

Sept. 15, 1953

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2,652,252

AUTOMATIC SCORING APPARATUS FOR BOWLING GAMES

Filed March 20, 1947

8 Sheets-Sheet 1

Fig. 1

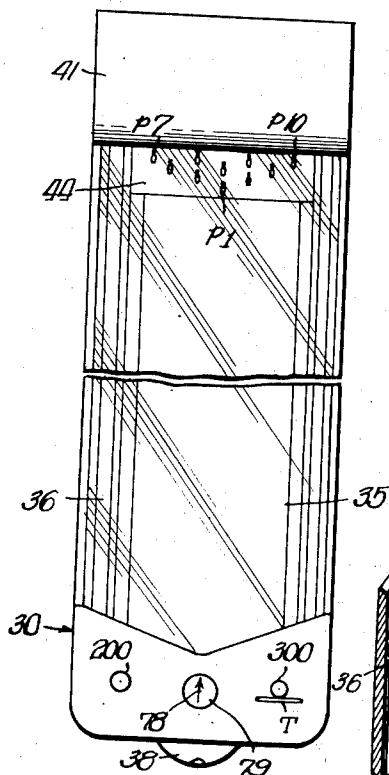


Fig. 2

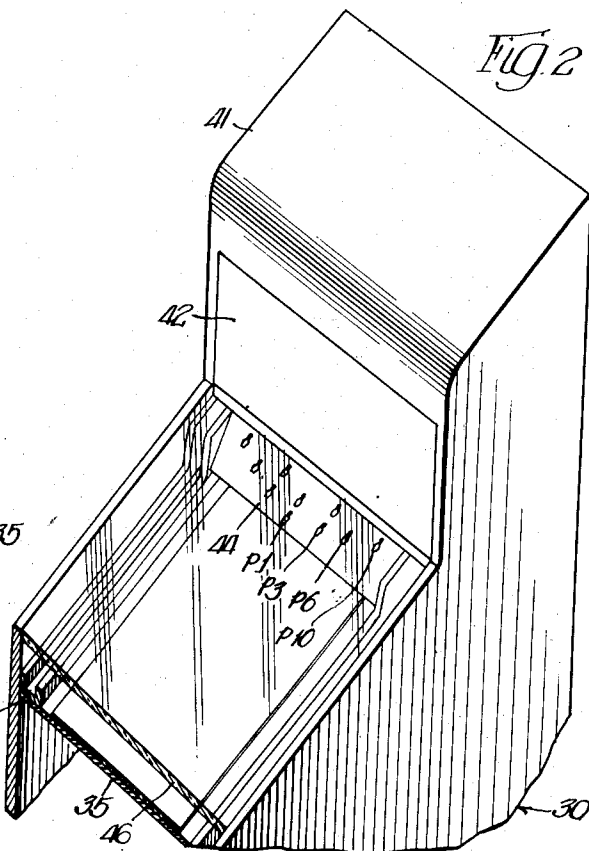
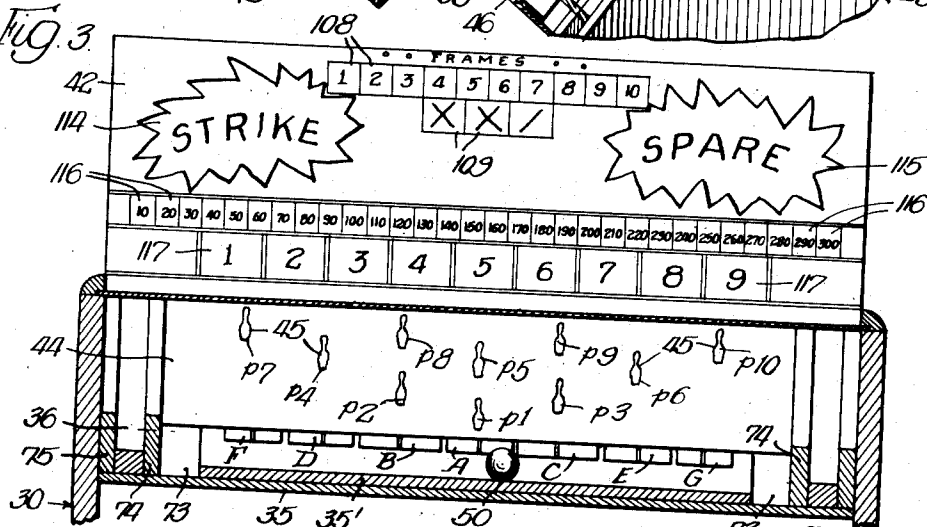


Fig. 3



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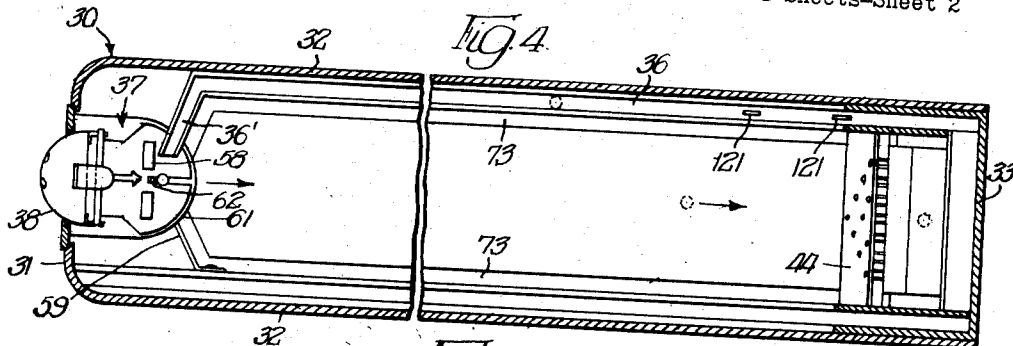
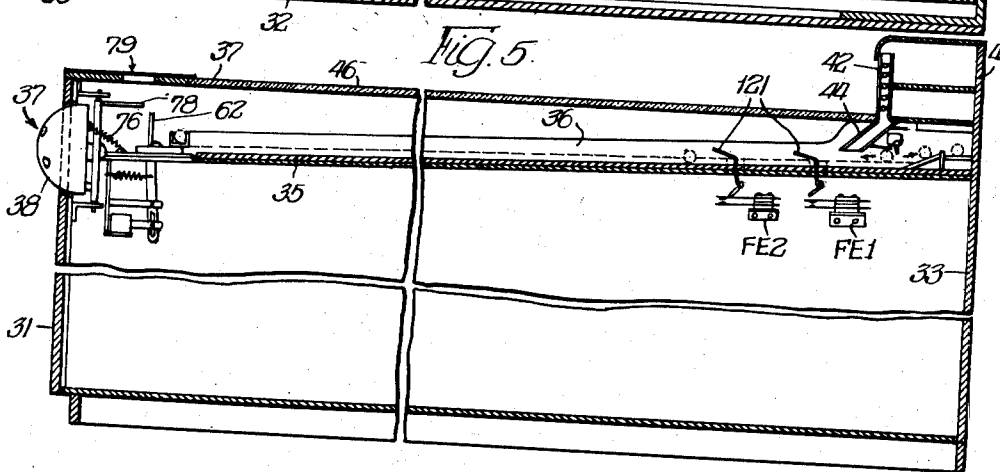
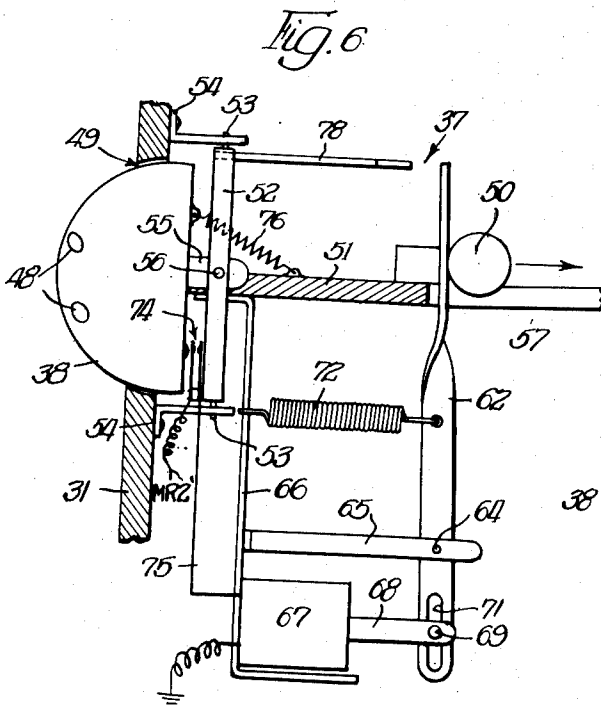
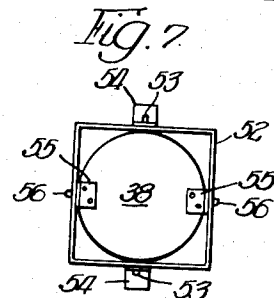
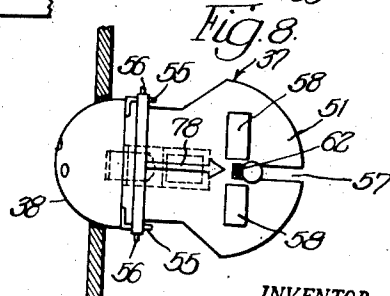
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8 Sheets-Sheet 2



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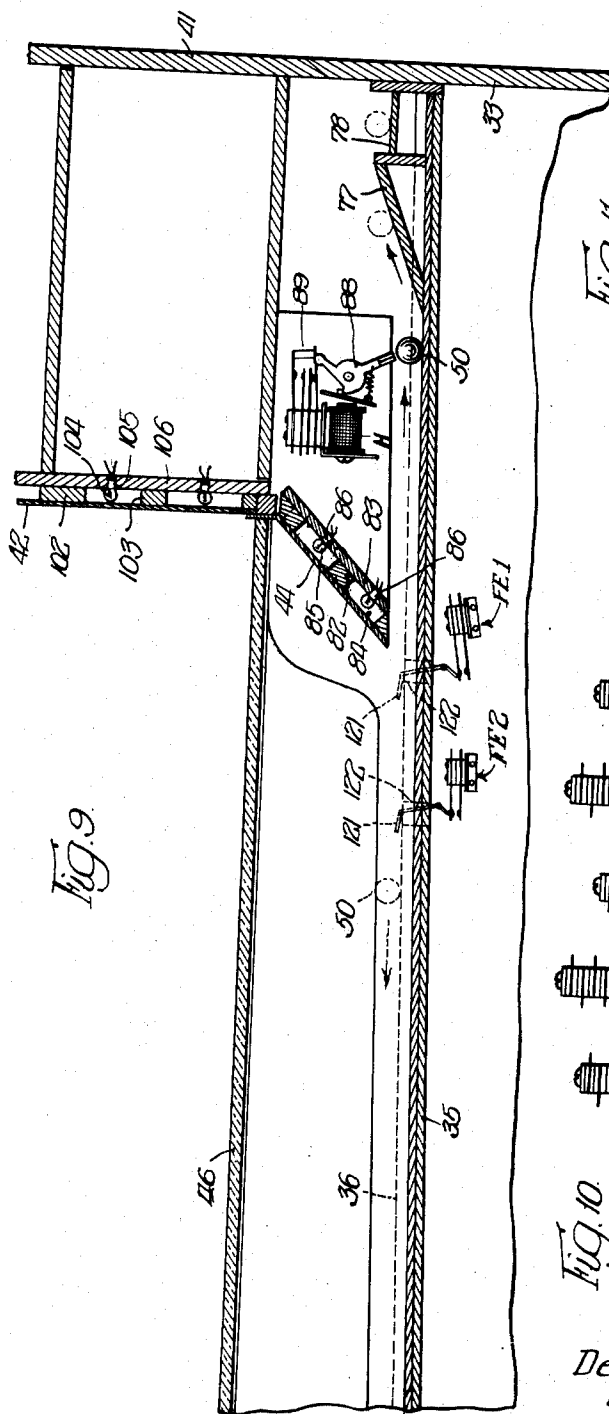
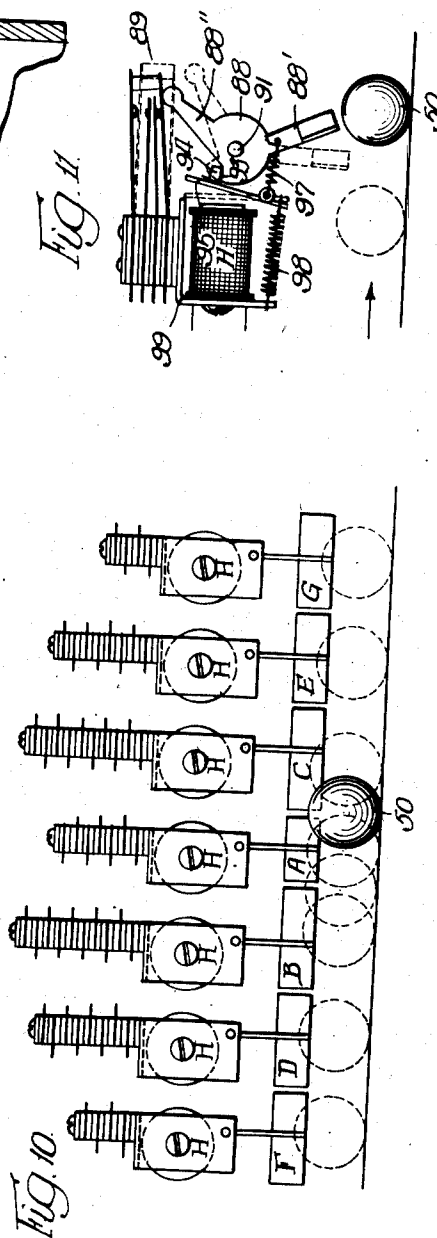
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8 Sheets-Sheet 3



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AUTOMATIC SCORING APPARATUS FOR BOWLING GAMES

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Fig. 12

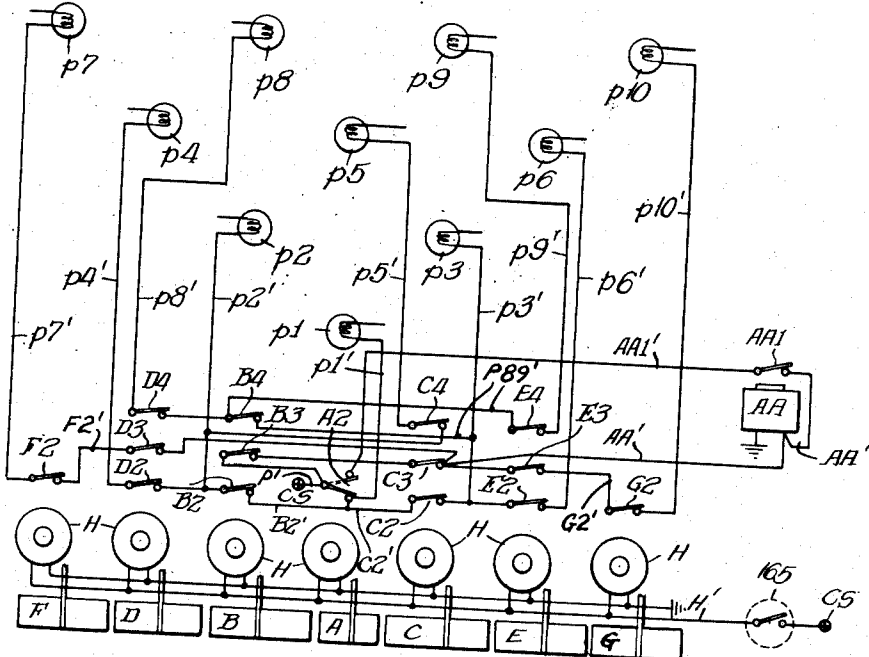


Fig. 13

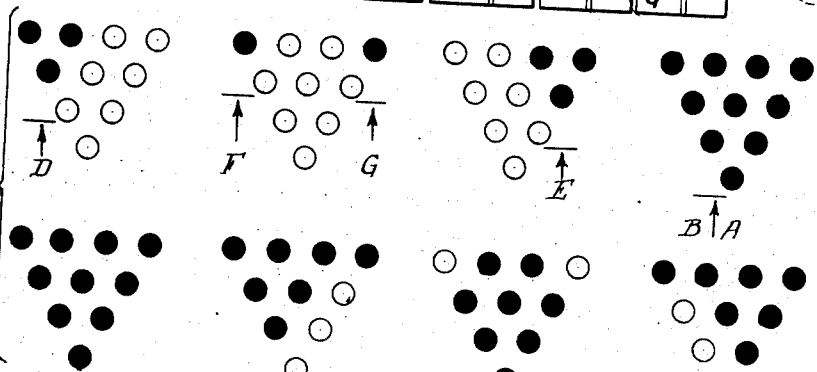


Fig. 14

	1	2	3	4	5	6	7	8	9	10	(10)	(10)
FRAME	E-B	X	X	X	A-F	C-A	AB	G-AC	G-C	X	D-E	
TALLY	8	—	—	30	28	—	20	20	17	—	16	
SCORE	8	38	66	85	94	114	134	151	158	174		

BALL-RETURN CIRCUIT-FE1-001'-5T3-P5'-P5.
 STRIKE (PRIMARY CIRCUIT-ONE) S'-P10-PF1-S'-5T.
 SPARE (PRIMARY CIRCUIT TWO) S'-P11-PF1-5P'-5P.
 MISS (PRIMARY CIRCUIT-THREE) P22-PF2-01-5P4-MR'-MR.

