July 3, 1951 W. C. BROEKHUYSEN 2,559,274

BOWLING PIN SETTING MACHINE

Filed Nov. 9, 1945 5 Sheets-Sheet 1

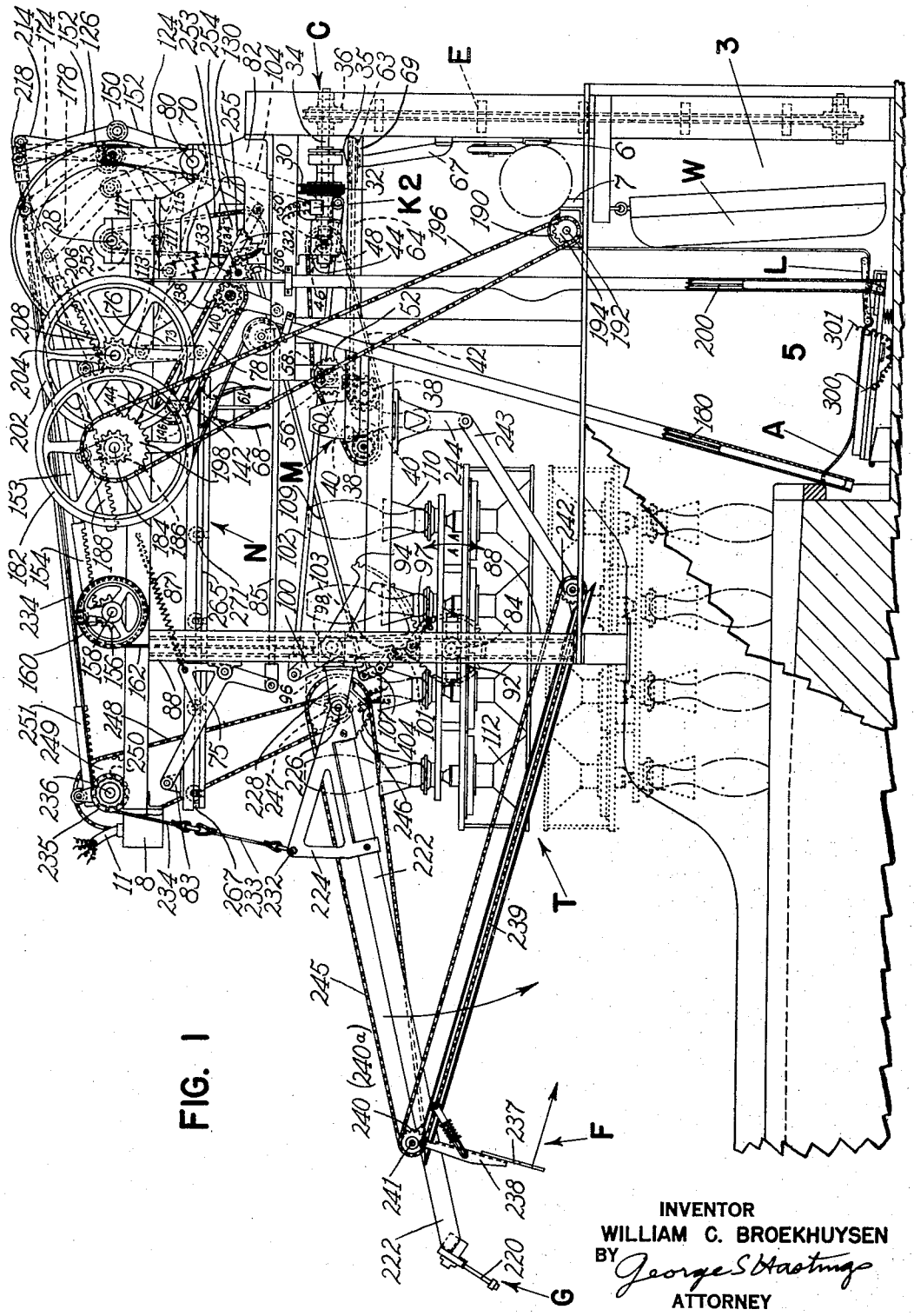


