

The prior art dealing devices with which we are familiar are useful only in distributing the cards successively in rotation in the order in which they occur in the deck. It is apparent therefore that, in the prior art dealing devices, the order of the cards in the deck, as it is placed in the device to be distributed, is the determining factor in the ultimate distribution. In our device the original order of the cards in the deck plays a relatively unimportant part in the determination of the ultimate distribution.

These and further objects will be apparent from a detailed description of our device, taken in connection with the accompanying drawings, which illustrate a preferred embodiment of our novel concept. Variations in the means shown will be apparent to one skilled in the art and it is to be understood that we do not intend to limit ourselves except as indicated in the appended claims.

In a general way the operation of our device is as follows,—a deck of cards is placed on a support in a suitable receptacle, a hand crank is then turned and the cards are fed from the deck, one at a time, into several separate compartments or trays, where they are kept in neat order. All the cards falling in one compartment comprise a hand for one player. Shunting mechanism determines into which compartment any given card will fall, and the movement of this mechanism is determined by the shapes of cams which have been

designed in accordance with a predetermined mathematical formula which makes a normal random distribution of the cards inevitable, irrespective of the original order of the cards in the deck.

In the drawings:—

Fig. 1 is a side elevation of the right side of the device, with certain parts indicated in broken lines;

Fig. 2 is a front elevation of the device with 10 certain parts indicated in broken lines;

Fig. 3 is a sectional view taken on the line 3-3 of Fig. 1.

Fig. 4 is a sectional elevation view taken on the line 4-4 of Fig. 2 with the parts of the device 15 shown in broken lines;

Fig. 5 is a view taken vertically on the line 5-5 of Fig. 2;

Fig. 6a shows in detail a card guide finger and certain related mechanism;

Fig. 6b is a view of the parts shown in Fig. 6a in another position;

Fig. 7 is a horizontal sectional view of certain parts of the device taken on the line 7-7 of Fig. 2;

Fig. 8 shows the large cam in detail;

Fig. 9 shows the small cam in detail; and

Fig. 10 is a perspective view of the supporting platform, sliding member and card selector.

Referring to the drawings,—we enclose our device in a suitable casing A which may be constructed of any light weight, durable, attractive material. This casing may be built on a frame B as shown. The casing is cut away on one side as at O, Fig. 1, to give access to the compartments 35 where the cards fall to comprise the hands. A cam housing H projects slightly from one side of the casing (Fig. 2).

Referring to Figs. 4 and 10, a platform I forms the bottom of a box-shaped receptacle which receives the deck of cards C and supports it. Sliding member 2 is arranged to slide in grooves 3 formed on the under side of the platform by the members 4. One end of connecting link 5 is pivotally fixed to the sliding member by means of lugs and a pin as is clearly shown at D in Fig. 10. The other end of connecting link 5 is pivotally fixed to gear 6, which gear is fast on the end of shaft 7. Shaft 7 is supported by, and rotatably mounted in a suitable collar lug F which in turn depends from the under side of platform I. Pinion 8 is fast to the other end of shaft 7, and the pinion is in mesh with gear 9.

Gear 9 is fast on shaft 40 (Fig. 2), which shaft

extends through the device and outside the casing on the right side, being supported in a suitable bearing in the wall of the casing. Crank 41 is fast to that end of shaft 40 which extends beyond the casing, and handle 42 is rotatably mounted on crank 41 in the usual way. Dog 43, held in engagement with gear 9 by spring 44 prevents any counterclockwise rotation of the said gear. It is apparent that when handle 42 is rotated clockwise dog 43 will give and allow this movement by increasing the pressure on spring 44. By this gearing clockwise rotation of crank 41 will cause sliding member 2 to reciprocate backwards and forwards in grooves 3.

Card selector 45 is adjustably supported by screws 46 to the rear side of sliding member 2. By loosening the screws the card selector may be adjusted so that it projects above the upper surface of the sliding member to a height such that the card selector will engage the rear edge of, and push forward, the bottom card, and only the bottom card, each time the sliding member moves forward. The upper rear edge 47 of the card selector is preferably beveled or rounded so that on the return stroke of the sliding member the friction and wear on the now bottom card will be minimized.