Fig. 15

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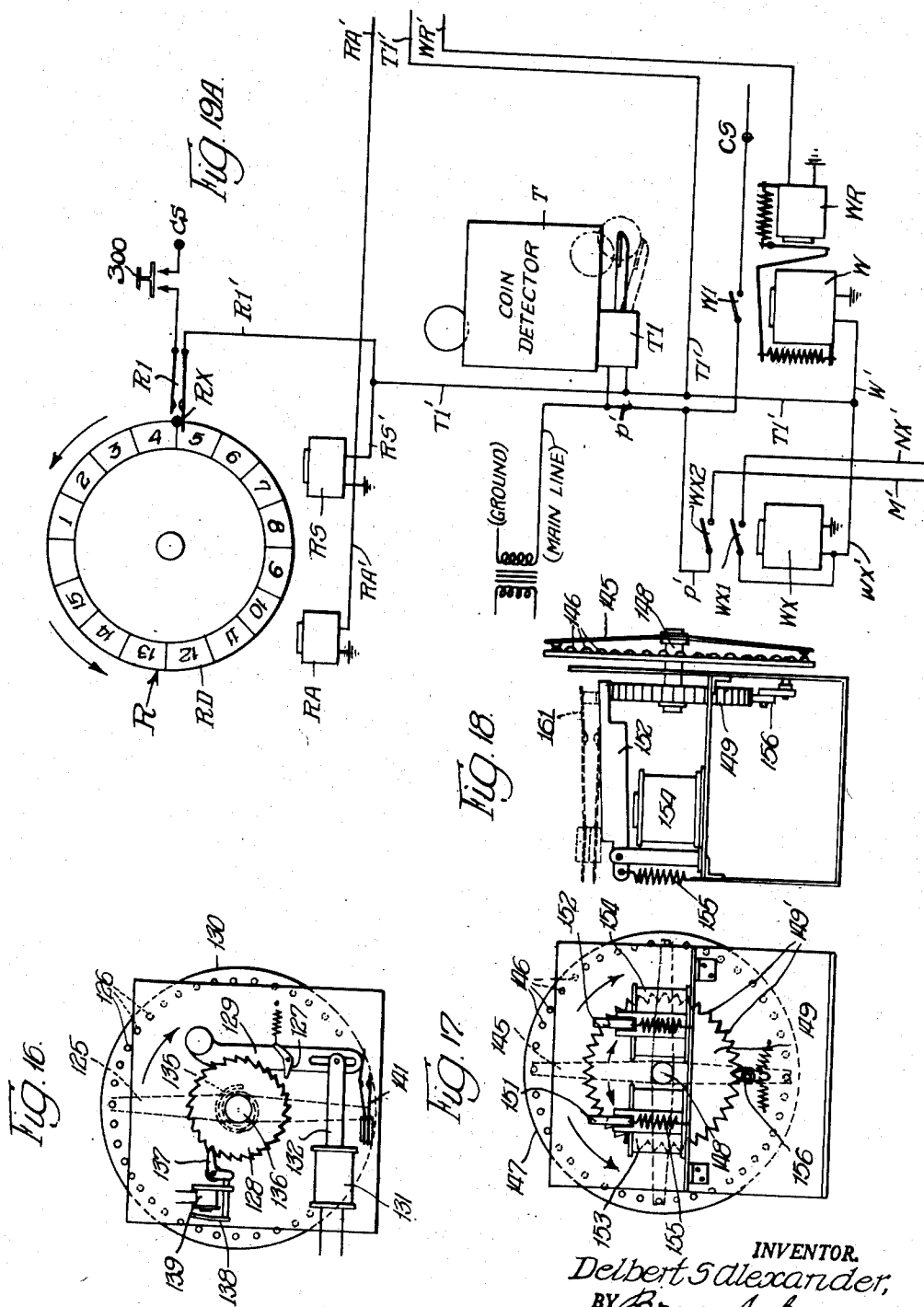
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AUTOMATIC SCORING APPARATUS FOR BOWLING GAMES

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8 Sheets-Sheet 5



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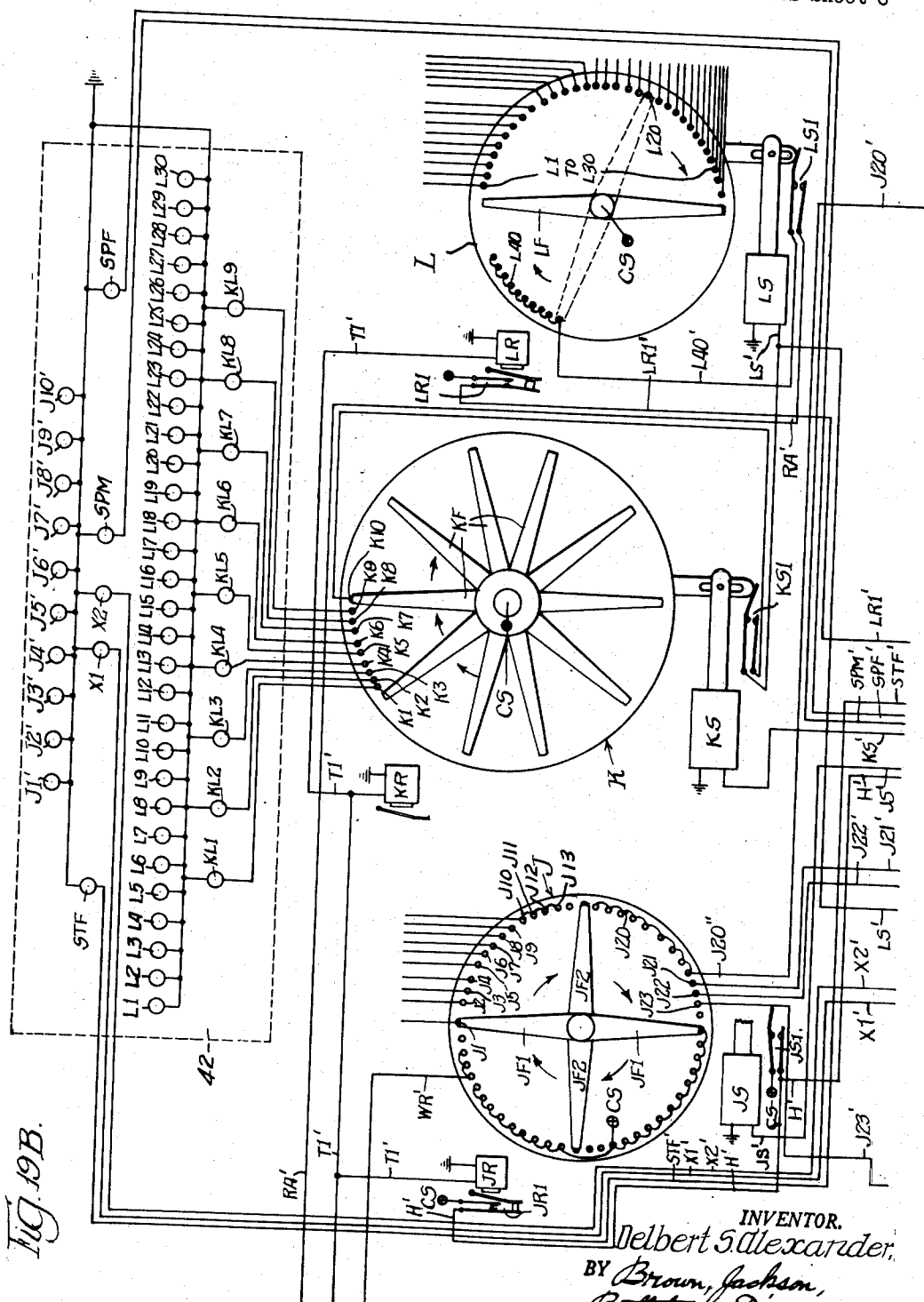
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AUTOMATIC SCORING APPARATUS FOR BOWLING GAMES

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8 Sheets-Sheet 6



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AUTOMATIC SCORING APPARATUS FOR BOWLING GAMES

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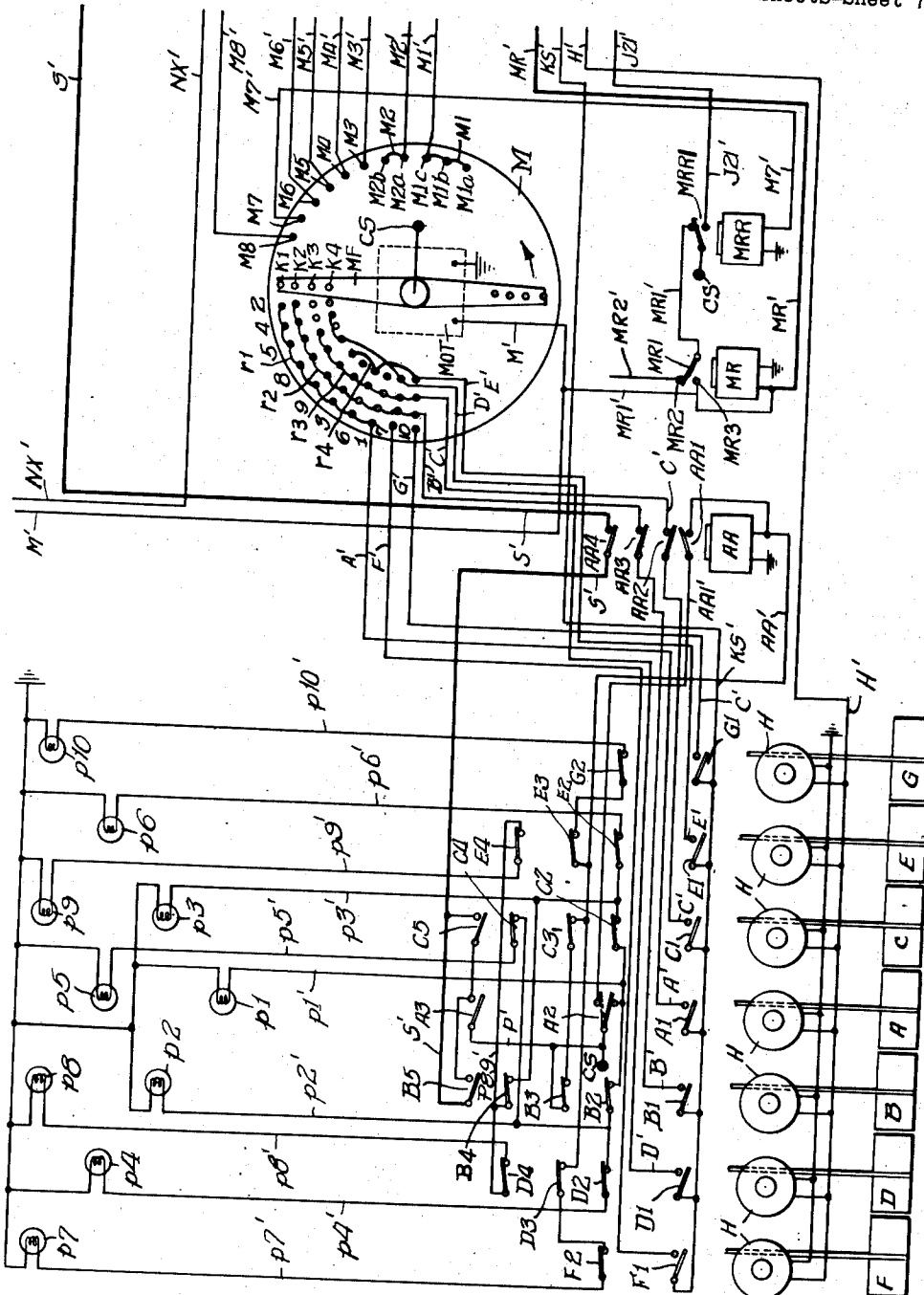


Fig. 19C.

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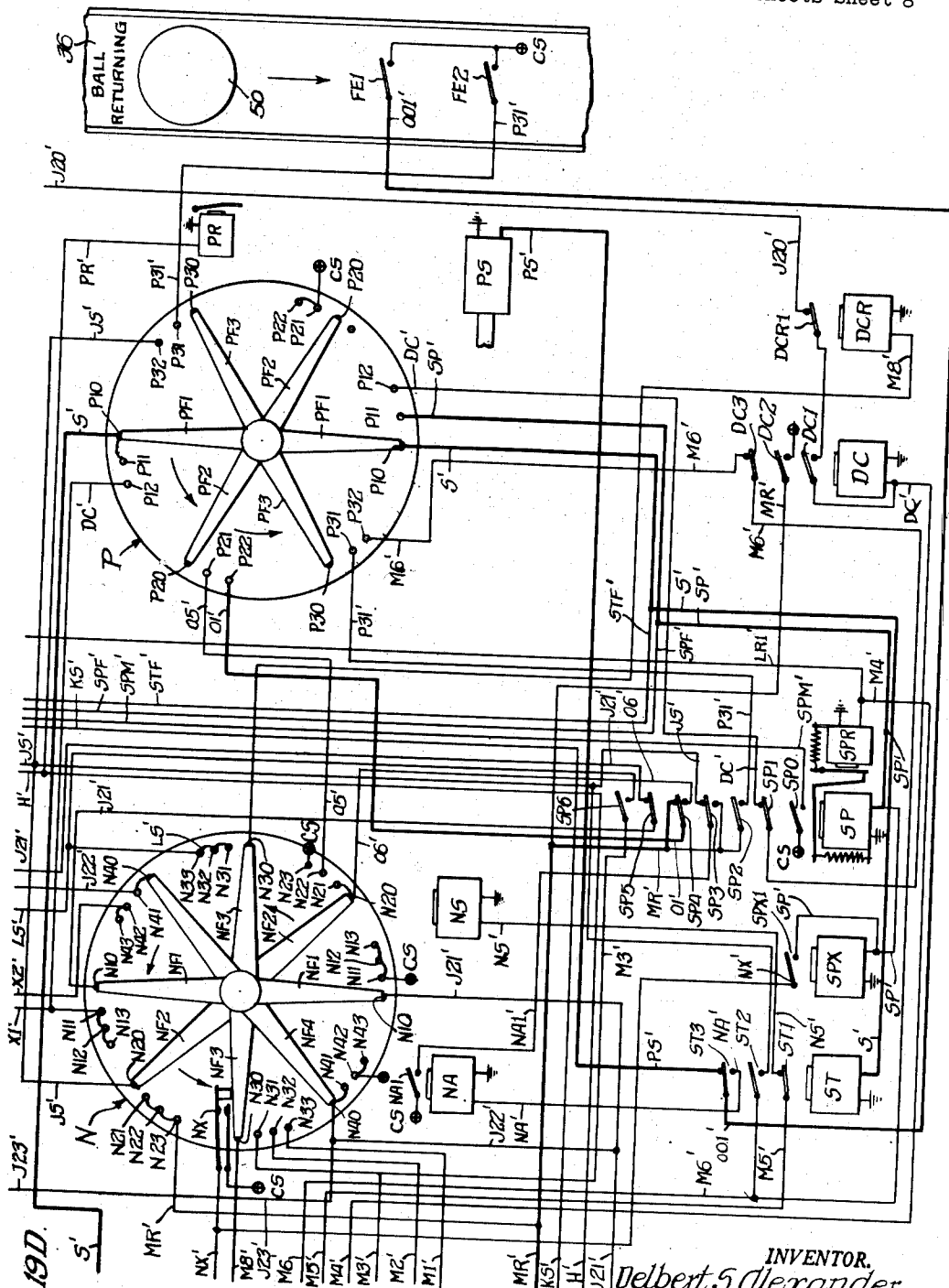


Fig. 19D.

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UNITED STATES PATENT OFFICE

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AUTOMATIC SCORING APPARATUS FOR BOWLING GAMES

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Application March 20, 1947, Serial No. 735,821

19 Claims. (Cl. 273—38)

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The present invention relates to an improved bowling game which is particularly adapted to be built in miniature form either for use in the home, or for coin operated use in taverns, depots, clubs and other places of amusement. While the invention has been devised primarily as a miniature bowling game, nevertheless I wish it to be understood that the invention contains unique features which can also be embodied in a full size game played in a full size bowling alley.

One of the main objects of the invention is to provide improved pin simulating means which give the general appearance and scoring characteristics of actual bowling pins but without the complications of actual pins, such as pin collecting and pin re-setting operations. My improved pin simulating means comprises a panel extending across the rear portion of the alley and provided with openings or transparent areas shaped in the form of standard bowling pins. These openings or transparent areas are illuminated from the rear by individual electric lights, whereby each opening or transparent area gives the appearance of a standing pin when lighted, and when not lighted the opening or transparent area merges into the remainder of the panel to give the appearance that the pin has been knocked down and displaced from the alley. The top of this indicating panel is sloped rearwardly to give depth or third dimension to the spacing between the illuminated pin openings, so that when the player looks diagonally downwardly and rearwardly from the front end of the alley in playing position he receives the optical effect or illusion that the pins are spaced in depth and that they are situated on their conventional pin spots on the surface of the alley.

Another object of the invention is to provide such a bowling game in which the player is required to exercise a high degree of skill in aiming the bowling ball, almost as much as the aiming skill required in playing on a standard bowling alley.

Another object is to provide such a bowling game with ball delivery means which has the feel of a real regulation size bowling ball. The physical ball which is actually projected at the simulated bowling pins is of relatively small size, comparable to the size of this small bowling game, but this small ball is aimed and projected by a large ball simulating member of approximately the same spherical radius and having substantially the same arrangement of finger holes as a regulation bowling ball. This ball simulat-

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ing member is mounted at the delivery end of the housing which encloses the game, such ball simulating member being capable of sidewise aiming motion for aiming the small ball, and also being capable of motion in a vertical plane for projecting the small ball. This feature of having the small bowling ball respond to the manipulation of the life size ball simulating member mounted in the end of the case is advantageous in coin controlled games adapted to be played by the general public, because this small ball then remains inaccessible to the general public and cannot be stolen. If the game is to be used in the home, the ball simulating member can be dispensed with, if desired, so that the player can then actually roll the small bowling ball. In this regard, coin control of the game is not limited to the embodiment employing the ball simulating member, but can also be employed on the other embodiment where the player actually rolls the small bowling ball.

Another object of the invention is to provide a bowling game having automatic scoring mechanism which will keep a perfectly true and accurate score, rather than an approximate or arbitrary score. Since the scoring in actual bowling follows an irregular pattern, it is of great aid to the player and to the playing of the game to have a score indicating and registering mechanism which will keep a true score with the same accuracy that a player would keep it himself when scoring with pencil and paper. In this regard, an important object of the invention is to provide automatic storing mechanism which will temporarily store the scoring values of strikes and spares until after subsequent balls have been bowled; i. e. in the case of a strike until after the next two balls have been bowled, and in the case of a spare until after the next single ball has been bowled.

Another object of the invention is to provide a bowling game having improved automatic indicating or display mechanism, which will indicate the frame in which the player is then bowling; which will indicate with a very prominent momentary display that a strike or spare has just been made; and which will also give another sustained indication after a strike or spare has been made that the player is still "working" on said strike or spare.

Another object of the invention is to provide a bowling game of the above general description which can be coin controlled. As above remarked, the game can be constructed as a commercial embodiment arranged for coin control,

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such embodiment being intended for use in public places, such as depots, taverns, amusement centers, and the like; or the game can be constructed as a home embodiment in which there is no coin control. Both embodiments will be hereinafter described in the appended detailed description.

Another object of the invention is to provide a bowling game of the coin controlled type in which a free-play is awarded to a player if he attains a certain score in the bowling of any one game. That is to say, if he attains this predetermined score in the bowling of a game, he is rewarded by the ability to bowl another game without depositing another coin. This free-play feature may or may not be embodied in the coin controlled games, as desired.

Other objects, features and advantages of this invention will appear from the following detailed description of certain preferred embodiments thereof. In the accompanying drawings illustrating such embodiments:

Figure 1 is a fragmentary plan view of my improved bowling game, with a transverse portion broken away in the middle to shorten the figure;

Figure 2 is a fragmentary sectional perspective view of the rear end of the game showing the inclined panel which bears the simulated pins;

Figure 3 is a transverse sectional view through the upper portion of the housing of the game, looking rearwardly toward the simulated pin panel;

Figure 4 is a fragmentary horizontal sectional view through the game, showing the ball projecting means, the ball return chute, etc.;

Figure 5 is a vertical sectional view giving a side view of these same parts;

Figure 6 is a fragmentary sectional view of the ball projecting means on a larger scale;

Figure 7 illustrates the trunnioned mounting frame which enables the ball simulating member to have horizontal and vertical pivotal movement;

Figure 8 is a detail sectional view in plan showing the ball projecting means;

Figure 9 is a vertical sectional view on a larger scale of the rear end of the alley showing the arrangement of the inclined pin simulating panel, the vertical indicating panel and the target plates and their contacts, etc.;

Figure 10 is a fragmentary front elevational view of the series of target plates, showing in full lines and in dotted lines several of the many possible positions of the bowling ball for striking the target plates;

Figure 11 is a fragmentary detail view showing how the bowling ball actuates the target plates from their normal positions to their latched positions and thereby actuates the controlling switches;

Figure 12 is a digram showing the fore and aft alignment or transversely spaced relationship between the target plates and the simulated bowling pins, this view also showing a simplified embodiment of the pin lighting circuits, which simplified embodiment may be incorporated in a home embodiment of the game not provided with automatic scoring apparatus.