FIG. 1

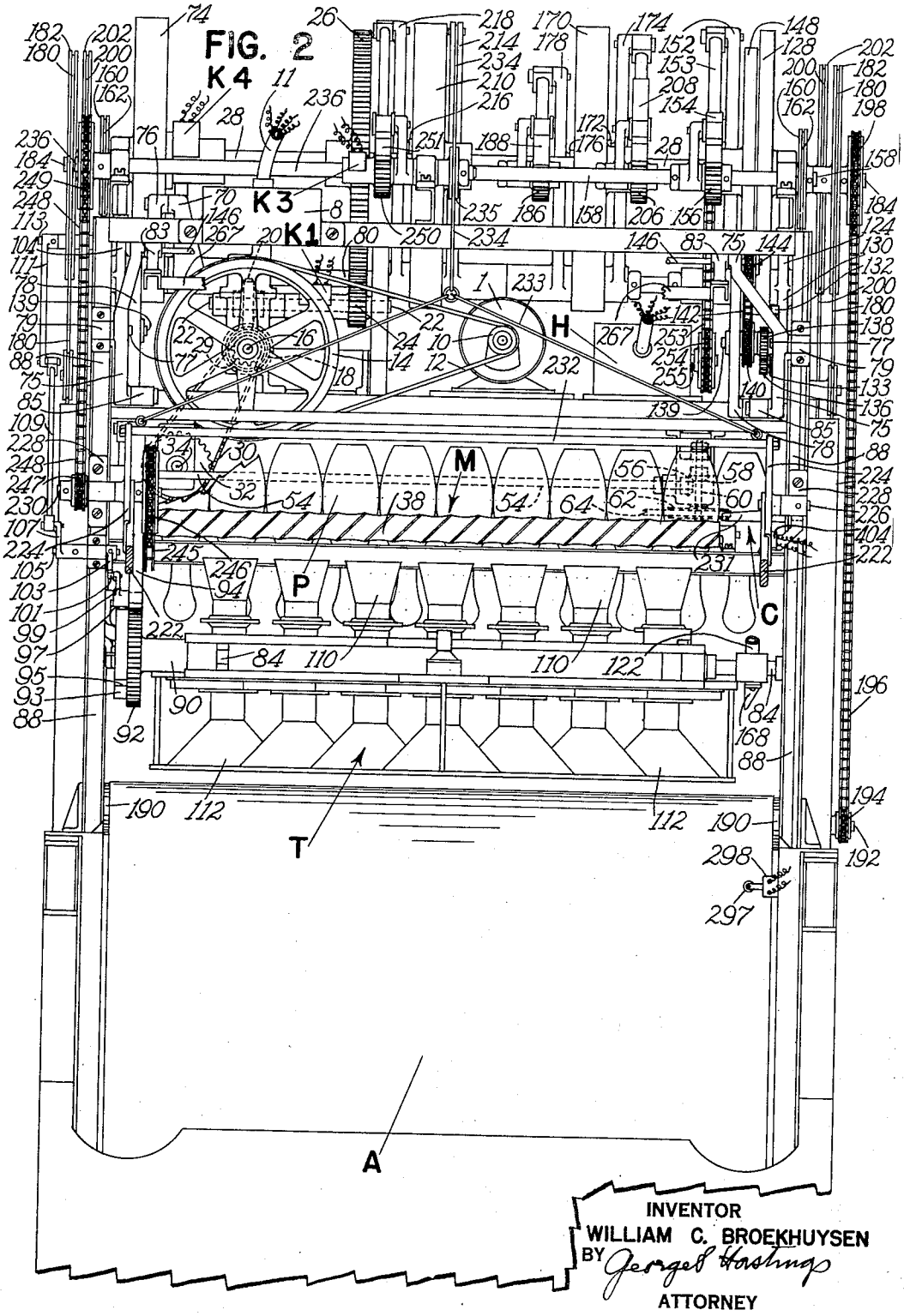
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FIG. 2