Weight member 48 rests on the deck when the cards are placed in the receptacle preparatory to shuffling and dealing them. The weight acts to keep the cards in place and assures a positive contact between the card selector and the bottom card each time the sliding member moves forward. The arc of movement of weight member 48 is controlled by U-shaped member 49 on which the weight member is pivoted, and the ends of member 49 are turned at right angles and pivotally supported in lugs 50 (Fig. 2). Thus the weight member can be swung up and forward so that a deck of cards can be placed in the receptacle, whereupon the weight member is returned to its place on top of the deck.

Pinion 51 is fast on shaft 52, which shaft is rotatably mounted on suitable bearings in lugs F, F' (Fig. 10). Pinion 51 is in mesh with gear 6, so that when handle 42 is rotated in a clockwise direction it is apparent that shaft 52 will rotate in the same direction. Feed rollers 53 are fast on ends of shaft 52. The feed rollers may carry tires of rubber or other friction material, and they coast with rollers 54 to engage the bottom card as it is pushed forward by the card selector and carry it on to distributing platform 55. Rollers 54 are rotatably mounted on a shaft 56 which is mounted in suitable lugs on the inside walls of the casing. These rollers may also carry tires of rubber, and the shaft 56 may carry fixed collars abutting each roller to keep it properly located lengthwise of the shaft. Rollers 53 project through a recess slightly above the surface of platform 55 (Fig. 4).

The front wall 57 of the card receptacle is adjustably supported by screws 58 (Fig. 4). The adjustment may be effected by the use of offset screws or by vertical grooves in the frame members 59. Wall 57 is adjusted so that an aperture sufficient for the passage of one card only is formed between the lower edge of the wall and the surface of platform 1. It is apparent that the card selector will thus push the bottom card through the aperture a sufficient distance so that the leading edge of the card will be engaged by the rollers 53 and 54.

Pinion 60, fast on shaft 40, meshes with gear 61 which is fast on the inner end of stub cam

shaft 62 (Fig. 7). The inner end of shaft 40 is housed in a bearing fixed on the inner surface of casing A. Stub cam shaft 62 is mounted in a bushing 63 in the casing wall and the other end of the shaft 62 extends through the wall of cam housing H. The end of the shaft is threaded and nut 64 may be employed for adjusting the shaft lengthwise, after which nut 64 may be made fast to the shaft in any suitable way (Fig. 7). Cams 10 and 11 are fast on shaft 62.

Cam follower 13 (Figs. 5 and 7) rides on cam 11. The cam follower is mounted on one end of lever 65, which pivots on pin 15, which is suitably fixed in the casing wall. The cam follower is kept in constant engagement with cam 11 by tension spring 27. As cam follower 13 follows cam 11 it is apparent that lever 65 will pivot with a back and forth motion about pin 15. On the opposite end of lever 65 is pin 17 to which is attached one end of tension spring 20 19. The other end of spring 19 is attached by pin 21 to arm 67. Arm 67 is fixed at its other end to shaft 23, which is journaled in suitable bearings in the casing walls. Card guide fingers 25 are fast on shaft 23. The action of the card guide fingers is shown best in Figs. 6a and 6b. In Fig. 6a cam follower 13 is in its lower position. In this position spring 19 lies above the axis of shaft 23, and has rotated shaft 23 and card guide fingers 25 to their extreme counterclockwise position through the coaction with arm 67. Fingers 25 (Fig. 4) are now in position to shunt a card moving forward on platform 55 into either compartment S or compartment W, depending on the position of card guide fingers 32. In Fig. 6b cam follower 13 has been raised by one of the raised portions of cam 11. In this position spring 19 lies below the axis of shaft 23, and its tension on arm 67 has caused shaft 23 and fingers 25 to rotate to their extreme clockwise position. It is apparent that the card guide fingers 25 are now not in a position to direct a card approaching on platform 55, so the card will fall into either compartment N or compartment E depending on the position of fingers 24.