Figure 13 is a chart showing typical scoring plays when the bowling ball strikes different pins and different combinations of pins;

Figure 14 is a chart showing the scoring procedure in connection with certain typical plays carried through the ten frames of a bowling game;

Figure 15 is a chart designating the successive parts of four main circuits of the system;

Figure 16 is an end elevational view, partly diagrammatic, of one type of spring return rotary stepping switch, several of which are employed for performing various functions in my improved game;

Figures 17 and 18 are end elevational and side elevational views, partly diagrammatic, showing an add and subtract rotary switch, which is used in a plurality of places in my improved system; and

Figures 19A, 19B, 19C and 19D are related parts of a complete circuit diagram, wherein Figures 19A and 19B are adapted to be joined end to end horizontally, and Figures 19C and 19D are likewise adapted to be joined end to end horizontally, and with Figure 19C also joining vertically with the bottom of Figure 19A, and Figure 19D joining vertically with the bottom of Figure 19B.

Referring first to Figures 1 to 9, inclusive, showing one preferred construction of housing for the game, this housing or case, designated **30** in its entirety, is about two feet wide and anywhere from five to eight feet long, constructed in proportion to simulate an actual bowling alley. These are the approximate proportions of a portable unit which can be moved into and out of a store, tavern, depot, or other place of amusement, but it will be understood that the same fundamental features of the game can be embodied in larger built-in installations of intermediate size, or even actual standard bowling alley size. In the portable unit size shown in Figures 1, 2, 3, 4, 5, etc. the housing **30** is about waist high or counter high, so that a person can play the game comfortably and conveniently while standing at one end of the housing. Said housing or casing **30** comprises a front end wall **31**, preferably merging with rounded corners into the two side walls **32, 32**, the other ends of these side walls being joined together by a rear wall **33**. The surface of the bowling alley proper is preferably composed of a length of plywood **35**, although it may be otherwise constructed of wood, metal, or other material. This board is preferably given a slight uphill slope toward the rear end of the alley, as shown in Figure 5, and a ball return gutter or trough **36** extends along the one side of this alley board **35**, being sloped downhill substantially correspondingly to the slope of the alley, so as to return the physical bowling ball to the ball projecting mechanism. This ball projecting mechanism, indicated at **37** in its entirety, comprises the aforementioned ball simulating member **38** which projects slightly from the front end **31** of the casing. Projecting upwardly from the rear portion of the casing is a raised housing portion **41** which carries the score and play indicating panel **42** in its front wall. Sloping downwardly and forwardly from the lower portion of the indicating panel **42** is the pin simulating panel **44** in which the bowling pins **45** are electrically simulated, as I shall presently describe. A glass cover **46** (Figure 5) extends over the top of the alley **35** and over the pin simulating panel **44**, the rear edge of this glass pane **46** terminating substantially at the raised housing portion **41**, so that the indicating panel **42** extends upwardly above the glass cover. Such glass cover prevents tampering with the bowling ball, the ball projecting mechanism, the target plates or any of the other working parts of the mechanism.

Ball delivering mechanism

Referring now to the details of the ball projecting or delivering mechanism 37, as that shown in Figures 6, 7 and 8, it will be seen that the ball simulating member 38, which is preferably a life size replica of the standard bowling ball, having conventional finger holes 48, is mounted for universal rotative movement within a circular opening 49 in the front casing wall 31. This ball simulating member 38 is arranged to swing to right or left a platform 51 upon which the bowling ball 50 comes to rest after it has been returned through the ball return gutter 36. The rear portion of this horizontal platform 51 is fixedly secured to a rectangular pivoting frame 52 which has vertically aligned pivot studs 53 projecting upwardly and downwardly from its top and bottom legs for pivotal mounting in pivot brackets 54 projecting inwardly from the front wall 31 of the casing. The ball simulating member 38 is provided with horizontally aligned pivot brackets 55 (Figure 8) carrying horizontal pivot pins 56 which project through pivot apertures in the side legs of the pivoting frame 52. It will thus be seen that horizontal pivoting movement imparted to the ball simulating member 38 will swing the ball supporting and aiming platform 51 to right or left around the vertical pivot axis 53 for aiming the ball 50 at the desired point in the group of bowling pins or at a particular pin. The ball normally rests at the rear end of a slot or notch 57 cut in the forward portion of the platform 51, this platform or the slot being given sufficient fore and aft tilt to normally hold the ball 50 at the inner end of the slot 57. The platform may also be sloped or dished down laterally from each side to the slot. When the ball is returned through the return trough 36, a laterally projecting end portion 36' of this trough directs the ball on to the surface of the platform 51 and into the slot 57. Transverse guide blocks 58 mounted upon the platform 51 assist in directing a ball into the rear portion of the slot 57. If for some abnormal reason the ball should roll back down the surface of the alley 35, it will be guided back into the slot 57 by the trough extension 36' on one side or by the guide finger 59 (Figure 4) on the other side. The swinging edge of the platform is rounded to swing within an arcuate forward edge 61 of the bowling alley surface 35, so that when the ball 50 is projected from the slot 57 it passes from the platform 51 directly onto the bowling alley 35.

The projection or delivery of the ball is effected by a projecting lever 62 which has an upper pushing portion extending upwardly through the slot 57, and against which pushing portion the ball 50 normally rests. The lower portion of the lever 62 is pivotally mounted at 64 upon a stationary bracket 65 which projects rearwardly from a vertical hanger bracket 66 extending downwardly from the under part of the platform 51, so as to swing therewith. The lower end of this vertical bracket 66 carries a solenoid winding 67 arranged to actuate a solenoid core 68. The projecting end of the solenoid core carries a pivot pin 69 operating within a pivot slot 71 formed in the lower end of the ball projecting lever 62. A tension spring 72 connected between the lever 62 and the bracket 66 normally tends to hold the lever 62 in the retracted position shown. When the solenoid 67 is energized, it swings the lever 62 around the pivot pin 64 and imparts a quick ball projecting motion to the ball

50 for propelling the ball outwardly along the slot 57 and up along the bowling alley toward the simulated pins at the rear end of the alley. The energization of the solenoid 67 is accomplished by tipping the ball simulating member 38 in a downward direction around the pivot pins 56. This is operative to force two normally separated contact springs 74 into contacting engagement for completing a circuit through the solenoid 67. The contact springs 74 are mounted upon the lower portion of the pivoting frame 52, and the circuit 75 is conventionally represented as leading from a source of current supply over conductor MR2' through the contact springs 74 and through the solenoid winding and thence to ground. The ball simulating member 38 may be held in its normal elevated position shown by the spring pressure of the contact springs 74, or a separate spring 76 may be provided for holding it in this normal position, with the spring contacts 74 separated. The player is aided in giving the proper aiming angle to the ball by a directional pointer 78 which projects from the top leg of the pivoting frame 52 toward the rear end of the alley and which is readily visible through a sight window 79 (Figure 5) defined in the cover glass 46. Upon completing the aiming operation by getting the arrow pointer 78 pointed at the desired spot at the rear end of the alley, the player then rocks the ball simulating member 38 downwardly for closing the contacts 74 and projecting the ball toward that aimed spot. In the commercial coin controlled embodiment of the game, the aforementioned current supply conductor MR2' is preferably made subject to switch MR1 and relay MR of motorized switch M (as by being connected to back contact MR2 of switch MR1, Fig. 19C), so that no ball can be projected while the scoring apparatus is in operation, as will be later described in connection with the circuit diagram of Figures 19A-19D. In the simplified home embodiment of the game not having automatic scoring mechanism but using the ball projecting mechanism 37, this terminal MR2' would be connected to the regular source of current supply for the game.

As shown in Figure 3, the surface of the alley proper is defined by a board or length of plywood 35' which is secured to the upper surface of the supporting board 35. Side gutters 73 are defined between the edges of this alley strip 35' and longitudinally extending side rails 74. The ball return trough 36 is defined between the left hand rail 74 and another adjacent side rail 75. Referring to Figure 9, when the ball reaches the rear end of the alley it rolls up a ramp 77 which extends across the entire width between side rails 74, 75, so as to receive a ball rolling in either gutter 73, as well as balls rolling on the alley proper. From the top edge of the ramp 77 the ball drops into a transverse sloping trough 73 which directs the ball into the upper end of the return trough 36, through which it is delivered to the ball projecting or delivery mechanism 37.

Referring now to the arrangement of the simulated bowling pins, this comprises the downwardly and forwardly sloping panel 44 adjacent to the rear end of the alley, which panel bears the ten simulated bowling pins $p^1, p^2, p^3, p^4, p^5, p^6, p^7, p^8, p^9$ and p^{10} , as best shown in Figure 3. These simulated bowling pins, designated collectively as the bowling pins 45, are distributed laterally across the width of the panel 44 in the same transverse positions that they would occupy in an actual bowling alley, and these simulated

7 pins are distributed or spaced vertically across the vertical dimension of the panel 44 in such relation as to give the optical illusion that the pins are actually setting on the surface of the alley board 35' when viewed from the front or ball delivering end of the alley. The lower edge of the panel is spaced from the surface of the alley just enough to allow the ball 50 to pass freely under the panel. This panel 44 is preferably composed of a translucent material, such as a colored plastic or painted glass, and may have decalcomania or like translucent images of bowling pins properly placed on its under side to denote the simulated bowling pins p^1 — p^{10} , inclusive. Directly under the panel 44 is a partition 82, and directly under this partition is a back board 83. The partition 82 is provided with openings 84 for receiving the light bulbs 85 which are mounted in sockets 86 carried by the back board 83. There is an opening 84, a light bulb 85, and a socket 86 corresponding to each simulated bowling pin p^1 — p^{10} . In one preferred embodiment, each opening 84 has the desired outline of a bowling pin in such proportions as to make the pin look life-like when viewed by the player looking diagonally downwardly from the front end of the casing. These pin-shaped outlines in the openings 84 may be provided with decalcomania transfers, if desired. When the light bulb corresponding to a particular bowling pin is illuminated, that pin stands forth from the panel in contrasting life-like appearance, and when that light bulb is extinguished the bowling pin is blanked out or merged into the background color of the panel, so that the effect is that the bowling pin has been completely removed from that spot on the surface of the alley. To facilitate a further description of these simulated bowling pins, I shall hereinafter use the reference characters p^1 , p^2 , etc. in the collective sense as including the light bulb 85 associated with that particular bowling pin. Hence, a statement that a particular ball delivery has struck pins p^6 , p^9 and p^{10} merely means that the light bulbs in back of p^6 , p^9 and p^{10} have been extinguished.

Referring now to the target plates which are hit by the bowling ball after it passes under the lower edge of the simulated pin panel 44, there are preferably seven of these target plates distributed across the pin spot width of the alley, as clearly shown in Figure 3. The central target plate designated A is substantially aligned with the two centrally disposed pins p^1 and p^5 . To each side thereof are target plates B and C which are substantially aligned with pins p^2 and p^8 and with pins p^3 and p^9 , respectively. Disposed outwardly of the latter target plates are plates D and E which are substantially aligned with pins p^4 and p^6 , respectively. Finally, the two outermost target plates F and G are substantially aligned with the two outermost pins p^7 and p^{10} , respectively. The adjacent edges of these target plates come into close proximity to each other, so that a ball can strike two adjacent target plates at the same time, as illustrated in Figure 10 where the ball in its full line position is striking target plates A and C, and in a dotted line position is striking target plates A and B. Referring to Figure 11, each target plate is mounted upon the downwardly extending arm 88' of a contact actuating lever 88 substantially of bell crank form, this lever having an upwardly extending arm 88'' which is adapted to actuate a pile of movable contact springs 89 which are

to be actuated by that particular target plate. The switch actuating lever 88 is pivoted for rocking movement around a pivot pin 91 suitably carried in a mounting plate or bracket constituting part of the switch structure. The dotted line position in Figure 11 shows the target plate in its normal position, and the full lines represent the target plate in its actuated position. The target plate and lever 88 are adapted to be latched in this actuated position by a latching shoulder 93 on the lever 88 which is adapted to swing in under a latching lug 94 projecting from a pivoted armature 95. This armature is adapted to be retracted into its released position by a releasing coil H. A tension spring 97 restores the target plate and lever 88 to the normal position illustrated in dotted lines when the releasing coil H is energized, and a tension spring 98 operates as soon as this coil is deenergized to place the latching armature 95 in readiness to again snap the latching lug 94 over the latching shoulder 93 as soon as the target plate has been swung rearwardly by the bowling ball 50. The pile-up of movable and stationary contact springs 89 is suitably supported on the conventional frame member 99 that carries the tripping coil H. These seven target plates, target plate switches and release coils are suitably supported on any desired type of frame structure disposed in rear of the pin simulating panel 44. The different stationary and movable contacts of the pile-ups 89 will be hereinafter described in connection with the circuit diagrams.

Projecting upwardly from the top edge of the pin simulating panel 44 is the other indicating panel 42 (Figure 9), also composed of translucent material, such as a colored plastic, painted glass or the like. Behind this panel 42 is a partition 102 having openings 103 therein in which are disposed light bulbs 104. These light bulbs are mounted in sockets 105 carried in a back board 106. This upper indicating panel is provided with a plurality of indicating areas best illustrated in Figure 3. Extending across the upper portion of the panel is a series of ten box areas 108 designated 1 to 10, inclusive, for indicating the particular frame of the game that the player is then bowling. In the coin controlled embodiment of the game, it may be desirable to confine the cycle of the game to five frames to be bowled for five cents (5¢), and in such case there would only be five of these box areas 108 designating five frames in each coin controlled cycle of the game. A series of three box areas 109 is preferably disposed below the frame designating areas 108, these latter areas 109 bearing the conventional cross and diagonal line symbols indicating two strikes and a spare. These indicating areas designate whether the player is "working" on a strike or a spare from a preceding frame or frames. At the left and right sides of the panel 42 are relatively large indicating areas 114 and 115 designating a Strike and a Spare, respectively. These indicating areas give a very large prominent indication as soon as a strike or a spare has been bowled. Extending across the lower portion of the panel 42 are two rows of score indicating areas 116 and 117. The upper row 116 designates the tens count of the score. In the case of a ten frame game the score would extend to a total of 300, as illustrated in Figure 3, but in the case of a five frame game the score would extend to a total of 150, representing a perfect score for five frames. The lower row of score indicating areas 117 carry the digit nu-

merals from 1 to 9, inclusive, for indicating the unit portion of each score. Thus, the player can tell at any instant in the game what his score is up to that point in the game. It will be understood that all of the above described indicating areas 103 to 117, inclusive, will have openings 103 formed in the partition board 102 in rear thereof, and will have one or more light bulbs 104 in these openings for illuminating those particular indicating areas.

Referring to Figure 9, it will be seen that when the ball travels down the return trough 36 toward the ball delivery end of the alley it successively actuates two ball return trip switches FE1 and FE2. These trip switches are suitably mounted on supporting brackets directly below the ball return trough 36 and have trip fingers 121 which extend up through openings 122 formed in the bottom of the trough, these fingers being positioned to be struck in sequence by the ball in its return motion down the trough 36. The operating functions performed by these trip switches will be later described in connection with the circuit diagram.

The various indicating functions, scoring functions and other automatic functions of the game are governed or controlled by six rotary stepping relays or stepping switches, shown in Figures 19A-19D. Three of these rotary switches designated J, K and L appear in Figure 19B; another rotary switch M appears in Figure 19C; and rotary switches N and P appear in Figure 19D. If the game is provided with free-play apparatus, then another rotary switch R (Figure 19A) is provided for this function. These seven rotary switches fall into either one of three classifications: first, a unidirectional stepping type of switch in which the stepping impulses only step the switch unit in one direction, the switch being restored in the opposite direction by a return spring upon the electrical tripping of a holding pawl; second, a duo-directional or add and subtract stepping type of switch in which the switching function can occur selectively in either direction for performing adding and subtracting operations; and third, a uni-directional motor driven switch in which the advancing motion is a continuous motor driven motion rather than a stepping motion, and in which there is no return motion. Figure 16 diagrammatically illustrates a typical structural arrangement of a uni-directional spring restored type of rotary stepping switch in which the rotatable wiping contact or contacts 125 are stepped over a series of stationary contacts 126 mounted in a disk 130, such stepping being effected in a clockwise direction in the embodiment shown by a stepping pawl 127 engaging ratchet wheel 128. The pawl 127 is carried by a stepping lever 129 which is adapted to be actuated from a stepping coil 131 either through an armature or solenoid core 132. The rotary switch arms are adapted to be restored to a normal position by a spring 135 preferably surrounding the rotor shaft 136. The switch arms are adapted to be held in each position of stepping advancement by a holding pawl 137 engaging in the teeth of the ratchet wheel 128, this holding pawl being adapted to be released through a tripping armature 138 adapted to respond to a tripping or releasing electromagnet 139. For certain situations, this rotary switch is provided with switch contacts 141 which are arranged to be moved to closed position by the stepping lever 129 with each movement of said lever in a stepping direction.

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Referring now to the duo-directional or add and subtract type of rotary stepping switch shown in Figures 17 and 18, in this construction the rotary contact arms or commutators 145 wipe back and forth over contacts 146 mounted in the disk 147. The shaft 143 for these rotary switch blades is adapted to be stepped in either direction by a stepping wheel 149 having symmetrically shaped stepping teeth 149' around its periphery. This stepping wheel is adapted to be actuated in a counter-clockwise direction by the downward stepping motion of a left-hand stepping pawl 151 which is adapted to engage the teeth 149' at the left-hand side of the wheel, and the wheel is advanced or rotated in a clockwise direction by a similar stepping pawl 152 disposed to the right-hand side of the shaft 148 and arranged to engage the stepping teeth 149' at the right-hand side of the stepping wheel. The pawl 151 responds to a stepping electromagnet 153 and the pawl 152 responds to a similar electromagnet 154, these pawls being both spring returned to their normal elevated positions out of engagement with the ratchet teeth 149' through the action of tension springs 155 (Fig. 18). A spring centered holding pawl 156, capable of spring resisted throw to either side of a neutral position, is arranged for engaging the teeth 149' of the wheel 149 so as to yieldingly hold the wheel in each position to which it has been turned by either the counter-clockwise advancing pawl 151 or the clockwise advancing pawl 152. This type of add and subtract rotary switch can also be equipped with auxiliary switches 161 disposed above either or both of the stepping pawls 151 and 152 so as to respond to the motion of these stepping pawls.