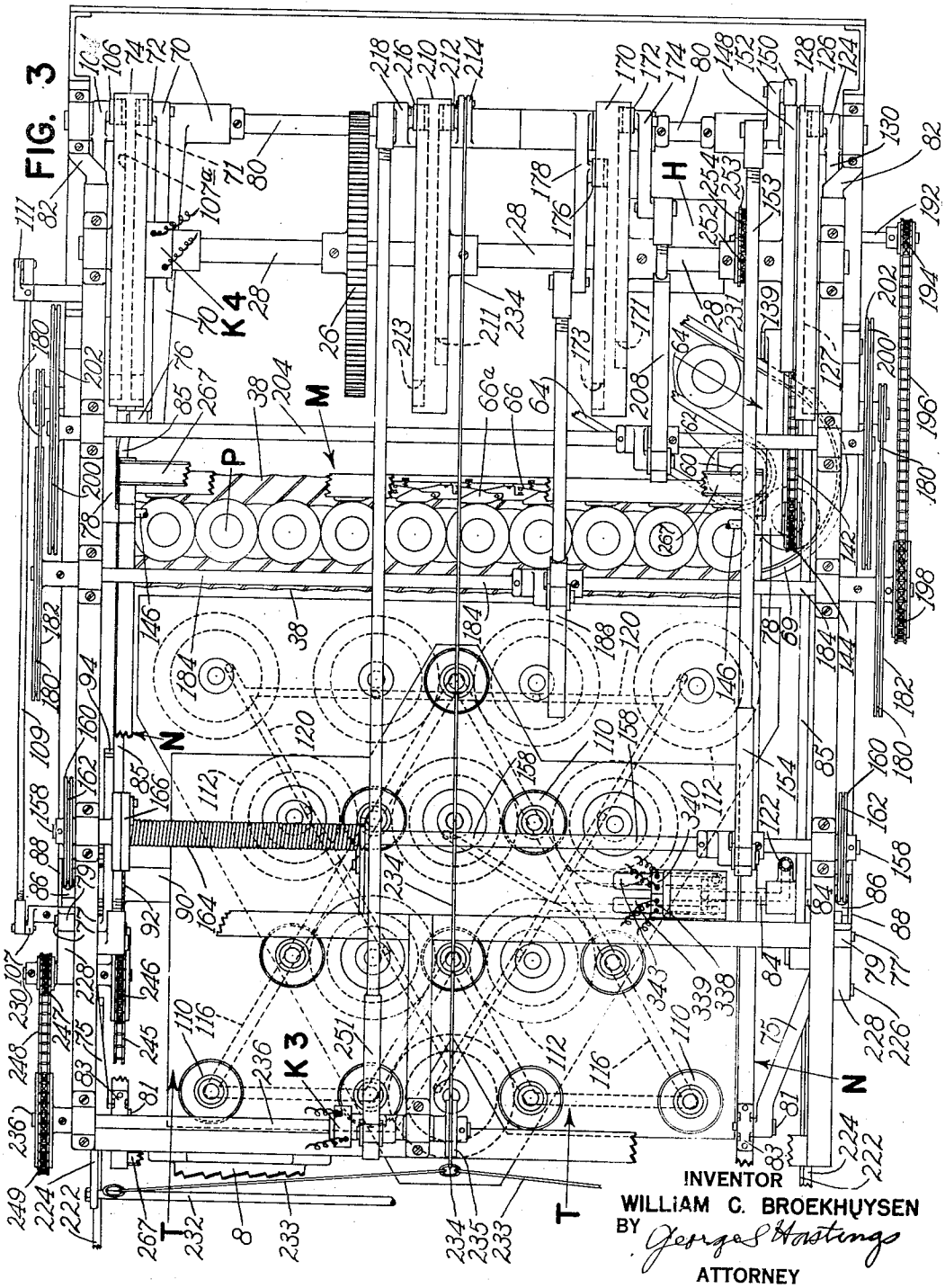
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FIG. 3