Cam follower 12 (Fig. 5) rides on cam 10. The cam follower is mounted on one end of lever 66, which pivots on pin 14, which is suitably fixed in the casing wall. The cam follower is kept in constant engagement with cam 10 by tension spring 26. It is clear that lever 66 will pivot with a back and forth motion about pin 14 as the cam follower rides on the cam. On the opposite end of lever 66 is pin 16 to which is attached one end of tension spring 18. The other end of spring 18 is attached by pin 20 to one end of arm 68. Arm 68 is fixed at its other end to shaft 22, which is journaled in bearings in the casing wall. Card guide fingers 24 are fast on shaft 22. The action of card guide fingers 24 is similar to the action of card guide fingers 25, described above. When cam follower 12 is raised by one of the raised portions of cam 10, fingers 24 are also raised to their extreme clockwise position so that the approaching card will fall into compartment N. When the cam follower is in its lower position the fingers 24 will be in their extreme counterclockwise position, and the approaching card will be shunted into compartment E.

One end of link bar 28 is pivotally attached by pin 20 to arm 18. The other end of bar 28 is pivotally attached to arm 30 by pin 29 (see Fig. 5). The other end of arm 30 is fast to shaft 31 which is mounted in a bushing through the left wall 75

of casing A and in a bearing on the right wall of the casing. Card guide fingers 32 are fast to shaft 31. It is apparent that card guide fingers 32 and card guide fingers 24 will have the same relative positions at all times, because of the action of their connecting member. Thus, when cam follower 12 is in its raised position, card guide fingers 32 will be in their extreme clockwise position and the approaching card will fall into compartment S. When cam follower 12 is in its lower position card guide fingers 32 will be in their extreme counter clockwise position and will shunt the approaching card into compartment W. It will be noticed in Fig. 4 that card guide fingers 32, when in their counter clockwise position, do not touch compartment wall 35. Playing cards are sufficiently stiff so that the leading edge of a card approaching on platform 55 and over fingers 25 would remain high enough to pass over fingers 32 when they are in their counter clockwise position. Suitable recesses 36 are provided in delivery platform 55 for the reception of the extremities of card guide fingers 24, 25 to insure positive shunting of the cards. Suitable recesses 37 are provided in the ends of the compartment walls on the open side (Fig. 3) to facilitate the removal of the completed hands. Projections 38 (Fig. 10) at the rear of platform 1 will prevent any of the cards from getting misplaced when the sliding member is returning from delivering a card to the feed rollers. If the extremities of card guide fingers 32 and 25 strike the upper wall of the casing (Fig. 4), when in their clockwise position no harm will result since the only result will be that the tension will be increased on springs 18, 19. It is apparent from the various gear ratios that the cards will be fed very rapidly by the card selector, and also that the feed rollers will rotate at such a speed that the momentum they impart to the cards, combined with gravity, will easily carry the cards to any one of the compartments. Referring to Fig. 1 and Fig. 4, which have been drawn to scale, it may be observed that delivery platform 55 has been given a slope or angle of 25° from the horizontal. We have made simple tests, easily checked, which indicate that the angle of repose of an ordinary playing card on a reasonably smooth surface is approximately 18° to 20°, and that at 25° a smooth surface will act readily as a gravity conveyor for a card placed thereon, even though the card may be without initial velocity. Referring to Fig. 4, we have shown a continuing slope of at least 25° in all four of the possible card paths. As a practical matter this is essential to the satisfactory operation of the machine. Whereas it is preferable for the operator to turn handle 42 at a uniform rate, and thereby through the agency of the gearing and the feed rollers 53 and rollers 54, to throw the cards on to the delivery platform 55 with a considerable velocity, perhaps enough in most cases to carry them to their destined compartments without further assisting means, it is certain that there will occur instances in ordinary use where the operator will stop turning in the midst of a deal, and so just allow a card to fall, without appreciable forward motion, from the rollers on to the delivery platform 55. In order to prevent the machine from becoming clogged due to such a card remaining on the platform, or at some other point above the compartments N, E, S, W, we have provided in our design the 25° minimum slope, thereby enabling the card chute, of which platform 55 forms a part, to act not