Referring briefly to the type and function of each of the rotary switches J, K, L, M, N, P and R, the rotary switch J is of the spring return type illustrated in Fig. 16 and is a frame counting switch, i. e. it counts the successive frames of the bowling game. Rotary switch K is also of the spring return type shown in Fig. 16, and functions as a units counting switch, i. e. it steps up the units score on the indicating panel 42 by controlling the lighting of the light bulbs behind the units indicating areas 117. Rotary switch L is also of the spring return type as shown in Fig. 16 and functions as a tens counting switch, i. e. it steps up the tens score on the indicating panel 42 by controlling the illumination of the light bulbs behind the tens indicating areas 116. Rotary switch M is of the aforementioned motor driven type, driven by a rotary armature type of motor, and functions as a "tally" switch, i. e. it counts the individual pin score (in collaboration with the target switches) and it transmits the tally of strikes, spares and individual pins to other parts of the system. Rotary switch N is of the add and subtract type shown in Figures 17 and 18, and functions as a temporary strike storing switch, i. e. it temporarily records or stores the strike value which may be existing at that moment of play in the game, awaiting the delivery of the next two balls. Rotary switch P is of the spring return type shown in Fig. 16, and functions as a ball counting switch, i. e. it counts the balls bowled in each frame so as to establish whether the first ball or second ball has been bowled in each frame. Rotary switch R is of the add or subtract type shown in Figures 17 and 18 and functions as a free play controller, i. e. in a coin controlled type of game

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it determines whether the player is entitled to bowl another game free by virtue of having obtained a predetermined high score in the previous game, or it may determine how many of these free games the player is entitled to bowl by virtue of a previous high score. Before starting a detailed description of all of the electrical circuits interconnecting the above mentioned rotary switches J, K, L, etc., I will first describe the conventional method of scoring in a standard or official bowling game so that the scoring procedure and the terms referring thereto will be clearly understood in the description of the circuits.

Method of scoring

If the player succeeds in knocking down all ten pins with the bowling of the first ball he has made a "strike." If the player succeeds in knocking down all ten pins in bowling two successive balls he has made a "spare." If the player fails to knock down all ten pins upon the bowling of two balls he has made a "miss," or "error." Referring first to the scoring value of a miss or error, the player merely receives one point each for the number of pins he did knock down upon the bowling of two balls, viz. if the two balls together merely knock down six pins he receives a score of "6." Referring now to the scoring value of a spare, the player receives ten points (one for each pin) plus the number of pins he knocks down with the first ball which he bowls in the next frame, as a reward for making a spare. This value of ten-plus is his score for the frame in which he made the spare, and should be tallied immediately after the first ball of the succeeding frame has knocked pins down. Referring now to the scoring value of a strike, should the player knock down all ten pins with his first ball delivery (a strike), he receives ten points (one for each pin) plus the number of pins he knocks down with his next two ball deliveries. If the player should strike again, with the first ball of the next succeeding frame, the score for the frame of the initial strike would be increased to 20, but still would not be tallied, since this ball was only the first ball after the initial strike. Then, if by chance, the player makes a third strike with his next delivery thereupon the initial strike score will be increased to 30 points, and this being the second ball following the initial strike, the 30 points should be tallied immediately and credited to the frame in which the initial strike was made. Having tallied this initial strike, the second strike made becomes the "initial" strike, and the third strike made by the player then becomes the first delivery after this latter initial strike. Should the player fail to strike on his next ball delivery, this delivery will then be the second ball of this present or later initial strike, whereupon 20 points plus what was obtained on this latter delivery should be tallied and credited to the proper frame. Thus, only one of the three strikes remains to be tallied. One ball has already been delivered following this last strike, and what the player knocks down on his next delivery, plus what he obtained on the preceding one, will be added to the ten he received for the last strike to comprise the score to be tallied and credited to the frame in which the strike was made. If the player failed to spare with his just mentioned second delivery, the number of pins knocked down for the last two deliveries will also be tallied at this time, and credited to this last frame. My improved bowling game keeps a perfectly true and accurate

score based upon this standard conventional scoring procedure just described and officially established as the official scoring in all full sized bowling alleys.

Simulated pin-lighting circuits

Attention is now directed to Figure 12 which illustrates a simplified circuit diagram of the circuits for the simulated pin-lights p^1 to p^{10} , inclusive. As previously described, when these light bulbs p^1 - p^{10} are illuminated; the simulated bowling pins corresponding thereto stand out on the simulated pin panel 44 in contrasting life-like appearance, and when any one of these light bulbs is extinguished the bowling pin corresponding thereto is blanked out or merged into the background color of the panel, so that the effect is that the bowling pin has been completely removed from that spot on the surface of the alley. In Figure 12, the seven target plates A, B, C, D, E, F and G are shown substantially in their geometrically aligned relation with the associated simulated pin-lights p^1 to p^{10} , inclusive. Directly above each target plate is also shown the stack or pile-up of contact switches controlled by that target plate (identical with the stacks or piles of contact springs 89 in Figures 10 and 11). Also associated with these target plates in Figure 12 are their respective releasing coils H, previously described in connection with Figures 10 and 11. This circuit diagram of Figure 12 is intended to illustrate a simplified embodiment of the invention, particularly adapted to home use in which no automatic scoring apparatus is provided. In this simplified home embodiment of the game, the bowling ball can be bowled by hand or by the ball delivery mechanism of Figures 6, 7 and 8, as desired. In this simplified embodiment, when target plate A is struck with the bowling ball it shifts switch A2 from the full line position to the dotted line position. When target plate B is actuated it moves switches B2, B3 and B4 to open circuit positions. When target plate C is actuated it moves switches C2, C3 and C4 to open circuit positions. When target plate D is actuated it moves switches D2, D3 and D4 to open circuit positions. When target plate E is actuated it moves switches E2, E3 and E4 to open circuit positions. When target plate F is actuated it moves switch F2 to open circuit position; and, similarly, when target plate G is actuated it moves switch G2 to open circuit position. As previously described, the bowling ball can actuate two adjacent target plates by striking both target plates at the same time. When changing this simplified embodiment of the game to the more complicated embodiment including the automatic scoring apparatus, it is only necessary to add a first circuit closing switch to each stack, and to add a second circuit closing switch to stacks A, B and C. This will be later described in connection with Figure 19C.

All of the release coils H are adapted to be energized simultaneously through a circuit H'. In this simplified embodiment of the game, circuit H' can be controlled by any conventional push button or manual switch 165 connected to a source of current supply designated CS. The other side of this release coil circuit is grounded or otherwise connected to the other side of the source of current supply. A relay AA has its winding connected through circuit AA' with switches D3, B3, C3 and E3, as will be later

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described, and switch AA' of relay AA is connected through circuit AA' with the back contact of switch A2. Current is supplied to this network of pin-light circuits from a current supply source CS which is connected with the movable contact of switch A2 and with the movable contact of switch B3. Any suitable manually operated switch can be arranged to disconnect the current supply source CS from switches A2 and B3 when the game is not in use. In the coin controlled embodiment of the game hereinafter described, the coin control mechanism governs the connection of the source of current supply CS to the terminals or bus marked CS. All of the pin-light circuits continue through the lights p^1 - p^{10} and connect to ground.

Referring now to the operation of the pin-light switches, most of the pin-light circuits originate through break-and-make switch A2 of target plate A. Since the target plates are all assumed to be in normal position, the respective target plate switches will likewise be assumed to be in normal positions (closed). Therefore, any circuits leading to these target switches will be allowed to continue through them. Thus, circuit p' from current supply source CS passes through switch A2 and continues to switches B2 and C2 by way of conductors B2' and C2'. Circuit p' also extends through switch A2 to conductor p^1 to pin-light p^1 for illuminating that light. Upon reaching switch B2, circuit B2' is completed through this switch and through conductor p^2 to pin-light p^2 for illuminating that light, and this circuit also continues through D2' and switch D2 and thence through conductor p^4 to pin-light p^4 for illuminating that light. Likewise, circuit p' , after passing through switch A2, continues through conductor C2' and switch C2 to pin-light conductor p^3 for illuminating pin-light p^3 , and also continues through switch E2 to pin-light conductor p^6 for illuminating pin-light p^6 . Thus the illumination of pin-lights p^1 , p^2 , p^4 , p^3 and p^6 is accomplished.

It will be noted that supply circuit p' also extends directly to switch B3 of target plate B and passes through this switch to switch C3 of target plate C. This latter switch C3 extends supply circuit p' (from current supply source CS) to relay circuit AA', which relay circuit also connects with target switches D3 and E3, as previously described. Target switch D3 allows relay circuit AA' to continue by way of conductor F2' through switch F2 and thence through conductor p^7 to pin-light p^7 . Similarly, target switch E3 allows the relay circuit AA' to continue by way of conductor G2' through target switch G2 and thence through conductor p^{10} to pin-light p^{10} . Thus, the illumination of pin-lights p^7 and p^{10} is accomplished.

According to the playing averages of the game, pin-light p^5 should be extinguished by hitting target plates A, B or C, and, hence, circuit p^5 is arranged to originate beyond switch B2 through p^2 , this circuit continuing through switch C4 to pin-light p^5 . For the same reasons, pin-lights p^8 and p^9 should also be extinguished simultaneously by the hitting of target plates A, B and C, and, hence, circuit p^{89} is caused to originate beyond switch C2 through conductor p^3 and thence through switch B4 to switches D4 and E4. Switch D4 completes the circuit through conductor p^8 to pin-light p^8 , and switch E4 completes the circuit through conductor p^9 to pin-light p^9 . By these circuit connections, pin-lights p^8 and p^9 are caused to be extinguished when the ball

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strikes target plates A, B and C, and these two lights are individually extinguished when the ball strikes either target plate D or target plate E, respectively. Thus, by illuminating the pin-lights p^5 , p^8 and p^9 through the circuit connections above traced, the lighting of all pins is completed.

It will be apparent from the foregoing how the pin-lights are extinguished as the target plates are struck with the bowling ball. For example, if the player should hit target plate D with a ball delivery, this target plate is swung back to latched position shown in Figure 11, thereby opening the associated target plate switches D2, D3 and D4. This interrupts circuit p^4 at the switch D2 and also interrupts circuit F2' at switch D3. In addition, circuit p^7 is interrupted at switch D4. Hence, pin-lights p^4 , p^7 and p^8 are simultaneously extinguished by this actuation of the target plate D. Figure 13 illustrates nine of the different scoring plays which can be made in the present game. This figure only illustrates eight diagrams, but the second diagram of the top row shows two different scoring plays when the ball strikes target plate F alone or when it strikes target plate G alone. The two diagrams designated BA and AC represent "strikes," the diagram BA showing the ball entering the so-called "1-2 pocket" represented by the simultaneous striking of target plates A and B, and the diagram AC showing the ball entering the so-called "1-3 pocket" represented by the simultaneous striking of target plates A and C. Each of these scores a strike by extinguishing all ten pin-lights. The third diagram in the bottom row designated A shows the scoring play which usually results when the ball is bowled right down the center in line with king pin 1, corresponding to the ball striking only target plate A. This usually results in a "split," leaving the 7 and 10 pins standing. Referring now to the unique arrangement of the switches and circuits which provides for this "split" scoring play, the relay AA exercises a control function at this time which maintains the "split" and prevents the possibility of both the p^7 and p^{10} lights being simultaneously extinguished if one or the other of the pins is picked off by the next ball. As previously described, supply circuit p' passes through switches B3 and C3 in series and thence joins relay circuit AA' which, in addition to supplying relay AA, also extends through switches D3 and E3 which eventually lead to pin-lights p^7 and p^{10} (through switches F2 and G2, respectively). Thus, relay AA is maintained energized whenever target plates B and C are both in their normal positions. Hence, when target plate A is hit (without also striking either target plate B or target plate C as well) the break-and-make switch A2 will change from a normal to an engaged position (from engagement with its front contact to engagement with its back contact), thereby breaking supply circuit p' at this switch and causing pin-lights p^1 , p^2 , p^3 , p^4 , p^5 , p^6 , p^8 and p^9 to be extinguished. However, pin-lights p^7 and p^{10} will not be extinguished at this time, since circuit p' energizes the circuit AA' for these lights directly through switches B3 and C3 (and thence through switches D3 and F2 and switches E3 and G2) instead of coming through break-and-make switch A2 first, as with the other pin-light circuits. Similarly, relay AA will still remain energized because it is not energized through switch A2. Therefore, having shifted switch A2 from its normal position to an en-

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gaged position in engagement with its back contacts, a circuit AA1' is thence completed from conductor p' to the relay switch AA1 which normally stands open. However, since relay AA is still being energized, as above explained, this normally open relay switch AA1 will be closed, thus enabling circuit AA1' to be completed through conductor AA' into the winding of relay AA, thereby causing said relay to lock up or hold itself energized until target switch A2 is restored to its normal position in engagement with its front contacts. By completing circuit AA1' through relay switch AA1 and into relay AA by way of conductor AA', as just mentioned, this latter circuit AA' will also be completed by current supplied over conductor AA1' to switches D3 and E3, causing pin-lights p⁷ and p¹⁰ to remain illuminated along with the energization of said relay AA. The primary purpose of employing this relay AA in the circuit relation just described is to prevent the player from being able to extinguish both pin-lights p⁷ and p¹⁰ simultaneously with his next delivery by hitting either target plate B or C, inasmuch as it is generally recognized as impossible in bowling for a player to remove both pins of a "7-10" split with one delivery. Furthermore, it would be unorthodox to be able to remove them by bowling practically down the center of the alley.

Now let us modify or turn this example around by assuming that instead of hitting target plate A with his first delivery, the player first hits target plate B, and thereafter hits target plate A with his second delivery. With reference to the first delivery striking target plate B, this will cause the normally closed switches B2, B3 and B4 to open, thereby extinguishing pin-lights p², p⁴ and p⁵ at switch B2; extinguishing p⁷ and p¹⁰ at switch B3; and extinguishing pin-lights p⁸ and p⁹ at switch B4. It will be noted that the opening of switch B3, which serves to extinguish pin-lights p⁷ and p¹⁰, also interrupted relay circuit AA', thereby returning relay switch AA1 to its normal position (open). Then, assuming that the player hits target plate A with his next delivery, he will extinguish the remaining three pin-lights p¹, p³ and p⁶, as heretofore described. This act of striking target plate A changed the break-and-make switch A2 from its normal to an engaged position in engagement with the back contact, thereby causing circuit p' to be diverted to conductor AA1', as heretofore described, and on to switch AA1 of relay AA, but this circuit will not be completed to AA', since relay AA is not being energized at this time, which means that switch AA1 is in its normal open position. It will thus be seen that the player successfully extinguished all ten pin-lights with two deliveries, thereby accomplishing a "spare."

In order to make a strike, viz extinguish all ten pin-lights with one delivery, the player must hit target plates A and B or target plates A and C simultaneously (and not hit target plate A alone). The opening of switch A2 will extinguish pin-lights p¹, p², p³, p⁴, p⁵, p⁶, p⁸ and p⁹, as previously described, and switch B3 of target plate B or switch C3 of target plate C, depending upon which of these two target plates was also struck, will extinguish pin-lights p⁷ and p¹⁰ and will also release relay AA, restoring its switch AA1 to normal open position. Thus, by actuating targets A and B or A and C simultaneously, switch B3 or switch C3 will open, releasing relay AA, before the break-and-make switch A2

can change position and cause the relay AA to hold itself energized, as heretofore described. That is to say, when switches A2 and B3, or A2 and C3, are actuated simultaneously, there is a very short interval when no current is being conducted to relay AA and, hence, this relay re-energizes, thus cutting off current to pin-lights p⁷ and p¹⁰. This is the condition for a strike. In contra-distinction to this when the ball travels down the middle of the alley and only hits target plate A for a "split," the movement of switch A2 to its actuated or upper position supplies current to relay AA over contact AA1, thus locking up relay AA until all target plates are restored. While this relay AA thus locks up, either pin-light p⁷ or pin-light p¹⁰ can be extinguished by the next ball but both cannot be extinguished.

After the frame has been completed, either by the making of a strike on the first ball, or by the bowling of two balls, the target plates must all be restored to normal, and all of the target plate switches and related circuits restored to normal, so that the ten pin-lights will again be illuminated for starting the next frame of the game. In the simplified home embodiment of the game illustrated in Figure 12, this is done by merely closing the push button switch 155 which energizes all of the release coils H simultaneously and, hence, permits any latched target plates to be released and restored to normal position. The player can then proceed to bowl the next frame. With this embodiment of the game the player would, of course, tabulate the score on a score sheet in the way ordinarily done in a regulation bowling alley.

Automatic scoring embodiment

Referring now to the automatic scoring embodiment of this game, the seven target plates A to G, inclusive, together with their automatic switches and release magnets, remain the same as previously described of the non-scoring embodiment, except that each target plate is provided with an additional switch designated A1, B1, C1, D1, E1, F1 and G1, (Figure 19C) and, furthermore, target plate A is provided with additional switch A3 and target plates B and C are provided with additional switches B5 and C5. In the automatic scoring embodiment of the game the ball return trough 36 (Figure 9) is provided with two ball return trip switches FE1, FE2. These trip switches are suitably mounted on supporting brackets directly below the ball return trough 36 and have trip fingers 121 which extend up through openings 122 formed in the bottom of the trough, these fingers being positioned to be struck in sequence by the ball in its return motion down the trough 36. It is appropriate to briefly describe the main operating functions of these two trip switches FE1 and FE2 in connection with Figure 19D before describing the complete circuit diagram in its entirety. Accordingly, attention is directed to Figure 19D which shows that when trip switch FE1 closes under the action of a returning ball, it originates a circuit from current supply source CS which continues along conductor OO1' to break-and-make switch ST3 of "Strike" relay ST. Assuming that the first delivery of the ball which has thus actuated the trip switch FE1 did not accomplish a "Strike," then strike relay ST will not be energized, for reasons pointed out later on in connection with "primary circuit one." Hence, circuit OO1' will continue through the normally closed position of switch ST3 along

conductor PS' to solenoid PS of rotary switch P, this being the ball counting switch. Rotary switch P is of the impulse stepping type that advances its fingers PF1—PF3 one position, as indicated, each time that the stepping solenoid PS is impulsed. Therefore, fingers PF1, PF2 and PF3 are moved from their respective normal or rest positions P10, P20 and P30 to their first actuated positions P11, P21 and P31. Fingers PF1, PF2 and PF3 are insulated from each other, and are utilized primarily to complete secondary circuits whose operations are made subject to whether the ball delivery is the first ball or the second ball of the particular frame being bowled. This rotary switch P is provided with an electrical reset PR which, upon energization, releases the holding pawl and permits the contact fingers to be instantly restored to normal position by a return spring, this occurring each time that the coil of reset PR is energized. The other trip switch FE2 functions primarily as an auxiliary switch in connection with secondary circuits to be later described, and hence the operation of this switch will be discussed later under "Scoring."