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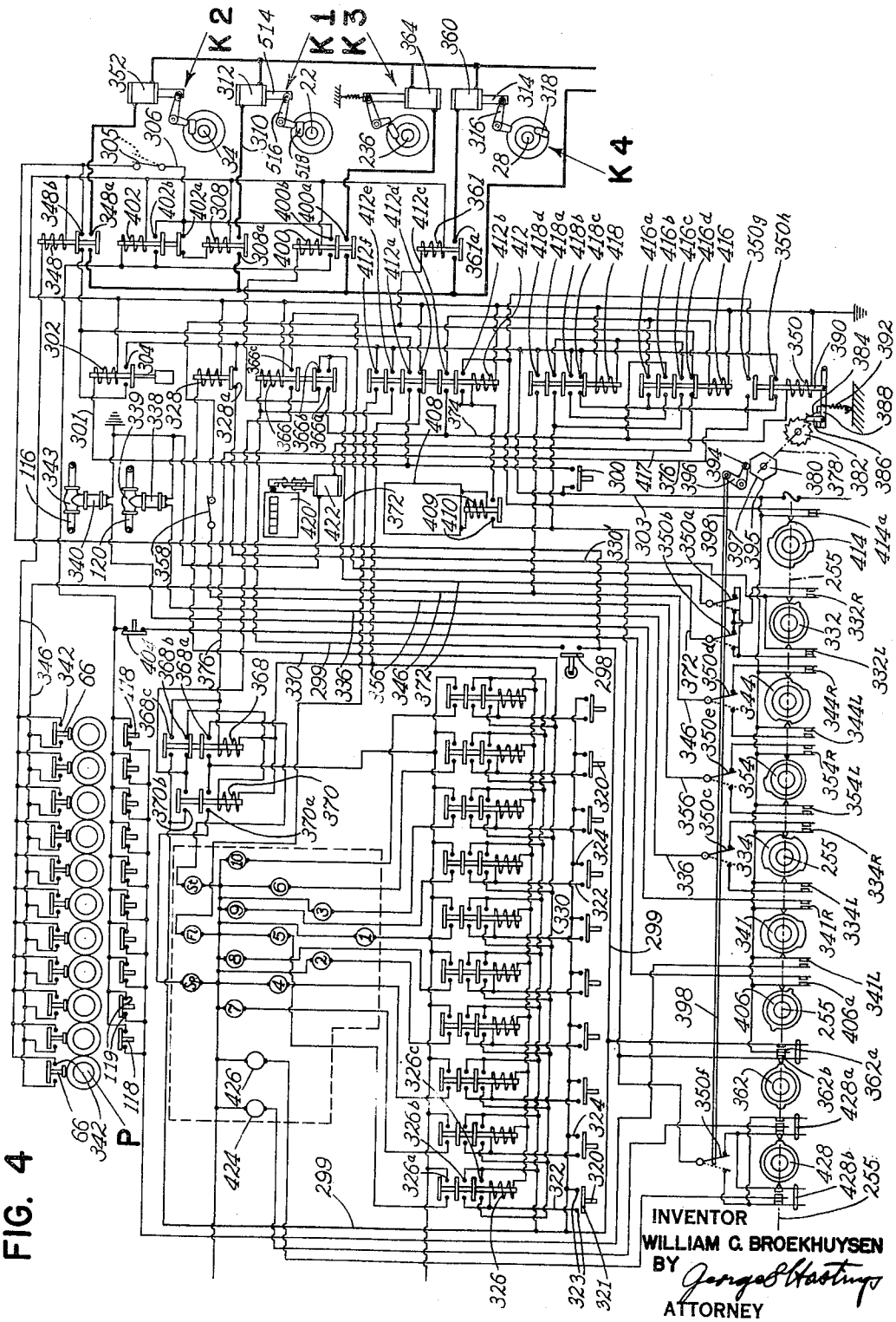