only as a means for guiding the successive cards into the compartments, but also for moving them thereinto by calling into play the action of gravity. It is for this last purpose and no other that we have provided the greater height at the receptacle for cards C; there is in fact a positive disadvantage of greater bulk due to this construction, but this in our judgment is outweighed by the necessity for providing a dependable and simple means for moving or conveying the cards.

In Figs. 8 and 9 are shown the cams 10 and 11 respectively. In Fig. 5 they are shown in their proper relative rotational positions when made fast on the cam shaft. It will be noted that the numbers around the rims of the cams are in the same order on each and in the same relative positions. In the operation of the machine the cards being dealt, when the arcs numbered 4 are controlling the cam followers, will fall in the compartment N. The arcs marked 3 will act on the cam followers to direct the cards affected into compartment E. Thus the arcs of the cams marked 2 will send cards to compartment S, and the arcs marked 1 will send the cards affected at those times to compartment W. The order of the 52 numbers around the cams 10 and 11, Figs. 8 and 9, on the basis of which the cams are shaped, was empirically determined by first marking thirteen ones, thirteen twos, thirteen threes and thirteen fours on the cards of a deck of 52 cards; next shuffling the deck thoroughly several dozen times and then observing the order in which the numbers lay in the shuffled deck. By the theory of probability the expected number of sets of 2, 3, 4, etc. adjacent like-numbered cards was computed. Comparisons were then made between the expected number and actual number of these sets to check the fact that the empirical distribution represented very closely a normal random distribution. Thus, shaping the cams in accordance with this sequence gives a redistribution as thorough as that obtained by several dozen shuffles in the ordinary manner; and this may be obtained in a few seconds time.

Since the cams are intended to be used definitely, and since their shapes do not change, the card redistributions produced by the machine are not completely random; but rather they follow some one of a plurality of predetermined irregular sequences. An important element in the invention however lies in the proper shaping of the cams; that is, in the selection of a suitable series of sequences such that the deals which will result from the use of the machine in actual play (at bridge, for example) will approximate, in types of distribution, lengths of suits, etc., those obtained by thorough hand shuffling and dealing. This is accomplished, in our invention, by choosing sequences for the cams such that the mathematical expectation (as defined for example in Chapter VII of Fry's Probability and its Engineering Uses, or in any other good book on probability) that a small number of cards, grouped contiguously or otherwise in a deck before shuffling, shall after a thoroughly random shuffle and deal be found in a single hand; that this expectation, as just stated, shall be at least approximately equal to the expectation that this same small group of cards shall be found in a single hand if the deck were shuffled and dealt by the machine instead of with true randomness.

Practically, there is a strong tendency for the cards, as picked up in tricks after a bridge hand, to be associated in contiguous groups of four-of-a-suit. Such groups contain of course contiguous 75

sub-groups of two- and of three-of-a-suit. Especial care needs to be taken therefore in balancing the machine expectation and the random expectation of contiguous groups of two, three and four cards going into the same hand. If for simplicity of the mathematical relations we consider the fifty-second and first cards of a deck contiguous as well as the first and second, second and third, etc., then a deck of fifty-two cards has 52 contiguous pairs, 52 contiguous groups of three; and 52 contiguous groups of four. Considering now the randomly-determined destination of a contiguous pair, the first one of the pair will go to some one hand, and the expectation of the second falling into the same hand will be $12/51=0.235$, since of the fifty-one remaining cards twelve must fall into the hand mentioned, and thirteen each into the other three hands.