After the ball has returned to the ball delivery mechanism 37, or to the delivery end of the alley in the manually controlled embodiment of the game, the player then attempts to extinguish the remaining pin-lights with his second delivery. Whether he does or not, the returning ball will again actuate trip switches FE1 and FE2 and repeat the above described operation, so that fingers PF1, PF2 and PF3 of rotary switch P will be advanced to positions P12, P22 and P32, respectively. If the player obtained a "Spare" with his second delivery, then "primary circuit two" would be established through this second stepping position of the fingers PF1, PF2 and PF3 of rotary switch P, as will be later described under "primary circuit two." If the player fails to make a "Spare" with his second delivery, it constitutes a miss, and the resulting operations would begin with "primary circuit three," which will also be hereinafter described. Figure 15 defines by reference characters the four main circuits of the system. For example, the ball return circuit consists of elements FE1—OO1'—ST3—PS—PS. If the player makes a "Strike" then primary circuit one functions, such being defined by elements S'—P10—PF1—S'—ST. If the player makes a "Spare" in the bowling of two balls for that particular frame, then primary circuit two is caused to function, this circuit comprising elements S'—P11—PF1—SP'—SP. If the player makes a miss in that particular frame, the primary circuit three is caused to function, this circuit comprising elements P22—PF2—O1'—SP4—MR'—MR. We shall now refer to—

Primary circuit one, the strike circuit

As previously described under the heading of "Simulated Pin Lighting Circuits," in order to complete a "Strike" circuit, the player must simultaneously hit either targets A and B or targets A and C. In the present instance, let us assume that he has hit targets A and B, thereby causing the levers of these two target plates to be raised to a locked position, and resulting in the actuation of the respective stacks of contacts above targets A and B, as shown in Figure 19C. This will cause normally open switches A1 and A3 to close and will also cause normally open switches B1 and B5 to close. As previously

described, this strike actuation of targets A and B also causes normally closed switches B2, B3 and B4 to open, and causes break-and-make switch A2 to change position back into engagement with its back contacts, thereby extinguishing all ten pin-lights, as previously described in connection with the pin-lighting circuits.

With target plates A and B latched up in their actuated positions, supply circuit *p'* supplies current out through switches A3 and B5 in series to circuit S'. In this automatic scoring embodiment of the game, the relay AA is provided with additional contact switches AA2, AA3 and AA4, as shown in Figure 19C. Circuit S' connects with relay switch AA4, which is normally closed, and continues through this switch to the point P10 on rotary switch P, as shown in Figure 19D. As heretofore explained, rotary switch P determines whether the delivery is the first ball or the second ball of the frame. Inasmuch as targets A and B were both swung back into their locked position by the first ball delivered, the fingers of rotary switch P are still standing in their normal or "Home" positions (the "0" position). Therefore, circuit S' continues through finger PF1 of rotary switch P and continues from the lower contact P10 of this switch past the junction point with conductor ST1' and finally terminates at the coil of strike relay ST, the other terminal of which is connected to ground or a common return. This energizes the coil of strike relay ST, with the result that normally closed switch ST1 opens, normally open switch ST2 closes and break-and-make switch ST3 changes position, thereby being placed in a position to accommodate any secondary circuits affected by this "Strike." The above described "Strike" circuit (consisting primarily of conductor S') will hereinafter be referred to as "primary circuit one" when dealing with the secondary circuits derived from the various scoring conditions illustrated in Figure 14.

The returning ball actuates trip switch FE1, as previously described, thus originating circuit OO1' as described above in connection with the ball return function, but inasmuch as this particular play is a "Strike," switch ST3 of strike relay ST has changed from its normal position in engagement with its back contacts to an engaged or actuated position in engagement with its front contacts. Therefore, instead of circuit OO1' continuing along conductor PS' to the stepping solenoid PS, it is diverted to circuit NA' which is connected to the actuating coil NA of rotary switch N. This energization of actuating coil NA advances the switch fingers NF1—NF4 from their respective resting positions N10, N20, N30 and N40 to their first advanced positions N11, N21, N31 and N41. As previously described, this rotary switch N is an add and subtract rotary switch adapted to be stepped collectively in either direction by the two actuating coils NA and NS. The switch fingers NF1 to NF4 are insulated from each other and advanced in an adding direction (counter-clockwise), each time actuating coil NA is impulsed. The switch fingers will also step backwardly or subtract one position each time that actuating coil NS is impulsed (as hereinafter described under "Scoring"). The main purpose of this rotary switch N is to temporarily record "Strikes" until they have been duly tallied. After being tallied, they are individually removed in accordance with the scoring system of actual bowling, this occurring by the impulsing of actuating coil NS. The

switch fingers NF1—NF4 therefore move back and forth to and from the four positions shown, permitting the proper circuits to operate in accordance with the number of strikes that are recorded and tallied.

Whenever the add coil NA is impulsed, the normally open switch NA1 associated with this coil (switch 161 of Figure 18) is caused to close, thereby originating circuit NA1' which starts from current source CS and continues through break-and-make switch SP3 of spare relay SP and thence continues through conductor JS' to solenoid JS of the frame counting rotary switch J. Upon the energization of this stepping solenoid JS, the fingers JF1 and JF2 of this rotary switch are advanced one point to signify the completion of a frame of the game. The contact points J1, J2, J3, etc. are each individually connected with the light bulbs J1', J2', J3', etc. which are disposed in the box areas 108 of panel 42, these box indicating areas indicating the particular frame of the game that the player is then bowling. If the game is constructed to score ten frames, then there are ten of these light bulbs J1' to J10', inclusive, which are arranged to be energized collectively from pin contact points J1 to J10 of the frame counting switch J. If the game is constructed to score only five frames, then there are only five of these light bulbs and five associated contact points on the rotary switch. In addition to these five or ten contact points on the rotary switch, there are provided two additional contacts indicated at J11 and J12 which are multipled to the last light connected contact, which in the case of a ten frame game would be the contact J10, and in the case of a five frame game would be the contact J5. These provide for strikes beyond the last frame. Each time that solenoid JS is energized to step the switch J for counting one more frame, an auxiliary switch JS1 is also moved to a closed position, thereby completing a circuit from current source CS over conductor H' directly to all of the releasing coils H of the seven target plates, as a result of which all actuated target plates are released for returning to normal position. Referring to Figure 19D, attention is directed to the fact that circuit PR' leading to the reset coil PR of rotary switch P branches off or originates from circuit H'. Thus, the reset PR is energized each time that the release coil circuit H' is energized, with the result that the ball counting switch P is restored to normal position each time that the release magnets H are energized for restoring the target plates to normal position. It should also be noted that when finger NF1 of rotary switch N is advanced or retracted to switch points N11, N12, or N13, a circuit is completed over conductor X1' to tally board light X1 (Figure 19B) which illuminates the first box area 109, Fig. 3, on indicating panel 42 for the purpose of indicating that the player still has a strike to be tallied, pending what he receives on his next two deliveries. Also, if and when finger NF4 of rotary switch N contacts points N42 and N43, it will complete a circuit X2' to the tally board light X2 which is in the second box area 109, thereby serving to indicate that the player has two strikes yet to be properly scored and tallied. Still further, attention is directed to the fact that when a strike is made, the energization of strike circuit S' continues through switch finger PF1 of rotary switch P and thence branches through conductor STF' (in addition to con-

tinuing on through conductor S' to strike relay ST). This energization of conductor STF', in this instance, energizes tally board light STF which illuminates the large indicating area 114 on the indicating panel for designating a "Strike" in a prominent manner. This illumination of the strike indicating area 114 continues until the returning ball engages the trip switches FE1 and FE2 in its path, causing the targets and their respective switches to return to normal, and thereby breaking the circuit S'.

Primary circuit two, the spare circuit

In order to register a "Spare," the player must originate or energize the same circuit S' of primary circuit one, viz the strike circuit, with two ball deliveries, instead of one. If his first delivery fails to hit either target A, B or C (Figure 19C) he will have to hit targets A and B simultaneously or A and C simultaneously with his second delivery (like making a strike), in order to extinguish all of the lights and obtain a "Spare." If the player hits target B or target C with his first ball he will close either one of the normally open switches B5 or C5, as the case may be. Then if he hits target A with his second delivery, he will have originated primary circuit S' through switch A3. In either case, circuit S' will continue along S' to point P10 of rotary switch P (Figure 19D), the same as previously described in connection with primary circuit one. However, since the "spare" occurred after one ball had been delivered, finger PF1 has been advanced to point P11 by the return of the first ball, as described above under the heading of "Ball return." Therefore, circuit S' continues to point P11 and through finger PF1 and along conductor SP' to the spare relay SP. By energizing the coil of spare relay SP, the normally open switches SP0, SP2, and SP6 will close, and the normally closed switches SP1 and SP5 will open; and the break-and-make switches SP3 and SP4 will change positions, whereby these switches are placed in positions to accommodate any secondary circuits affected by this "Spare." This just described "Spare" circuit will hereinafter be referred to as "primary circuit two" when referring to secondary circuits derived from the various scoring conditions of Figure 14.

As just mentioned, the "Spare" circuit is completed the moment the second ball hits the target. Therefore, as the ball returns, the contact fingers of rotary switch P are advanced to points P12, P22 and P32, thereby breaking circuit S' to relays SP and SPX through points P11. Thus, circuit O1' is originated from current source CS through contact point P22 and through contact finger PF2 and thence through the other switch point P22 and conductor O1' down to the make-and-break switch SP4 of the spare relay SP. Since this spare relay SP has been energized over circuit SP', and is now locked up by the action of spare release relay SPR, the switch SP4 of the spare relay has changed from the normal position shown to an engaged position against its front contact, whereby circuit O1' is diverted to conductor O6' which leads to point N20 and point N21 of rotary switch N. As previously described, rotary switch N temporarily records the strikes. If no strikes have been made in the previous frame, then the contact fingers NF1, NF2, NF3 and NF4 will be at their "home" positions, as shown. Therefore, circuit O6' will continue from switch point N20 through contact fingers NF2 and over conductor JS' to solenoid JS of frame

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counting switch J, which will thus be actuated to tally a frame. The energization of solenoid JS will close switch JS1 and thereby complete circuit H', thereby causing all latched targets to be released by the energization of their releasing coils H. In addition, circuit PR' will be energized so as to actuate the reset PR of rotary switch P, thereby causing this rotary switch to be spring-restored back to its normal or home position. This is the ball counting rotary switch, and the restoration of such switch to its home position indicates that the second ball of that frame has been bowled.

Spare relay SP and its companion release relay SPR are the interlocking type. When spare relay SP is energized, the armature of release relay SPR snaps outwardly and latches the armature of relay SP in its attracted position. Therefore, spare relay SP remains in an actuated position after it has been de-energized by the moving of finger PF1 of rotary switch P from points P11 to P12. This spare relay SP will remain in this latched position until release relay SPR has been energized, as will be later described under the heading of "Scoring."

It will be noted that whenever spare relay SP is latched in its engaged position, a circuit is completed through switch SPO to tally board light SPM over conductor SPM'. The illumination of this tally board light will show on the tally panel 42 that the player still has a "Spare" to be added to his score, pending what he accomplishes on his next delivery. Attention is also directed to the fact that each time circuit SP' is completed to spare relay SP and its auxiliary relay SPX, a branch of this circuit designated SPF' is also energized, this branch circuit extending up to the tally board light SPF which illuminates the large indicating area 115 bearing the word "Spare" (Fig. 3).

Primary circuit three, the miss circuit

When the player fails to extinguish all of the pin-lights with the two ball deliveries of the frame, this is usually referred to as a "Miss" or an "Error." This condition means that the player has failed to close circuit S', as heretofore described under primary circuit one (strike) and primary circuit two (spare). Let us assume that the player has hit target E with his first delivery, thereby extinguishing three pin-lights, as shown in Figure 13E. The returning ball engages the trip switches FE1 and FE2 in the return trough and advances the fingers of ball counting switch P one point, as previously described. Let us assume that on the second delivery the player hits target B, which normally would extinguish seven pin-lights (Figure 13B), but which now only extinguishes five, because the previous striking of target E has extinguished pin-lights p^6 , p^9 and p^{10} . Hence, it will be seen that the player has failed to extinguish all ten pin-lights in two deliveries. The second ball returns, as previously described, and advances the fingers of ball counting switch P one more point.

Fingers PF2 of this rotary switch P (Figure 19D) now rest on points P22. Thus, a circuit is originated from current source CS through the switch arm and through the switch points and continues along conductor O1' to switch SP4 of the spare relay SP. Inasmuch as the player did not make a spare in the bowling of these two balls, he failed to energize this spare relay SP. Hence, switch SP4 is in its normal closed position, i. e. closed against its back contacts. Accord-

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ingly, circuit O1' then continues along conductor MR' to the relay MR (Figure 19C) which controls the motorized rotary switch M that counts the pins, etc., as I shall later describe under "Scoring."

This just described "miss" circuit will hereafter be referred to as "primary circuit three" when referring to the secondary circuits derived from the various scoring conditions of Figure 14.

Scoring

Since the accumulative type of scoring used in bowling depends so much on what was accomplished in the preceding frame, a chart has been shown in Figure 14 to aid in explaining how this irregular type of scoring is successfully accomplished in the automatic scoring embodiment of my improved bowling game. This chart is laid out to represent ten frames of bowling, and is so designed as to permit the counting and tallying to be illustrated as the game progresses. The "Strikes," "Spares" and "Misses" and their various scoring conditions are so arranged in this chart of Figure 14 that all ten possible conditions that can affect the irregular scoring of bowling will arise in the first nine frames. By permitting a strike in the tenth frame, it will be possible to describe how the game, instead of shutting off, will permit the player to make the two extra deliveries to which he is entitled, in order to complete his strike score, should this situation arise during the playing of the game.

Commencing with the first frame in which the player makes a "miss," we will follow the examples used previously under the heading of "Primary circuit three," the miss circuit, wherein it was assumed that the player hit targets E and B with his two deliveries. Having completed circuit O1' to the relay MR, and thereby energizing the coil of said relay, a make-and-break switch MR1 is caused to change position from normal engagement with its back contact MR2 to engagement with its front contact MR3, completing a circuit from current source CS through switch MRR1 of relay MRR back into relay MR and rotary switch M, which in turn actuates a switch finger MF in a counter-clockwise direction, as illustrated (Figure 19C). This switch finger MF has connection with a source of current supply CS, and carries a row or series of contact points at each end which are operative to energize any stationary switch points which the rotating points contact, thereby completing circuits from the current source CS through the rotating switch arm and through the stationary contact points engaged thereby. The switch arm MF is preferably driven through a suitable speed reducing gear train from a small electric motor MOT. When this motor is energized it causes the switch arm MF to rotate through one half revolution in a counter-clockwise direction and to come to rest in the home position illustrated out of engagement with the stationary contacts. We have previously assumed that the player has hit targets E and B with his two deliveries, whereby eight lights are extinguished (Figure 13) and normally open switches B1 and E1 are caused to be closed. As switch arm MF advances counter-clockwise it simultaneously engages four rows of stationary contacts on the left side of the stationary disk, these rows being designated $r1$, $r2$, $r3$ and $r4$, and the contact arm also engages one row on the right side of the disk. The numbers 2, 4, 5, 8, 9, 3, 6, 1, 7 and 10 disposed around the outer upper side of the disk represent the

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order in which the counting of the extinguished pin-lights is accomplished. This permits "overlapping" circuits to score simultaneously, thus giving a count identical to the number of pin-lights extinguished. In this instance in which we assumed target switches E1 and B1 to be closed, switch finger MF contacts circuit E' at points 9-6-10 of row r4. The circuit E' is completed through target switch E1 and thence through the common line KS' which continues to the advancing solenoid KS of the units counting switch K (Figure 19B). Rotary switch K is the common stepping type that rotates its common contact fingers KF one point each time the actuating solenoid KS is impulsed, the switch being also equipped with an electrical reset KR that permits the switch fingers, through spring action, to return to rest position instantly each time that the coil of reset KR is energized.

Referring back to the motor driven switch M (Figure 19C) the finger MF also contacts circuit B' at points 2-4-5-8-9-7-10 of row r2, thus completing this circuit B' through switch B1 to the common return circuit KS' and thence to advancing solenoid KS of the units counting switch K. Inasmuch as pin-lights p⁹, p⁶ and p¹⁰, which are normally extinguished by hitting target E, and pin-lights p², p⁴, p⁵, p⁸, p⁹, p⁷ and p¹⁰, normally extinguished by hitting target B, have both pin-lights p⁹ and p¹⁰ in common, they are so arranged on the disk that the finger MF will contact points 9 and 10 of each row simultaneously, thereby delivering only one impulse for point 9, and only one impulse for point 10. Therefore, in addition to points 9 and 10, advancing solenoid KS will receive through circuits KS' one impulse by way of circuit E' (for point 6) and will receive five impulses by way of circuit B' (for points 2, 4, 5, 8 and 7), thus making a total of eight, which conforms with the number of pin-lights extinguished. Rotary switch K (Figure 19B) having been advanced these eight points, remains in this tallied position, with a finger KF resting on point K3. This completes a circuit from current source CS through contact finger KF and thence through stationary contact point K3 to the light KL3 on tally board 42.

Contact finger MF of this motor driven switch M in advancing in a counter-clockwise direction also engages contacts M1, M2, M3, M4, M5, M6, M7 and M8 successively on the right side of the stationary disk. Contacts M1 through M5 deal with secondary circuits arising later, and will be discussed as they are encountered. Upon reaching contact M6, a circuit M6' is originated from current source CS through contact finger MF and through conductor M6' to the normally closed switch DC3 of relay DC (Figure 19D). Switch DC3 is then in its normal position closed against a back contact, and permits the circuit M6' to be continued through this back contact and thence to point P32 of the ball counting rotary switch P. Inasmuch as the fingers of this rotary switch P have been advanced two points or steps by the ball returning twice through the return trough, switch finger PF3 now rests on switch points P32, thus enabling circuits M6' to be completed through this switch finger to circuit JS'. Circuit JS' in turn leads to advancing solenoid JS of rotary switch J (Figure 19B). By thus impulsing advancing solenoid JS, the auxiliary switch JS1 causes the circuit H' to be completed to the release coils H of the targets, thus restoring all actuated targets to normal posi-

tions. Concurrently therewith, the fingers JF1 and JF2 of the frame counting rotary switch J are advanced one point, thus completing a circuit from current source CS through switch finger JF1 and through switch point J2 to the light J2' on the tally board. This frame counting rotary switch J remains in this position until impulsed again, thus leaving light J2' illuminated behind frame "2" of the tally panel, indicating the game is ready for the second frame. By energizing the coil of reset relay PR by way of circuit H', the ball counting rotary switch P is allowed to return to its normal position, thereby removing the "two-balls-delivered" position established by the "miss." Referring back to Figure 19C, upon reaching switch point M7, contact finger MF of the motorized switch M completes the circuit M7' to motor release relay MRR. By energizing this motor release relay MRR the break-and-make switch MRR1 is caused to change from the normal position shown to an engaged position in contact with a front contact, thereby breaking circuit MR1 leading to relay MR over its own switch MR1 and, likewise, breaking the circuit to the motor of the motorized switch over conductor MR1'. Thus, the motor of this switch is stopped, and the coasting interval of the switch is such as to cause the switch finger MF to continue past stationary switch point M8 and thereby complete a half turn, so that the contact finger is returned to its original diametrical position with the opposite ends of the switch finger reversed. Also switch MR1, having been returned to its normal position (in engagement with back contact MR2) permits a circuit to be established from source CS through the back contact of switch MRR1, conductor MR1', switch MR1 and its back contact MR2 and through conductor MR2' to the control contacts 74 of the ball delivery circuit 75, which ball delivery circuit was previously described in connection with Figure 6.