FIG. 4

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FIG. 5

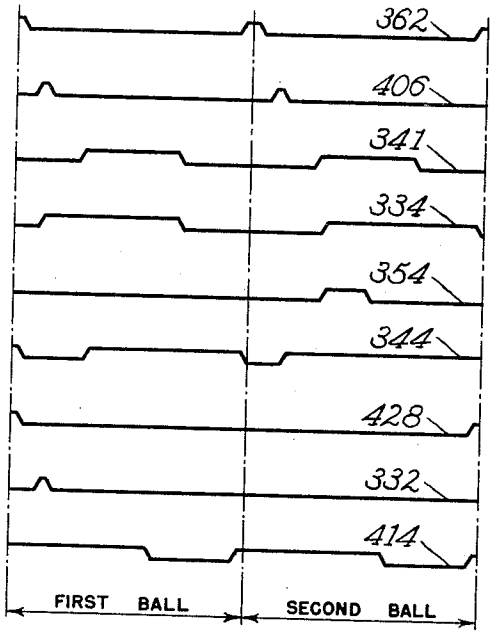


FIG. 6

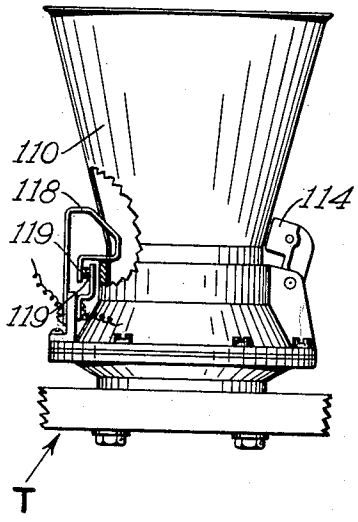


FIG. 7

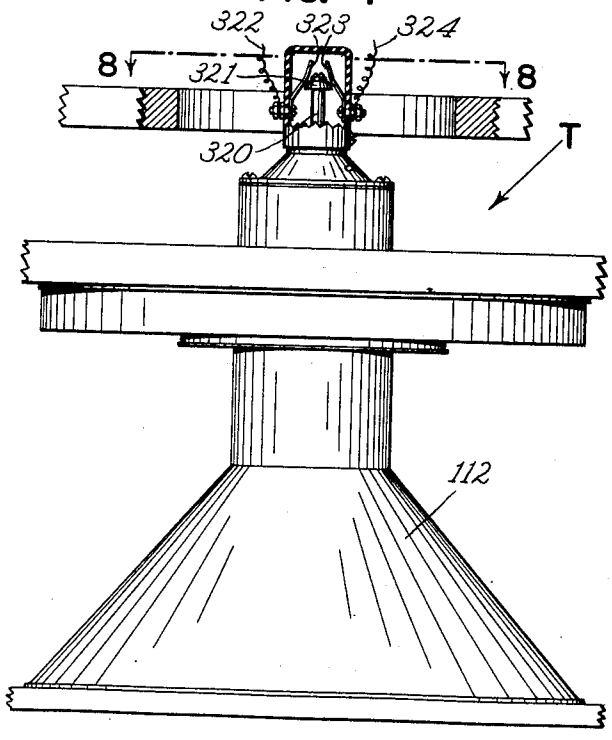
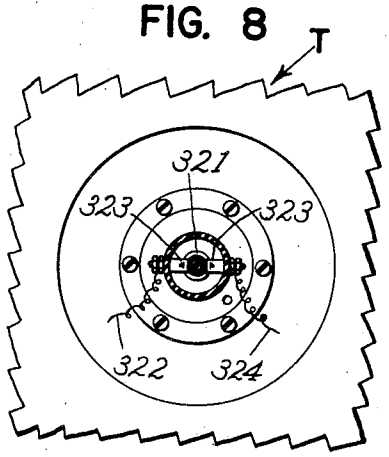


FIG. 8



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Patented July 3, 1951

2,559,274

UNITED STATES PATENT OFFICE

2,559,274

BOWLING PIN SETTING MACHINE

William C. Brockhuysen, Garden City, N. Y., assignor to American Machine and Foundry Company, a corporation of New Jersey

Application November 9, 1945, Serial No. 627,605

19 Claims. (Cl. 273—43)

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This invention relates to bowling pin setting machines and more particularly to completely automatic bowling pin setting machines wherein the operations are electrically controlled in accordance with conditions arising incident to the playing of the game and the operation of the machine is controlled in accordance with the number of pins knocked down by each ball of a frame rolled along the bed at the pins standing on the pin supporting bed of the alley.

In bowling pin setting machines, one of the main problems is to insure that all operations will be automatically carried out as quickly as possible and that rules prescribed by the American Bowling Congress will be fully complied with so that all setting, removal of fallen pins or deadwood, and other positioning of pins will compare with the present day setting of pins by pin boys.