In a similar way the expectation of a contiguous group of three falling into a single hand may be calculated, and is equal to

$$12 \times 11/51 \times 50 = 0.0517$$

and for a four-group it is

$$12 \times 11 \times 10/51 \times 50 \times 49 = 0.01057.$$

Summarizing, we have the following tabulation:

Cards in contiguous group	2	3	4
Random mathematical expectation of all cards of group falling into a single hand, in percent.....	23.5	5.17	1.057
Expectation as above, expressed in units per 52.....	12.23	2.69	0.549

Approximate equality between the random and the machine expectations in relation to the grouping described above will be attained by selecting the sequence for the cam structure so that it will have twelve or thirteen (in theory 12.23) pairs of contiguous like numbers; two or three (in theory 2.69) sets of three contiguous like numbers; and 0 or 1 (in theory 0.549) set of four contiguous like numbers.

The sequence illustrated in the drawings, Fig. 8, starting at the top and reading clockwise around the periphery, is

211144244434321231124344134
2213233131224213323134421

or, equivalent, as explained above

SWWWNNSNNENESWSEWWSNENN
WENSSWESEEWSSNSWESEWENNSW

Inspection of this sequence will disclose that there are eight contiguous pairs, two contiguous sets of three, and zero contiguous set of four. Since each contiguous set of three constitutes two contiguous pairs (partly overlapping) the total number of contiguous pairs is raised from eight to twelve, and the comparison of true random expectation with machine expectation is as follows:

	True random	Machine
Expectation of number of contiguous pairs of cards going into a single hand.....	12.23	12
Expectation of number of contiguous sets of three cards going into a single hand.....	2.69	2
Expectation of number of contiguous sets of four cards going into a single hand.....	0.549	0

It is our intent that in using the machine in

play there should be rotation of the hands in that the player to the left of the dealer may be given the hand from the bottom compartment, the next player (dealer's partner) the next hand, and so on. This obviates the necessity of so shaping the cams that each hand should receive the same number of pairs, sets of three, etc., contiguous cards, which would create an undesirable artificiality.

By adopting a cam sequence having more than the expected number of adjacent sets of three and/or four like numbers, it is possible to cause the machine to deal hands in which the mathematical expectation of extra long suits and of voids is abnormally high, producing hands of the so-called "goulash" type.

It is also apparent that 52 different sequences of redistribution will result, depending on the position of the cams at the start of the deal.

It will be evident to those skilled in the art that our invention may be embodied in various forms, and we therefore intend to be limited only by the present state of the art, and by the appended claims.

What we claim is:

1. In a playing card shuffling and dealing device, the combination of means for receiving a deck of cards, means for feeding the cards from the deck, means for directing the cards into compartments and means for controlling the directing means to produce one of a plurality of predetermined irregular distributions of the cards among the compartments.

2. A device as defined in claim 1, in which the means for feeding the cards from the deck consists of a reciprocating member having card engaging means.

3. A device as defined in claim 1, in which the card directing means consists of fingers adapted to move from one card shunting position to another card-shunting position.

4. In a playing card shuffling and dealing device, the combination of means for receiving a deck of cards, means for feeding the cards from the deck, means for directing the cards into compartments and means for controlling the directing means to produce one of a plurality of predetermined irregular distributions of the cards among the compartments, in which the means for controlling the directing means consists of a cam mechanism adapted to move the said directing means from one card-shunting position to another card-shunting position in such a manner that one of a plurality of predetermined irregular distributions of the cards among the compartments will be produced.

5. A device as defined in claim 1, in which the means for directing the cards are arranged in series, the position of the first directing means determining into which two of four compartments the approaching card falls and the position of the subsequent directing means determining into which one of two compartments the approaching card falls.

6. A device as defined in claim 4, in which the said cam mechanism includes cams of predetermined shape affixed to a common shaft in predetermined rotational relation to each other.

7. A device as defined in claim 1, in which the said means for controlling the directing means includes cams of predetermined shape affixed to a common shaft in predetermined rotational relation to each other whereby one cam controls one card directing means while another cam controls the other card directing means.