Referring back to frame 2 of Figure 14, we have assumed that the player makes a strike in this frame. Under the previous description of a strike, we find that circuit S' is completed to the strike relay ST (primary circuit one), which in turn completes circuit OO1' from trip switch FE1 to the actuating coil NA of the temporary strike recording rotary switch N (Figure 19D), thus causing switch fingers NF1, NF2, NF3 and NF4 to advance. By impulsing the actuating coil NA, the auxiliary switch NA1 is caused to change from its normally open to a closed position. A circuit is thus completed from current source CS through this switch to the break-and-make switch SP3 of spare relay SP. Since a miss (8 pins) was the score in the preceding frame, switch SP3 will be in its normal position, as illustrated, and circuit NA1' will continue over conductor JS' to solenoid JS of frame counting switch J (Figure 19B). The energization of stepping solenoid JS will cause auxiliary switch JS1 to be closed, thereby completing circuit H' to the release coils H and hence restoring any actuated targets to their normal positions. By so restoring the targets, circuit S' will be broken at pin-light switches A3 and B5 (or C5), thereby de-energizing the strike relay ST and causing strike relay switches ST1, ST2 and ST3 to return to their normal positions. Inasmuch as reset circuit PR' is joined to release coil circuit H' (Figure 19D) this reset circuit is also completed to energize reset coil PR of the ball counting rotary switch P, but no resetting occurs because

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this switch P is not advanced when a strike occurs. Furthermore, by actuating the stepping solenoid JS of the frame counting switch J, the switch finger JF1 is now advanced to point J3, thus illuminating frame 3 on tally panel 42. The foregoing having occurred in frame 2 of Figure 14 (a strike preceded by a miss), no scoring will occur, since the scoring of a strike is delayed until it is determined what the player accomplishes on his next two deliveries, as previously set forth under the heading "Method of Scoring."

In frame 3 (Figure 14) the player succeeds in making another strike, which merely causes a repetition of the above described operations, excepting that the fingers of the temporary strike registering switch N are advanced another point, thereby placing switch finger NF3 on points N32. Also, finger JF1 of the frame counting rotary switch J is moved to point J4 for illuminating light J4' to indicate that the player has now come into the fourth frame. Since the single ball of frame 3 produced a strike, and was only the first ball after the strike of the preceding frame, no score is ready to be tallied as yet.

In frame 4 (Figure 14) let us assume that the player again makes a strike. The switch fingers NF1, NF2, NF3 and NF4 of temporary strike registering switch N are advanced a third time to engage with switch points N13, N23, N33 and N43, respectively. This completes a circuit from current source CS through switch points N23 and switch finger NF2 to circuit MR' and thence to relay MR, thereby starting the motor driven switch M. By making a strike and thus causing the actuating coil NA of temporary strike registering switch N to be energized for advancing switch fingers NF1, NF2, etc., it will be seen that the normally open switch NA1 will be closed, thereby completing circuit NA1' through switch SP3 and circuit JS' to the actuating solenoid JS of frame counting switch J. By energizing this stepping solenoid JS, the release coil circuit H' is established through auxiliary switch JS1, causing the targets and associated switches to be restored to normal position. As the contact finger MF of the motorized switch M advances, it will engage the contacts of rows r1, r2, r3, and r4, as previously described, but no counting impulses will be delivered to the common return conductor KS' leading from all of the switches A1 to G1, inclusive, because, as just stated, the targets and their associated target switches A1 to G1, inclusive, have all been restored to their normally open positions.

In advancing along the right side of the rotary switch disk, the contact finger MF engages, among others, contacts M1 (M1a, M1b and M1c) thereby originating a circuit M1' which conducts current from current source CS to switch point N33 of the temporary strike registering switch N (Figure 19D). Inasmuch as this is the third consecutive strike, finger NF3 will be resting on switch point N33, thus completing a circuit LS' to the solenoid LS of the tens counting rotary switch L (Figure 19B). Since the circuit M1' will be contacted or impulsed three times (by points M1a, M1b, and M1c), the stepping solenoid LS will in turn be impulsed three times. By thus stepping the solenoid LS the finger LF of tens counting switch L will be advanced to point L3, thus causing tally board light L3 to illuminate 30 points on the tally panel 42. When the contact finger MF of the motorized switch M reaches contact M5, a circuit M5' is originated, this circuit extending to switch ST1 of strike relay ST.

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Although the current frame is a strike, relay ST will be in its normal position, due to the fact that circuit S' was broken when the targets were restored to normal position through circuit NA1' by the just mentioned operation of stepping coil NA and auxiliary switch NA1. Therefore, circuit M5' is completed through the normally closed contact ST1 and over conductor NS' to the actuating coil NS of switch N. As previously described, actuating coil NS is so arranged that each time it is impulsed it will retract the fingers of add-and-subtract rotary switch N through a stepping distance of one point. Thus, having tallied the 30 points for the strike of frame 2 (Figure 14), said strike is retracted or subtracted on switch N, leaving two strikes on record for frames 3 and 4. These 30 points were scored for the strike of frame 2, because the player received 10 points for the strike, plus the scores which he accomplished on his next two deliveries. Inasmuch as he also made strikes on his next two deliveries, he received 10 points for each of these, making a total of 30 points in all.

The motorized switch finger MF then contacts switch point M7, which shuts off the motor, as previously described. The tally panel 42 (Figure 3) now has "8" and "30" illuminated, thereby indicating the score which the player has accumulated up to this point of the game.

Referring now to frame 5 of Figure 14, let us assume that in this frame the player delivers his first ball right down the middle of the alley, hitting only target A, and thereby extinguishing eight pin-lights, but leaving the split pins 7 and 10 still standing. As the ball returns and engages trip switch FE1, the fingers PF1, PF2 and PF3 of ball counting switch P are advanced one point, as heretofore described, thereby placing these switch fingers on points P11, P21 and P31, respectively. Thus, circuit O5' is originated from current source CS through switch points P21 and switch finger PF2, this circuit continuing to point N22 of the strike registering rotary switch N. Inasmuch as this rotary switch N has just been retracted from a "three" to a "two" position in frame 4, this circuit O5' will continue from the other point N22 to conductor MR' which, in turn, will start the motor of rotary switch M, as previously described. This present delivery, which is the first of this frame, also is the second delivery following the strike of frame 3. Therefore, the score for frame 3 should be tallied now.

As switch finger MF of motorized tally switch M advances, circuit A2 operating through row r1 will deliver eight impulses through closed switch A1 (now closed because of the ball having hit target A), and these eight impulses will be transmitted through conductors KS' into stepping solenoid KS, thereby advancing the fingers KF of rotary switch K eight more steps (Figure 19B). In advancing these eight steps or points, the switch finger upon reaching point K10 originates a circuit from this point to the auxiliary switch KS1 of solenoid KS, which circuit is completed to the stepping solenoid LS of the tens counting rotary switch L. Thus, every tenth count of the unit counting rotary switch K will be tallied on the tens counting rotary switch L. When the finger MF of motorized tally switch M engages contact M2, a circuit M2' is originated to point N32 of the temporary strike registering switch N. Switch finger NF3, having been retracted from point N33, as just mentioned in the previous frame, now rests on point N32, permitting circuit M2' to be completed through conductor LS' to the

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stepping solenoid LS of the tens counting rotary switch L (Figure 19B). Since switch finger MF engages or completes circuit M2' at two switch points, namely, at points M2a and M2b, two impulses will be delivered to the stepping solenoid LS of tens counting rotary switch L. By adding the eight points above to the tally panel, point K10 of unit counting rotary switch K was contacted by one of its fingers KF, thus increasing through tens counting rotary switch L the "30" on the tally panel to "40." Then by impulsing the solenoid LS of tens counting switch L, two more steps by way of circuit M2', as just described, 20 more points are tallied, increasing the tally of "40" to "60." The next finger KF of unit counting switch K having come to rest on switch point K6 illuminates light "6" on the tally board, thereby showing that the player has thus far accumulated a score of 66.

The switch finger MF of the tally switch M continues to advance, passing over switch points M3 and M4 which do not perform any operative function at this time. When the switch finger reaches contact point M5, the circuit M5' is originated to the normally closed switch ST1 of strike relay ST. Since this first ball delivery is not a strike (but rather a 7-10 split) switch ST1 will be closed in its normal position, thereby continuing circuit M5' through conductor NS' to the subtracting coil NS of the temporary strike registering switch N. Having duly scored the strike of frame 3 (Figure 14), subtracting coil NS will retract switch fingers NF one point, as heretofore explained. Switch finger MF of motorized switch M then advances to contact M6, whose circuit M6' will not, however, be completed through switch DC3 of relay DC and through switch points P32 to circuit JS' (which would otherwise restore the targets to normal position), such circuit not being completed owing to the fact that since this is a first ball delivery the finger PF3 of switch P is now resting on points P31 and, hence, no circuit can be completed through the switch between points P32. The motorized switch M proceeds to contact point M7 whereupon the energizing circuit of the switch motor is interrupted for bringing the switch to rest after a half revolution to the normal position shown, this having been previously described in the description of the scoring in frame 1.

The player now delivers his second ball in an attempt to extinguish either one of the two remaining pin-lights p^7 and p^{10} of the split. Assuming that he hits target F, then normally closed target switch F2 will be opened so as to extinguish pin-light p^7 , and normally open target switch F1 will be closed. The returning ball engages trip switch FE1 as usual, advancing the fingers of ball counting rotary switch P (Figure 19D) another point. This places switch finger PF2 on contacts P22, thus completing the circuit O1' through switch SP4 of spare relay SP, this circuit continuing over conductor MR' to relay MR, and to the motor (MOT) of the motorized switch M, therefore causing it to start. Inasmuch as target A is still in its activated position, normally open switch A1 is still closed. Thus, eight impulses are again delivered through circuit A' (row r1) by way of conductor KS' to solenoid KS of unit counting switch K, this occurring as the motorized switch finger MF advances. Having closed target switch F1 by the hitting of target F with the second delivery, circuit F' will also be completed through conductor KS' to the actuating solenoid KS of unit counting switch K,

this circuit F' only delivering one impulse at its one contact point in row r1 when contacted by switch finger MF. Thus, a total of nine impulses (eight impulses from circuit A' and one impulse from circuit F') is delivered to the actuating solenoid KS of unit counting switch K, thereby causing the switch fingers KF to be advanced nine points. A finger KF, which came to rest on point K6 after the first ball scoring ended, will contact point K10 while advancing these nine points, thus moving finger LF of tens counting switch L from point L6 to point L7, thereby increasing the score from "60" to "70" on the tally panel 42. The following finger KF of unit counting switch K then comes to rest on switch point K5. Referring back to the motorized switch M, the finger MF while advancing on the right side of the disk contacts point M3, thus initiating circuit M3' leading to point N31 of the temporary strike registering switch N (Figure 19D). The finger NF3 having been retracted from points N32 to points N31 during the scoring that followed the first delivery of this frame, this finger NF3 now rests on said points N31, thereby completing circuit M3' through conductor LS' to advancing solenoid LS of the tens counting rotary switch L. This advances switch finger LF from point L7 to point L8, thereby increasing the tally from "70" to "80" on the tally panel 42. Thus, the "ten" score just received on tens counting switch L, plus the aforementioned nine scored on units counting rotary switch K makes a total of nineteen to be tallied for the strike of frame 4 (Figure 14) and its two following deliveries. Finger MF of motorized switch M then contacts switch point M5 which, as previously explained, causes the subtracting coil NS to retract switch N from the remaining point, thereby placing switch N in its home position.

This second delivery now being described, besides being the second delivery after the strike in the fourth frame, is also the second delivery of frame 5, which means that this fifth frame should also be scored and tallied at this time. Inasmuch as the player managed to extinguish only nine pin-lights (all except p^{10}) with this second delivery, the frame is designated a "miss" (Figure 14). A "miss" is scored and tallied by starting the motor of motorized switch M, causing switch finger MF to originate impulses through the circuits formed in rows r1, r2, r3 and r4, as heretofore described in frame 1. Since the motor is already in operation, relay DC (Figure 19D) is employed to prevent circuit M7' from shutting the motor off when finger MF reaches point M7. Referring back to when the second ball, in returning, caused switch fingers PF1—PF3 to advance to their second position, finger PF1 completed a circuit DC' which originated from current source CS through the one strike point N11 of rotary switch N through switch finger NF1, which switch finger was resting on points N11 at that time. This circuit continued through switch points P12 and switch finger PF1 of rotary switch P, extending through normally closed switch SP1 of spare relay SP to the winding of relay DC. By energizing relay DC its switch DC1 is caused to close, permitting a circuit (J20'), originating from current source CS on rotary switch J (thru either finger JF1 or JF2), and passing through closed switch DCR1 of relay DCR, to continue through said now closed switch DC1 into the coil windings of its relay (DC), causing the relay to remain energized until switch DCR1 is opened. Like-

wise, by energizing relay DC its switch DC2 is caused to close, thereby energizing a circuit from current supply source CS through switch DC2 to conductor MR' for supplying current to relay MR and, likewise, to the motor of motorized rotary switch M, thus keeping said motor in operation as switch finger MF engages contact M7. Upon leaving contact M7, switch finger MF engages contact point M8, thereby establishing a circuit M8' leading to point N30 of rotary switch N. Fingers NF1, NF2, NF3 and NF4, having been retracted to their normal or home positions, permit a circuit to be continued through switch fingers NF3 and switch point N30 to the extension conductor leading down to relay DCR. By energizing the coil of relay DCR, the normally closed relay switch DCR1 is caused to open, thus deenergizing relay DC, which in turn restores relay switches DC1, DC2 and DC3 to their normal positions, as shown. Nevertheless, relay MR is still being held energized by circuit MR1' which is originated through the normally closed contacts of switch MRR1 of relay MRR, and will continue to remain energized until after another half revolution of switch arm MF is made, causing this switch arm MF to contact switch point M7 again, thereby energizing relay MRR and causing circuit MR1' to be broken, de-energizing relay MR and opening switch MR1 causing the motor to stop. During this just described energization of relay DC, it will be noted that normally closed switch DC3 of said relay DC was opened, thereby preventing circuit M6' from restoring the targets to their normal positions.

Therefore, contact finger MF of motorized switch M, by being allowed to continue rotation, will again contact the eight points of circuit A' (row r1) and the one point of circuit F' (row r1), thus delivering nine more impulses to the stepping solenoid KS of unit counting switch K, these impulses being transmitted by way of target switches A1 and F1 and circuit KS'. Upon contacting switch points M1, M2 and M3 on the right side of the switch disk, contact finger MF will not complete any circuits through contact finger NF3 of strike registering rotary switch N, since this latter switch has now been retracted to home position. These nine impulses just delivered to stepping solenoid KS of unit counting switch K advanced a finger KF from the point K5 that it was resting on, across point K10, allowing the following finger to come to rest on point K4. When contact was established with point K10, the finger LF of tens counting switch L was caused to advance from point L8 to point L9. Thus, the point K4 of unit counting switch K and the point L9 of tens counting switch L will complete circuits to their respective tally board lights, which will, in turn, illuminate the "4" and the "90" on the tally panel 42, showing that the player has accumulated a total score of "94" during the five frames thus far played. Finger MF of motorized switch M, upon reaching contacts M6 and M7 will complete circuits, as previously described in "Frame 1," which will restore the targets to their normal positions, advance the fingers of frame counting switch J from J5 to J6 (from frame 5 to frame 6 on the tally panel), reset the ball counting switch P (by way of conductor PR' and reset PR), and stop the motor of the motorized switch M. Thus, the game is ready for the playing of the next frame.

Let us assume that in frame 6 the player makes a "spare," shown in Figure 14. We will assume that target C was hit with the first delivery, and

that Target A was hit with the second delivery, thus completing circuit S' to the spare relay SP and auxiliary relay SPX, as described in detail under the heading of "Spare." As the second ball returns, it advances finger PF2 of ball counting switch P to the points P22, thereby originating circuit O1' to break-and-make switch SP4 of the spare relay SP. Since this spare relay SP has been energized and is now latched in an engaged position by the armature of relay SPR, switch SP4 will be in an actuated position, thus permitting circuit O1' to join circuit O6' and thereby continue to switch point N20 of the strike registering switch N. Finger NF2 of this switch, having been retracted to "Home" position (in frame 4) completes circuit O6' through conductor JS' into stepping solenoid JS of the frame counting switch J. This, in turn, causes switch JS1 to close, thereby completing the release circuit H' to the release coils H of the targets, causing said targets to be restored to their normal positions. As heretofore described, the completion of a circuit through H' also energizes the reset coil PR of ball counting switch P (over conductor PR'). Referring back to the impulsing of solenoid JS of frame counting switch J, the switch fingers thereof are caused to advance, and finger JF1 advances from point J6 to point J7, thereby illuminating frame "7" on the tally panel 42. It will be noted that no score was counted. This being a spare, the player receives ten points, plus the number of pin-lights extinguished by the first delivery of the next frame. Spare relay SP and spare release relay SPR have the interlocking relation previously described under the heading "Spare". Therefore, spare relay SP is still latched in an engaged position as the player starts his next frame.

Let us assume that the player now succeeds in making a strike in frame 7. Primary circuit one, the strike circuit, is accordingly energized, as previously described, starting a cycle which eventually advances fingers NF1, NF2, NF3 and NF4 of the temporary strike registering switch N, these fingers being advanced one point, so that they are brought into engagement with switch points N11, N21, N31 and N41, respectively. In the energization of the adding coil NA, which causes the switch fingers to be advanced, the auxiliary switch NA1 associated with this coil is, of course, moved to closed position. Since a spare was made in the preceding frame, this strike is the first delivery thereafter. Thus, the score for said spare (ten, plus the number of pin-lights extinguished on the next delivery) should now be counted and tallied.

By the just mentioned closing of auxiliary switch NA1, circuit NA1' is originated to the break-and-make switch SP3 of spare relay SP. Inasmuch as this spare relay SP is now latched in an engaged position (from frame 6), switch SP3 of this relay is now in its actuated position in engagement with its front contact. Therefore, instead of circuit NA1' continuing through circuit JS' and eventually causing the targets to be restored to normal, as on previous strikes, this circuit NA1' will be diverted through circuit MR' to relay MR, and to the motor of motorized switch M. Upon contacting circuits A' and B' on the disk of motorized switch M, the finger MF of said switch delivers a total of ten impulses through target switches A1 and B1 by way of conductor KS' to stepping solenoid KS, thereby advancing the switch fingers KF 10 points; in being thus advanced 10 points, a finger KF will

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contact K10, and the next one will come to rest again on point K4, thus re-illuminating the same "4" on the tally panel 42. By contacting point K10 with a finger KF (as just mentioned) stepping solenoid LS is caused to advance the switch finger LF of tens counting switch L one point, thereby stepping up the score from "90" to "100" on tally panel 42, in the manner previously described in connection with frame 5.

As the switch finger MF of the motorized switch M advances along the right side of the switch disk, it engages switch point M3, thus originating circuit M3' which extends to point N31 of strike registering switch N, and also extends to switch SP6 of spare relay SP. Since a strike has just been made, and spare relay SP is latched in an engaged position from frame 6, a circuit M3' will be completed simultaneously through switch finger NF2 (now resting on a switch point N31) and through switch SP6 of relay SP and thence through conductor LS', to solenoid LS of tens counting switch L. This causes the switch finger LF to advance from point K10 to K11, thereby setting up the score from "100" to "110" on the tally panel 42. Thus, this "ten" score, plus the ten just counted through circuits A' and B', give a total of 20 points scored and tallied for the spare (and following delivery) of frame 6. When finger MF of switch M contacts point M4 circuit M4' is completed directly to the spare release relay SPR. Thus, by energizing the coil of this spare release relay SPR, the spare relay SP is released from its latched position.