It is also highly desirable that the speed of setting and resetting pins will be at least equal to or better than that achieved by pin boys. It is also desirable that costs be maintained at a minimum. Automatic bowling pin setting machines in the past have been highly complicated and expensive machines to construct and operate, and in the main relatively slow in operation.

According to the present invention I have provided a machine in which the construction is simplified and the expenses decreased because of the inclusion of completely automatic electric controls and electrically operated mechanisms which result in quickly and accurately determining the result from each ball of a frame thrown. I have also provided improved electrical control mechanism for an automatic pin setting machine in which strikes, spares, less than ten pins, and any other conditions arising incident to play are automatically and electrically taken into consideration and the machine controlled accordingly during its operation from frame to frame as the play progresses.

The machine control constituting my invention utilizes standard electric equipment such as relays and switches instead of intricate and expensive mechanical units so that the cost of production of such machines is materially lowered without reducing in any way the efficiency of operation of the machine.

The invention also includes the use of electrically operated and controlled mechanisms which are substantially faster in operation than the slower operating mechanical units heretofore used in machines of this type so that the rate of play is increased appreciably. Hence a more flexibly operated machine is provided. For instance, the machine of the invention makes it

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possible to automatically swing over from the first ball of a frame to the second ball of a frame in the event that a foul is made on the first ball when the machine is standing still so that in effect a strike cycle is set up and then mechanism is automatically set into operation for the second ball cycle of the same frame, which would be relatively more difficult in machines of the prior art.

The machine of the present invention also consists in an organized electrically controlled mechanism which facilitates interconnection with auxiliary electrically controlled mechanism for carrying out special functions such as foul detecting on the first and second balls, which contribute to the general efficiency and fool-proof operation of the machine.

It is an object of my invention, therefore, to provide an improved electrically controlled automatic bowling pin setting machine control which is capable of rapidly and efficiently controlling the machine operation after the throwing of each ball of a frame for setting and resetting the pins in accordance with conditions arising relative to the throwing of each ball of a frame.

It is a further object of my invention to provide an improved automatic bowling pin setting machine having fully electrically operated control mechanism for carrying out the designed function of the machine with a minimum of delay or waste of time.

My invention also consists in the provision of an improved automatic bowling pin setting machine utilizing electrically operated controls which eliminate relatively intricate and expensive mechanical mechanisms thereby contributing to the efficiency and speed of operation of the machine with a concurrent reduction in the cost of construction and operation of the machine.

The invention also consists in the provision of foul control mechanism which automatically solves the problem of operating the machine properly whenever a foul is made. For instance, the foul control operates in such a manner that when a foul is made on the first ball of a frame the operation of the machine is automatically so controlled that a new set of pins is placed on the alley pending throwing of the second ball of the same frame. A signal, such as a light, advises the player that he has fouled. If a foul is made on the second ball, a signal informs the player of that fact, but the machine operation continues as for a second ball. In this latter case, however, if all pins are knocked down by the second ball, the spare light does not go on.

The invention also consists of the provision of

mechanism for solving the problem of controlling the operation of the machine if after a ball has been thrown, especially the first ball of a frame, one or more pins have "walked" or been moved, either by the ball or another pin, so that the table is prevented from moving to its lower limit and hence any standing pins are out of the range of operation of the resetter cups. This mechanism consists of means for incapacitating the sweep and stopping the machine. Any fallen pins can be removed manually. The machine is then restarted and continues operation in its proper operative cycle.

It is an added object of the invention to provide against damage to the machine or breakage of parts if or when the sweep and guard are prevented from moving into operative position adjacent the alley because of the presence of fallen pins therebeneath. In such case the machine is stopped. It is restarted in its proper operative cycle after removal of the obstructing pin or pins.

In establishments employing automatic bowling pin setting machines, it may be desirable to determine automatically the number of games played per machine. For this reason there is provided in the control mechanism a magnetic counter which registers the number of sets of pins placed on the alley. A predetermined number of sets of pins can be set to constitute a game. The control automatically takes into consideration fouls, and if a foul is made on the first ball of a frame, no count is registered for that particular new set of pins.

The invention also consists in the provision of signals, such as lights, which indicate to the player the number of the particular ball being thrown during the play of each frame. In this manner the player always knows whether the first or second ball is being played.