8. In a playing card shuffling and dealing device, the combination of means for receiving a deck of 52 cards, means for feeding the cards from the deck, means for directing the cards into four compartments, and means for controlling the directing means to deliver to each compartment a hand of thirteen cards in one of a selected plurality of predetermined sequences from the deck.

9. In a playing card shuffling and dealing device, means for receiving a deck of cards, reciprocating card engaging means, card restraining means adapted to restrain all except a single card, rotary card feeding means, a plurality of stationary card receiving compartments, a forked cord channel leading from said feeding means to said compartments, shunting means located at the forks of said channel, and means for controlling the shunting means in irregular sequences.

10. A card-shuffling and dealing device comprising a container for a deck of fifty-two cards, card restraining means at the center of the front edge of the deck with space below said restraining means for only one card to pass through at a time, means for forcing out the bottom card of the deck placed in the container, means for subsequently engaging and accelerating said bottom card, four stationary card receiving compartments, card directing means and means for controlling said directing means adapted to produce in each compartment a hand of thirteen cards such that mathematical expectation of important card group classifications in the original deck finding their way into single compartments approximates the expectation of like events under perfectly random distributional conditions.

11. A selector device for a card dealing mechanism having fifty-two stop faces located at different distances from its axis, there being at least thirteen stop faces at each distance, the number of said stop faces at each distance being evenly divisible by thirteen, and the order of recurrence of the distances to the stop faces around said axis being generally irregular.

12. In a playing card shuffling and dealing device, the combination of means for receiving a deck of 52 cards, means for feeding the cards from the deck, means for directing the cards into four compartments, and means for controlling the directing means to deliver from the deck to each compartment a hand of thirteen cards in an irregular sequence.

13. In a card dealing machine, the combination of means for successively removing the cards from a stack, a plurality of card receptacles, and means for individually moving each successive card removed from said stack into one of said receptacles in one of a plurality of possible determined irregular orders.

14. In a card dealing machine, the combination of means for successively removing the cards from a stack, a plurality of card receptacles, and means for moving each successive card removed from said stack into one of said receptacles in one of a

plurality of possible determined irregular orders.

15. In a playing card shuffling and dealing device, the combination of means for receiving a deck of 52 cards, means for feeding the cards from the deck, and means for moving and directing the cards into four compartments, and means for controlling the directing means to deliver to each compartment a hand of thirteen cards in one of a plurality of predetermined sequences such that the mathematical expectation of important card group classifications in the original deck finding their way into single compartments approximates the expectation of like events under perfectly random distributional conditions.

16. In a playing card shuffling and dealing device, the combination of means for receiving a deck of cards, means for feeding the cards from the deck, means for directing the cards into compartments, and means for controlling the directing means to produce among the compartments one of a plurality of predetermined irregular distributions such that the mathematical expectation of important card group classifications in the original deck finding their way into single compartments approximates the expectation of like events under perfectly random distributional conditions.

17. In a playing card shuffling and dealing device, the combination of means for receiving a deck of 52 cards, means for feeding the cards from the deck, means for moving and directing the cards into four compartments, and means for controlling the directing means to deliver to each compartment a hand of thirteen cards such that the mathematical expectation of important card group classifications finding their way into single compartments approximates the expectation of like events under perfectly random distributional conditions.

18. In a playing card shuffling and dealing device, the combination of means for receiving a deck of 52 cards, means for feeding the cards from the deck, means for directing the cards into four compartments, and means for controlling the directing means to deliver from the deck to each compartment a hand of thirteen cards in a predetermined irregular sequence.

19. In a playing card shuffling and dealing device, the combination of means for receiving a deck of 52 cards, means for feeding the cards from the deck, means for directing the cards into four compartments, and means for controlling the directing means to deliver from the deck to each compartment a hand of thirteen cards in a predetermined irregular sequence, such that the mathematical expectation of important card group classifications finding their way into single compartments approximates the expectation of like events under perfectly random distributional conditions.

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