It is to be remembered that strike relay ST is still being energized through circuit S', due to the fact that switch SP3 of spare relay SP, being latched in an engaged position, permitted circuit NA1' to energize relay MR (through conductor MR') and to start the motor, instead of registering a completed frame (JS') and restoring the targets to their normal positions (H'). Therefore, when finger MF of the motorized rotary switch M reaches switch point M5, the circuit M5' will not be complete to circuit NS', through the now open switch ST1 of strike relay SP. Thus, the strike just made and registered on rotary switch N will not be retracted at this time, but will remain on record until the results of the next two deliveries are obtained and scored with it. Switch finger MF, upon contacting point M6, originates circuit M6' to switch ST2 of strike relay ST. Since the strike relay ST is still being energized, switch ST2 is closed, permitting circuit M6' to join circuit JS', and now causing solenoid JS to advance switch fingers JF1 and JF2, and to close switch JS1, restoring the latched targets to normal by way of circuit H' and release coils H. The motor of the motorized switch M is again stopped, as previously explained, when the switch finger MF reaches point M7.

Thus, the tally panel 42 shows "110" and "4" as the score accumulated thus far by the player. Light X1 on the tally panel is also illuminated, indicating that the player is "working" on a strike, as previously explained under the heading of "Strike." Also, the frames number will have moved up to "8."

In frame 8 let us assume that the player makes a spare. We will assume that he hit target G with his first delivery, extinguishing only pin-light p¹⁰. Thus, he must now hit simultaneously targets A and B or targets A and C with his second delivery, in order to extinguish the remaining pin-lights. We will say that he hits targets A and C, thereby completing primary cir-

cuit two to the spare auxiliary relay SPX and to the spare relay SP, causing relay SP to be latched in an engaged position by relay SPR. Since the rotary switch N has been advanced by the preceding strike, the auxiliary switch NX thereof is now closed, completing a circuit through SPX1 of relay SPX into its coil and into the coil of relay SP, which will keep said relays energized until rotary switch N is retracted to the home position for causing switch NX to open. Switch finger PF2 of ball counting switch P has been advanced to switch points P22, as usual, thereby originating circuit O1' to the break-and-make switch SP4 of relay SP. Since relay SP is now being energized, switch SP4 is in an engaged or front contact position, thus allowing circuit O1' to join circuit O6' and to continue to points N20 and N21 of strike registering switch N. Having made a strike in the preceding frame (frame 7), finger NF2 is now resting on switch points N21. Thus, this circuit O6' passes through the switch finger NF2 and joins with circuit MR', which in turn energizes relay MR, and causes the motor of rotary switch M to start (Figure 19C).

Switch finger MF, in advancing, delivers a total of ten impulses through circuits A' and C' and through target switches A1 and C1 by way of conductor KS' to the advancing solenoid KS (the single switch point 10 of circuit G' is absorbed by the switch point 10 of circuit C' in the scoring). By impulsing the advancing solenoid KS of unit counting switch K the fingers KF are advanced ten points, as usual, causing one of the fingers KF to contact point K10, the following one to come to rest again on point K4. By contacting point K10, the switch finger LF of tens counting switch L is advanced (via LS' and LS) one point, as previously described, i. e. from L11 to L12. Finger MF, in reaching switch point M3, impulses the stepping solenoid LS again (by way of circuit M3', switch points N31, switch finger NF3 and conductor LS'), thereby advancing switch finger LF from point L12 to L13, thereby setting up the score from "120" to "130" on tally panel 42. Thus, twenty points have been duly scored for the strike of frame 7 and the two following deliveries, these two following deliveries being the spare of this eighth frame.

Upon contacting switch point M4, motorized switch finger MF completes circuit M4' directly to the spare release relay SPR. Since spare relay SP and spare auxiliary relay SPX are being held energized, as above described, the energizing of spare release relay SPR will not cause spare relay SP to release. Upon reaching switch contact M5, the switch finger MF completes circuit M5' through the normally closed switch ST1 of strike relay ST to the subtracting coil NS of rotary switch N, thereby retracting the fingers of this switch from the N11 position to the "Home" position. This retraction of rotary switch N to the "Home" position opens auxiliary switch NX of this rotary switch, thereby breaking circuit NX' to the switch SPX1 of auxiliary relay SPX, and causing the de-energization of relays SPX and SP, thereby returning relay SPX to normal and leaving relay SP latched. Finger MF of motorized switch M then contacts switch point M6 which, in turn, (by way of circuit JS') restores the targets to normal position, resets rotary switch P, and advances the switch finger JF1 of rotary switch J from point J8 to point J9, thereby stepping up

the frame count from frame "3" to frame "9" on the tally panel. By scoring the twenty points just acquired, tally panel 42 now has the scoring values of "130" and "4" illuminated, and also has the "Spare" marking light SPM illuminated. The motor of motorized switch M is stopped through circuit M7', as previously described.

Referring now to frame 9, let us assume that the player hits target C with his first delivery, thereby extinguishing seven pin-lights (Figure 13C). This being the first delivery following the "Spare" of the preceding frame (frame 8), the score for said spare and frame should now be counted and tallied.

As this ball, which has just hit target C, returns through the return trough, it encounters trip switch FE1 which eventually causes the fingers of rotary switch P to advance one point, as previously explained under the heading of "Ball return." In so doing, switch finger PF3 is brought to rest on points P31, as usual. As the ball continues to return in the return trough it also encounters trip switch FE2, thereby originating a circuit P31' through fingers PF3 to normally open switch SP2 of spare relay SP. Since this spare relay SP is still in its latched position, switch SP2 is now closed, permitting circuit P31' to be completed by way of conductor MR' to relay MR, and to the motor of motorized switch M. In advancing, switch finger MF delivers seven impulses through circuit C' by way of target switch C1 and conductor KS' to the stepping solenoid of rotary switch K, thereby advancing the fingers of this switch seven points. In so doing, a switch finger contacts stationary switch point K10, and another switch finger comes to rest on point K1. By virtue of contacting switch point K10, the stepping solenoid LS is caused to advance switch finger LF from contact point L13 to contact point L14, thereby advancing the score from "130" to "140" on the tally panel.

Switch finger MF upon contacting switch point M3, originates circuit M3' to the normally open switch SP6 of spare relay SP. Since this spare relay SP is still in its latched position, switch SP6 is now closed, allowing circuit M3' to join with circuit LS', which, in turn, impulses stepping solenoid LS so as to advance switch finger LF from switch point L14 to switch point L15, thereby stepping up the score from "140" to "150" on tally panel 42. Thus, the "Spare" of preceding frame 8 and the following delivery have been duly scored and tallied and credited to said spare and said frame. By moving to contact M4, switch finger MF completes a direct circuit M4' to spare release relay SPR which, upon being energized, releases the spare relay SP. When switch finger MF reaches switch contacts M6 and M7, circuit M6' will not be completed to circuit JS' inasmuch as switch finger PF3 of ball counting switch P has only been advanced to points P31 by this first ball delivery; but when said switch finger engages contact M7, circuit M7' will be energized to stop the motor of motorized switch M.

The player now makes his second delivery of this frame 9. Let us assume that in attempting to hit target A, the player is wide with his aim, and passes again under the now deflected target C. Thus no additional pin-lights are extinguished, and when switch fingers PF1-PF3 of ball counting switch P are advanced a second point by the returning ball, primary cir-

cuit three, the "Miss" circuit, will function, eventually scoring the seven impulses of circuit C' (Figure 19C), as heretofore described in connection with frame 1 and frame 5. By advancing the switch fingers KF of unit counting switch K the above mentioned seven points, the number "8" of tally panel 42 will be illuminated, along with the "150" illuminated by the scoring of the preceding spare. The frames count of the tally panel is advanced from the frame 9 to frame 10 (from point J9 to point J10 of frame counting switch J), the reset PR returns the switch fingers of ball counting switch P to "Home" position, and the latched target C is restored to normal position, (by way of M6'-DC3-P32-PF3-JS'-H' and PR').

Thus, every possible condition in actual bowling that affects the scoring of the game has been covered during the description of these nine frames just completed, with the exception of one condition. This condition is when the player makes a spare or strike in his last frame, the tenth frame. Although his game is technically over, he still has to make one or two more deliveries, depending respectively upon whether he made a spare or a strike, in order to receive due credit for this spare or strike.

If the player makes a "Miss" in his last frame, the tenth frame, then primary circuit three will function, eventually causing the switch finger MF of motorized switch M to score the number of pin-lights extinguished, this being the usual "Miss" procedure described above in frame 1. Upon reaching contact M7, switch finger MF energizes relay MRR as usual, causing break-and-make switch MRR1 to change position, thereby de-energizing relay MR and causing the motor of the motorized switch M to stop. By changing position, switch MRR1 originates a circuit through J21' to switch point N10 of strike registering switch N through finger NF1 of this switch and on to switch SP5 of spare relay SP. Switch SP5, being normally closed, allows circuit J21' to continue to switch point J21 of the frame counting rotary switch J. Switch finger JF1 of this rotary switch J has just been advanced from point J10 to point J11, by way of switch point M6, etc. of motorized switch M, thereby indicating the completion of frame 10. Concurrently therewith, switch finger JF2 has moved from the points J20 to point J21. Thus, circuit J21' is completed through switch finger JF2 to shut-off relay WR (Figure 19A) by way of conductor WR', thereby releasing start relay W from its latched or engaged position, which, in turn, opens switch W1 of start relay W, thus breaking the main supply circuit to the game, i. e. it interrupts the source of current supply to all of the current supply terminals heretofore identified as current supply sources CS.

Since this circuit J21' originates by switch finger MF of motorized switch M, energizing relay MRR over conductor M7', the game will not shut off unless scoring is accomplished in the tenth frame. Furthermore, scoring in the tenth frame will not shut off the game if this scoring is initiated by a spare or strike being made in this frame, due to the fact that either the spare relay SP will be latched, causing switch SP5 to be open, or else finger NF1 will have been advanced from point N10 to point N11, thus interrupting or breaking circuit J21' at that point, namely, at point N10.

If a spare is made in this tenth frame, then primary circuit two is caused to function, and the

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targets are eventually restored to normal position by the energization of release coil circuit H', and switch finger JF1 of rotary switch J is advanced one point, as usual, to point J11. Likewise, switch finger JF2 of this same switch is advanced to point J21. Thus, the player has to make one extra delivery in order to duly score this spare. Upon making this extra delivery, the game will score, as described in frame 9. As the switch finger MF of motorized switch M finishes this scoring and energizes relay MRR by way of conductor M7', circuit J21' is energized from relay switch MRR1, this circuit J21' extending to switch point N10 of strike registering switch N and through switch finger NF1 to switch SP5 of spare relay SP. Since spare relay SP was released during the scoring (by way of contact M4), this circuit J21' passes through this now closed switch SP5 and continues to point J21 of frame counting switch J, and through switch finger JF2 to the shut-off relay WR over conductor WR', the same as a tenth frame "Miss."

If a strike is made in the tenth frame, the primary circuit one is caused to function in the manner described above, eventually restoring the targets to normal positions over circuit H' and also causing the stepping solenoid JS to advance switch fingers JF1 and JF2 from points J10 and J20 to points J11 and J21, respectively. Since this strike is preceded by a miss, no scoring will take place at this time. Technically, the game is over, but in this instance the player is allowed two extra deliveries in order to receive due credit for the strike. We will assume that he hits target D with his first extra delivery, and hits target E with his second, thereby extinguishing six pin-lights, as shown in Figure 13D and Figure 13E. Inasmuch as this constitutes a "Miss," then primary circuit three will function, eventually starting the motor of motorized switch M which, in turn, causes switch finger MF to score six points (through circuits D' and E') for the two extra deliveries, and to score ten points for the strike, as explained above in frame 5. This gives the player a final score of 174, i. e. the tens score of "170" and the unit score of "4" on the tally panel 42.

Upon reaching switch contact M7, switch finger MF completes circuit M7', to relay MRR, thereby causing the motor to stop, as heretofore described. By energizing relay MRR, circuit J22' (via J21') is originated to switch point N40 of rotary switch N. Switch finger NF4, having just been retracted to home position (via M5' and NS') now rests on these switch points N40, thus permitting circuit J22' to continue to point J22 of rotary switch J. Since switch fingers JF1 and JF2 were just advanced (via M6' and JS') from points J11 and J21 to points J12 and J22, respectively, it will be seen that circuit J22' is completed through finger JF2 over conductor WR' to relay WR, thereby shutting off the game.

If, by chance, the player were to have made a strike with his first extra delivery, no scoring would have occurred, but fingers JF1 and JF2 would be advanced to points J12 and J22, respectively, and if he succeeded in making a strike with his second extra delivery, in addition to the strike on his first delivery, then fingers JF1 and JF2 would again be advanced, this time into engagement with points J13 and J23. Likewise, finger NF2 of strike storing switch N will have been advanced to points N23, thereby completing a circuit from current source CS through MR' to the motor of tally switch M. Thus, as the scoring is completed and finger MF of motorized switch

M reaches contact M7, circuit M7' will energize relay MRR, as before described, causing the motorized switch to stop and causing circuit J21' to be originated at contact MRR1. With finger JF2 now resting on switch point J23, circuit J23' (via J21' and J22') is completed directly to circuit WR' and thence to relay WR, thereby shutting off the game, as above described.

By way of further explaining the scoring, it will be seen from the descriptions previously given with regard to frames 2, 3 and 4 that a succession of strikes, beginning with frame 1 and continuing throughout the game, including the two extra deliveries just described, will produce a score of "300," which establishes that the player has bowled a perfect game. Beginning with the third frame, the player would score 30 points (as heretofore explained under frame 4), and 30 more in each frame thereafter, and on through the two extra deliveries or ten times in all, thereby accumulating this perfect score of "300."

Coin control mechanism and free play mechanism

As previously described, the coin control feature is a preferred feature in all commercial embodiments of the game intended to be played in bowling alleys, taverns, depots and the like, but this coin control feature is optional in that it can be dispensed with, particularly in those embodiments of the game adapted for use in the home. Similarly, the free play feature is likewise optional and may or may not be embodied in the game, as desired. Referring particularly to Figure 19A, interlocking relays W and WR are employed to turn the game on and off. They are similar in operation to the spare relay SP and spare release relay SPR of Figure 19D, which latter relays have heretofore been described in detail. Cooperating with these interlocking relays W and WR is the coin controlled apparatus which may be provided so as to insure that a coin must be deposited in a coin detector or in some similar injecting device, in order to turn the game on.

By depositing a coin, as illustrated, in a coin detector T of any conventional type, this will eventually actuate a normally open switch within enclosure T1, thereby completing a circuit T1' directly from the source of current p' to the relay W over conductor W'. By energizing relay W, it will become latched in an engaged position by relay WR, thereby causing the normally open switch W1 to be held closed. This switch W1, upon closing, permits the main circuit p' to be circulated or extended to different parts of the game, such as to the points marked current supply source CS, this continuing until relay W is again restored to normal by the energization of release relay WR, as just described above near the end of the "Scoring" description. It will be noted that the coin in actuating the switch enclosed in T1 not only completed a circuit to relay W over conductor W', but also completed a circuit to relay WX over conductor WX', and also to the reset coils JR, KR and LR of rotary switches J, K and L, respectively, these reset coils being energized over circuit T1'. Reset coil LR of tens counting switch L is further provided with an auxiliary switch LR1 which operates in conjunction with it. Thus, every time reset coil LR is energized, this auxiliary switch LR1 will close, thereby completing a circuit LR1' from current source CS to release relay SPR, thereby releasing spare relay SP in the event the previous game ended with a spare. Likewise, reset coil JR of

frame counting switch J is equipped with an auxiliary normally-open switch JR1 which will complete a release coil circuit H' to the release coils of the targets every time that reset coil JR is energized.

If the previous game ended with a strike, finger NF3 of strike registering switch N, along with fingers NF1, NF2 and NF4 would be advanced one or more points. Thus, the normally open auxiliary switch NX of rotary switch N would be closed. Thus, when circuit T1' (Figure 19A) energizes relay WX by way of conductor WX', switch WX1 will close, permitting circuit NX' to be completed from auxiliary switch NX of rotary switch N through switch WX1 to the winding of relay WX, causing this relay WX to hold itself energized. Likewise, switch WX2 will be held closed, thereby permitting a circuit from conductor p' to be completed to relay MR (Figure 19C), and to the motor of the motorized switch M. Since relay WX is holding itself energized via auxiliary switch NX of rotary strike storing switch N, reset coils JR, KR and LR are also being energized (by way of conductors WX' and T1'). Therefore, as finger MF of motorized tally switch M advances no scoring will be able to register. Upon reaching contact point M5, circuit M5' will be completed to the actuating coil NS of rotary switch N, thus retracting the fingers of this switch one point. If only one strike was on record from the previous game, the fingers would be returned to "Home" position, thereby causing NF3 to open auxiliary switch NX which, in turn, would break circuit NX' to relay WX via switch WX1, causing this relay WX and its switches to return to normal. The motor will then be stopped by finger MF reaching contact M7, as before described. If two strikes were on record, the motor of motorized switch M would continue to run until finger NF3 finally reached a "Home" position, opening auxiliary switch NX. Hence, it can be seen that by inserting a coin at the end of the game, or at any frame of the game, all tallying will be returned to normal and any spare or strikes still on record will be voided and removed.

Referring now to the free play apparatus, when this feature is embodied in the game the apparatus is set so that when the player's score reaches a pre-determined amount, such as "200" in a ten frame game or "100" in a five frame game, he will be allowed to play one game without depositing a coin. If he continues to increase his score in the same game, he will receive an additional free play for each additional ten points scored. Thus, if the player bowled a perfect game, having a scoring value of "300" for a ten frame game, or "150" for a five frame game, he would be awarded eleven free games, i. e. from L20 to L30, inclusive on rotary switch L, for the ten frame game, and he would be awarded six free games, i. e. from L10 to L15, inclusive, for a five frame game.

Rotary switch R of Figure 19A will record these free plays. This is an add and subtract type of rotary switch similar to that shown in Figures 17 and 18, except that it is provided with a transparent disk RD instead of with contact fingers. This disk has the numbers 1 to 15, inclusive, inscribed upon its face. Thus, each time that actuating coil RA is energized the disk RD will be advanced, indicating that another free play has been achieved. Each time that the subtracting coil RS is energized, this disk will retract one step or one number, indicating that a free play has been utilized or played. This

rotary switch R is suitably mounted in the game in such a manner that the numbers on the disk can be readily viewed by the player. For example, by mounting this switch in the front end of the housing, it can be arranged so that the numbers on the disk can be readily viewed through a glass covered aperture in the top of the housing, such aperture being indicated at 200 in Figure 1.

In order to further explain the operation of rotary switch R, we will refer back to rotary switch L of Figure 19B. It will be noted that switch finger LF of this switch, upon reaching point L20 on one side of the disk also engages the multiple connected contact point L40 on the opposite side of the disk. By reaching point L20 in his play, the player has tallied "200" on the tally panel 42. Thus, as solenoid LS is energized to advance switch finger LF, auxiliary switch LS1 will be caused to close, thereby completing circuit L40' through this auxiliary switch LS1 and through conductor RA' to the actuating coil RA of rotary switch R. By actuating this adding coil RA, the disk RD will be advanced one point. Each time that the player scores ten additional points thereafter during this same game, this operation will, of course, be repeated. If the player having finished his current game, or at any time during said game wishes to utilize his free play award and start anew, he merely presses a conveniently located push button 303, which is shown as being mounted at the player's end of the housing near the coin receiving slot or coin detector T (see Figure 1). By advancing RD of rotary switch R, as heretofore just described, switch R1 is relieved of the stop pin or stop lug RX, which is fastened to disk RD, and this switch is caused to close. Thus, by pressing push button 300 a circuit will be originated through switch R1 and conductor R1' to conductor T1', thereby causing the same operations to occur as when a coin is deposited. Also, circuit R1' will likewise be completed to the subtracting coil RS by way of conductor RS', thereby retracting the free play that is now being utilized.

It should be further noted that by removing the stop pin RX from the disk RD of rotary switch R (Figure 19A), the switch R1 will remain closed, thus permitting the game to be turned on and played repeatedly merely by pressing the push button 300, instead of inserting a coin, if so desired.

It will be seen from the foregoing that I have provided a bowling game which keeps a true bowling score and thereby retains one of the main appeals of a full-size bowling game. In keeping this true bowling score, the scoring values of strikes and spares are suspended or stored until subsequent balls have been bowled. In the case of a strike, the scoring value thereof must be suspended or stored until the next two balls have been bowled, and in the case of a spare the scoring value thereof must be suspended or stored until the next one ball has been bowled. This is identical with the scoring procedure in a regulation full-size bowling game. Another feature of my improved game is that the frames are counted and registered in response to the scoring values of the balls bowled i. e. a frame is registered for the single ball of a strike and a frame is also registered for the two balls of a spare or miss. This frame counting is also in accordance with a regulation bowling game. Still further, another feature is that the

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game is automatically terminated upon the bowling of a predetermined number of frames, sponse to the scoring values of the balls bowled, in those frames. This also follows the practice in a regulation bowling game. Thus, my improved bowling game conforms to a regulation game, both with respect to true scoring and continuity of play.

While I have illustrated and described what I regard to be the preferred embodiments of my invention, nevertheless it will be understood that such are merely exemplary and that numerous modifications and rearrangements may be made therein without departing from the essence of the invention.

I claim:

1. In a bowling game, the combination of a bowling alley along which a bowling projectile is adapted to be propelled, electrically lighted simulated bowling pins spaced above the surface of the alley adjacent the rear end thereof, whereby the bowling projectile can pass under said simulated pins in the bowling operation, switch means adapted to be actuated by the projectile and arranged to control the illumination of said simulated pins, and automatic scoring apparatus responsive to said switch means for automatically registering the score, including means for automatically storing strikes and spares until the proper time for their scoring after the completion of one or more subsequent bowling operations.

2. In a bowling game, the combination of a bowling alley along which a bowling projectile is adapted to be propelled, pin means adjacent the rear end of said alley, electrical control means responsive to the aimed travel of the bowling projectile relatively to said pin means in the bowling operations, automatic scoring apparatus responsive to said electrical control means for automatically registering the score, and scoring means for storing the values of strikes and spares until subsequent bowling operations have been completed before registering said values on said automatic scoring apparatus, said storing means including an electrical stepping switch operatively connected to respond to the operation of said electrical control means.

3. In a bowling game, the combination of a bowling alley along which a bowling ball is adapted to be rolled, simulated bowling pins grouped in a triangular pattern at the rear end of said alley, target plates adapted to be struck by the ball individually or in pairs depending upon the accuracy of the aimed travel of the ball relatively to said simulated bowling pins, switch means actuated by said target plates, electrical scoring apparatus responsive to said switch means for automatically registering the score, and storing means for automatically storing the values of strikes and spares until subsequent balls have been rolled before said values are registered on said electrical scoring apparatus, said storing means including a duo-directional stepping switch connected to be stepped in one direction by the bowling of a strike and to be stepped in the other direction by the registering of a strike.

4. In a bowling game, the combination of a bowling alley, bowling pin means near the rear end of the alley toward which a bowling ball is adapted to be rolled from the front end of the alley, said bowling pin means comprising electrically responsive devices individual to each pin adapted when energized to give the impression

of a standing pin and when de-energized to give the impression of a knocked down pin, target devices near the rear end of the alley adapted to be struck by the bowling ball, said target devices being located at transversely spaced points having predetermined relationship to the transverse spacing of the pins of said bowling pin means, electrical switches actuated by said target devices, circuits connecting said electrical switches with said electrically responsive devices, automatic score registering means responsive to said switches for registering the bowling score, and storing means for storing the scoring values of strikes and spares until subsequent balls have been rolled, said storing means including duo-directional rotary switch means responsive to the strikes, and interlocking relay means responsive to the spares.

5. In a bowling game, the combination of a bowling alley, bowling pin means near the rear end of the alley toward which a bowling ball is adapted to be rolled from the front end of the alley, said bowling pin means comprising electrically responsive devices individual to each pin adapted when energized to give the impression of a standing pin and when de-energized to give the impression of a knocked down pin, target devices near the rear end of the alley concealed by said bowling pin means and adapted to be struck by the bowling ball, said target devices being located at transversely spaced points having predetermined relationship to the transverse spacing of the pins of said bowling pin means, and being pivotally mounted on overhead pivots whereby said target devices swing rearwardly and upwardly when struck by the ball, electrical switches actuated by said target devices, circuits connecting said electrical switches with said electrically responsive devices, score registering means responsive to said switches for registering the bowling score, duo-directional rotary switch means electrically connected with said electrical switches for temporarily storing the scoring value of a strike until after the next two balls have been bowled, and interlocking relay means electrically connected with said electrical switches for temporarily storing the scoring value of a spare until after the next ball has been bowled.

6. In a bowling game, the combination of a bowling alley, bowling pin means near the rear end of the alley toward which a bowling ball is adapted to be rolled from the front end of the alley, target devices near the rear end of the alley adapted to be struck by the bowling ball, said target devices being located at transversely spaced points having predetermined relationship to the transverse spacing of the pins in said bowling pin means, electrical switches actuated by said target devices, circuit connections between said electrical switches and said bowling pin means, frame registering means electrically controlled by said electrical switches so as to be responsive to the scoring values of the ball bowled whereby the frames are automatically registered either by a single ball strike frame or by a two-ball spare or miss frame, and automatic score registering means comprising a rotary tally switch connected with said electrical switches, and storing means connected with said tally switch for storing the scoring values of strikes and spares until after one or more subsequent balls have been rolled.

7. In a bowling game, the combination of a bowling alley, electrically energized bowling pin

means near the rear end of the alley toward which a bowling ball is adapted to be rolled from the front end of the alley, target devices near the rear end of the alley adapted to be struck by the bowling ball, said target devices being located at transversely spaced points having predetermined relationship to the transverse spacing of the pins in said electrically energized bowling pin means, and being pivotally mounted on overhead pivots whereby said target devices swing rearwardly and upwardly when struck by the ball, electrical switches actuated by said target devices, circuit connections between said switches and said electrically energized bowling pin means, automatic score registering means comprising a units rotary switch and a tens rotary switch, and a motorized tally switch having continuous motor-driven rotary motion for transmitting counting impulses from said electrical switches to said units and tens rotary switches.

8. In a bowling game, the combination of a bowling alley, electrically energized bowling pin means near the rear end of the alley toward which a bowling ball is adapted to be rolled from the front end of the alley, target devices near the rear end of the alley adapted to be struck by the bowling ball, said target devices being located at transversely spaced points having predetermined relationship to the transverse spacing of the pins in said electrically energized bowling pins means, electrical switches actuated by said target devices, circuit connections between said electrical switches and said electrically energized bowling pin means for controlling the latter, score registering means responsive to said switches for registering the bowling score, a temporary strike recording rotary switch cooperating with said score registering means and operative by rotary motion in one direction for temporarily storing the scoring value of a strike until after the next two balls have been bowled, means for causing said strike recording rotary switch to rotate in the other direction after the strikes have been tallied, and frame counting means comprising a frame counting rotary switch responsive to the scoring values of the ball rolled whereby the frames are automatically registered either by a single ball strike frame or by a two-ball spare or miss frame.

9. In a bowling game, the combination of a bowling alley having a ball return trough, electrically energized bowling pin means near the rear end of the alley toward which a bowling ball is adapted to be rolled from the front end of the alley, said bowling pin means comprising electrical lights individual to each pin adapted when energized to give the impression of a standing pin and when de-energized to give the impression of a knocked down pin, target devices near the rear end of the alley adapted to be struck by the bowling ball, said target devices being located at transversely spaced points having predetermined relationship to the transverse spacing of the pins in said bowling pin means, electrical switches actuated by said target devices, circuit connections between said switches and said electric lights for controlling the latter, score registering means responsive to said electrical switches for registering the bowling score, a duo-directional strike storing rotary switch for temporarily storing the scoring value of a strike, means for actuating said duo-directional rotary switch in an additive direction when a strike is made, and means for actuating said duo-directional rotary switch in a subtractive direction

when said strike is eventually tallied, a ball counting rotary switch, trip switch means in said return trough connected to actuate said ball counting rotary switch, and frame counting means electrically connected so as to be responsive to said strike storing rotary switch and to said ball counting rotary switch whereby the frames are automatically counted either by a single ball strike frame or by a two-ball spare or miss frame.

10. In a bowling game, the combination of a bowling alley, bowling pin means near the rear end of the alley toward which a bowling ball is adapted to be rolled from the front end of the alley, target plates near the rear end of the alley adapted to be struck by the bowling ball, electrical switches actuated by said target plates, circuit connections between said electrical switches and said bowling pin means, automatic scoring apparatus responsive to said target actuated switches and including means for storing the scoring values of strikes until subsequent balls have been rolled, coin control means for controlling the starting of the bowling game, and free play mechanism electrically controlled by said electrical switches so as to be responsive to the score at the end of one game for permitting additional free play of the game in the event that a predetermined score has been attained.

11. In a bowling game, the combination of a bowling alley along which a bowling ball is adapted to be rolled, electrically illuminated pin simulating means adjacent the rear end of the alley adapted to give the impression of standing pins when energized and knocked-down pins when de-energized, electrical control devices responsive to the travel of the ball adjacent the rear end of the alley controlling said pin simulating means, automatic scoring apparatus responsive to said electrical control devices and including means for storing the scoring values of strikes until subsequent balls have been rolled, frame counting means controlled by said electrical control devices and responsive to the scoring value of the balls bowled whereby a frame is counted for the single ball of a strike and is also counted for the two balls of a spare or miss, and means for establishing the completion of a game cycle predicated upon the bowling of a predetermined number of frames irrespective of the total number of balls bowled in those frames.

12. In a bowling game, the combination of a bowling alley along which a bowling ball or other bowling projectile is adapted to be rolled or propelled, pin means adjacent the rear end of the alley, electrical control devices adjacent the rear end of the alley responsive to the aimed travel of the ball or projectile relatively to said pin means, circuits connecting said electrical control devices and said pin means, automatic scoring apparatus responsive to said electrical control devices for automatically registering the score including rotary switch apparatus for storing the scoring values of strikes and spares until the proper time for their scoring after subsequent balls have been rolled, frame registering means responsive to the scoring values of the balls bowled whereby a frame is registered for the single ball of a strike and is also registered for the two balls of a spare or miss, and means for automatically terminating the game upon the bowling of a predetermined number of frames independently of the total number of balls bowled in those frames.

13. In a miniature bowling game, the combina-

tion of an alley, a pin simulating panel at the rear end thereof raised above the surface of the alley to permit the bowling ball to pass under the panel, ten bowling pin images carried by said panel in the triangular pattern of real bowling pins, pin lights behind each of said images, a plurality of ball actuated pivoted target plates positioned behind said panel and arranged in predetermined fore and aft alignment with predetermined bowling pin images of the pin simulating panel, control switches actuated by said target plates, circuit connections between said switches and said pin lights so arranged that when a target plate is actuated by a bowled ball the pin lights immediately in line with said target plate will be extinguished and other pin lights corresponding to real bowling pins that would be knocked down in a real bowling game by a similar delivery will also be extinguished, relay means cooperating with said circuit connections to extinguish all of the pin lights when the ball is bowled into the area beneath either the 1-2 pocket or the 1-3 pocket of the bowling pin images but to leave the 7 and 10 pin lights illuminated if the bowled ball is directly in alignment with the 1 pin and to establish a condition whereby only one of these latter pin lights can be extinguished by the next ball, adjustable ball projecting means actuatable by the player for projecting the bowling ball along said alley in aimed travel toward said bowling pin images, said ball projecting means being substantially the shape of and having the finger holes of a real bowling ball to enable it to be manipulated, a ball projecting switch actuated by manipulation of said ball projecting means, electromagnetic projecting means responsive to said latter switch for projecting the ball, gravitational means for returning the bowled ball to said ball projecting means, circuit means for accurately counting all pin lights that have been extinguished by a projected ball having engaged one or more of said target plates, such counting being dependent upon what target plates were hit by that delivery and upon what had been accomplished by the preceding balls, circuit means including rotary switches for tallying all pin lights, means for preventing said ball projecting means from being operated while said counting of the extinguished pin lights and the tallying of them to the running score operations are being performed, circuit means for enabling the player to restore said rotary switches to their normal positions at any time during the playing of the game if he wishes to cancel the game and start anew, momentary display means responsive to said first and second circuit means for giving a momentary indication when a strike or spare has just been made, sustained display means responsive to said circuit means for giving a sustained indication that the player has accomplished a strike or a spare and that it has yet to be duly scored, and means for extinguishing said sustained indication after said strike or spare has been duly scored.

14. In an electric bowling game, the combination of an alley along which a bowling ball is adapted to be rolled, simulated bowling pins at the rear end of the alley, trip switches adapted to be actuated by the ball and controlling said simulated bowling pins, counting and tallying mechanism operatively connected to said trip switches and comprising circuit means for instantly indicating that a strike or a spare has been made, circuit means for temporarily stor-

ing the registration of a strike or spare until it is the proper time to count and tally said strike or spare in accordance with true bowling scoring, circuit means for automatically starting the counting and tallying operations when a strike or spare, having just been made, is due to be scored, circuit means for causing all strikes and spares to receive their proper counting while being tallied, circuit means for removing the strikes and spares from their temporarily stored registration, ball counting rotary switch means and cooperating circuit connections responsive to the spent ball whereby each ball projected that fails to make a strike actuates said rotary switch to be designated as the first or second delivery of the frame, circuit means for automatically starting the counting and tallying from said rotary switch when the conditions of the game being played call for scoring after either the first or second delivery, circuit means whereby three successive strikes will automatically store thirty points and whereby said thirty points will not be tallied until the third successive strike has been made, circuit means for removing the first strike of this succession from the stored registration after being duly counted and tallied while retaining the other two in stored registration, and means operative in the event another strike is made it will likewise be temporarily stored and another thirty points will be tallied, whereby such removal and retention operations will be repeated, thereby making it necessary for the player to obtain twelve consecutive strikes in order to receive a perfect score of 300, as in actual bowling.

15. In an electric bowling game, the combination of an alley along which a bowling ball is adapted to be rolled, simulated bowling pins at the rear end of the alley, trip switches adapted to be actuated by the ball and controlling said simulated bowling pins, apparatus responsive to said trip switches for accurately and correctly keeping a true bowling score comprising, circuit means whereby all scoring starts automatically in accordance with the proper scoring time in real bowling, circuit means for properly tallying said scoring, circuit means for preventing all strikes and spares from scoring when obtained including a duo-directional rotary switch for storing strikes, and interlocking relay mechanism for storing spares, circuit means for causing said strikes and spares to score and tally at the proper time in accordance with the real method of scoring bowling, circuit means for registering the number of frames played, circuit means for automatically giving the player a free play when his score reaches a predetermined amount, circuit means whereby the operation and score of the game can be nullified and all mechanism returned to normal either by manually operating a switch or by inserting a coin into the game, and circuit means for automatically rendering the game inoperative when ten or any predetermined number of frames have been bowled.

16. In a bowling game, the combination of a bowling alley along which a bowling projectile is adapted to be propelled, pin means adjacent the rear end of said alley, electrical control means responsive to the aimed travel of the bowling projectile relatively to said pin means in the bowling operations, and automatic scoring apparatus responsive to said electrical control means for automatically registering the score, said automatic scoring apparatus comprising means for storing the scoring value of a spare until the scoring value of the next bowling operation is obtained,

and means for storing the scoring value of a strike until the scoring value of the next two bowling operations is obtained.

17. In a bowling game, the combination of a bowling alley along which a bowling projectile is adapted to be propelled, pin means adjacent the rear end of said alley, electrical control means responsive to the aimed travel of the bowling projectile relatively to said pin means in the bowling operations, and automatic scoring apparatus responsive to said electrical control means for automatically registering the score, said automatic scoring apparatus comprising means for storing the scoring value of a spare until the scoring value of the next bowling operation is obtained, means for thereupon tallying said two scoring values, means for storing the scoring value of a strike until the scoring values of the next two bowling operations are obtained, and means for thereupon tallying said three scoring values.

18. In a bowling game, the combination of a bowling alley having a return trough, pin means near the rear end of the alley toward which a bowling projectile is adapted to be propelled from the front end of the alley, electrical control means responsive to the aimed travel of the bowling projectile relatively to said pin means in the bowling operations, automatic score registering apparatus responsive to said electrical control means for automatically registering the bowling score, a projectile counting rotary switch, trip switch means associated with said return trough to be responsive to the travel of bowling projectiles therethrough and connected to actuate said projectile counting rotary switch, and frame registering means electrically connected to be responsive to said trip switch means by way of said projectile counting rotary switch whereby said projectile counting rotary switch will permit scoring operations to occur on said automatic score registering apparatus when necessary after a first projectile of a frame without causing a frame to register, and electrical circuit means cooperating with said frame registering means whereby the game will not automatically become inoperative at the end of the final frame until the player has completed any additional bowling necessary to duly tally any stored values due from previous strikes or a previous spare.

19. In a bowling game, the combination of a bowling alley having a return trough, pin means

near the rear end of the alley toward which a bowling projectile is adapted to be propelled from the front end of the alley, electrical control means responsive to the aimed travel of the bowling projectile relatively to said pin means in the bowling operations, automatic score registering apparatus responsive to said electrical control means for automatically registering the bowling score, said automatic score registering apparatus comprising a duo-directional rotary switch for temporarily storing the scoring value of a strike, together with means for actuating said switch in one direction when a strike is made and for actuating said switch in a reverse direction when said strike is eventually tallied, a projectile counting rotary switch, trip switch means associated with said return trough to be responsive to the travel of bowling projectiles therethrough and connected to actuate said projectile counting rotary switch, and frame registering means electrically connected to be responsive to said trip switch means by way of said projectile counting rotary switch whereby said projectile counting rotary switch will permit scoring operations to occur on said automatic score registering apparatus when necessary after a first projectile of a frame without causing a frame to register, and electrical circuit means cooperating with said frame registering means whereby the game will not automatically become inoperative at the end of the final frame until the player has completed any additional bowling necessary to duly tally any stored values due from previous strikes or a previous spare.

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