With these and other objects not specifically mentioned in view, the invention consists in certain combinations and constructions which will be hereinafter fully described, and then set forth in the claims hereunto appended.

In the accompanying drawings which illustrate a preferred embodiment of the invention, and form a part of this specification, and in which like characters of reference indicate the same or like parts:

Figure 1 is a side elevation of a bowling pin setting machine embodying the invention;

Figure 2 is a front elevation of the same;

Figure 3 is a partial plan view of the machine;

Figure 4 is an electrical wiring diagram of the electrical control of the pin setting machine;

Figure 5 is a diagrammatic development of the electrical relay control cams;

Figure 6 is a side elevation of one of the spotting cups on the pin setting table, with parts broken away to illustrate a suitable electrical contact provided in each cup;

Figure 7 is a side elevation of one of the respotting cups carried by the pin setting table with parts broken away to show the electrical contact provided in each cup; and

Figure 8 is a sectional plan view of the same taken on line 8—8 of Figure 7.

In the embodiment selected for purposes of illustration, the machine is driven by a motor 1 (Figure 2) provided with a pulley 10 on which runs a belt 12 continuously driving a pulley 14 mounted on a shaft 16. A worm 18 secured to shaft 16 meshes with a worm wheel 20 keyed to a shaft 22 to which is attached the solenoid operated main clutch K_1 of the machine. Clutch K_1, which may be of the well known Bliss type, is connected with the hub of a gear 24 loosely mounted on shaft 22. Gear 24 meshes with gear 26 (Figures 2 and 3) secured to the main cam shaft 28 of the machine. Cam shaft 28 is supported by suitable bearings mounted on the frame of the machine.

The constantly rotating shaft 16 carries a sprocket 29 (Figure 2) on which runs a chain 30 driving a sprocket 32 loosely mounted on shaft 34. The hub of sprocket 32 (Figure 1) is provided with a solenoid operated one-revolution clutch K_2 which may be of the Bliss type which engages or disengages sprocket 32 from shaft 34, thereby controlling the drive of the pin distributing mechanism of the machine.

The mechanism for handling and distributing pins is of the same general construction as and similar in operation to that shown in Rundell Patent 2,388,707 issued November 13, 1945, for Bowling Pin Setter. This mechanism consists of a transverse, ascending conveyor E which carries upwardly pins which are removed by apron A from the pit and discharged into chamber 3 at the rear of bumper W and discharges pins one by one into a rectifying and aligning conveyor extending from a point adjacent the top or discharge end of conveyor E to a delivery point adjacent magazine M. Conveyor E is actuated at the proper time in the cycle of operations by a sprocket 36 mounted on shaft 34 to deliver pins from chamber 3 to conveyor C which in turn delivers them to magazine or storage M. Magazine M or the loading station of the machine includes a pair of spaced rotatable spirals 38. Conveyor C consists of a positively driven belt 64 having its active lap spaced from and extending substantially parallel to a stationary guide member 69. Each spiral carries a sprocket 40 driven by a chain 42 from a sprocket 44 fixed to shaft 46.

Shaft 46 carries bevel gear 48 (Figure 1) meshing with bevel gear 50 mounted on loading mechanism control shaft 34. Chain 42 also drives sprocket 52 mounted on one end of a horizontal shaft 54. The other end of the latter has secured thereto a bevel gear 56 (Figure 2) meshing with bevel gear 58 mounted on a vertical shaft 60. A belt 64 running on a pulley 62 secured to the lower end of shaft 60 and pulley 63 on shaft 65 supported by bracket 67 is the driven part of conveyor C.

Adjacent one of the spirals 38 are located eleven loading rack contacts or switches 66 (Figure 3) which are normally open when a predetermined number of pins P, eleven in the illustration shown, is in the loading station (see also Figure 4).

Pins P are lifted out of the magazine or loading station M by means of ten individual grippers 68 suspended from a supporting frame N similar in construction to that described in the above referred to Rundell Patent 2,388,707.

The pin setter table locking mechanism is provided for the purpose of locking the table in the spotting as well as respotting position. For this purpose integral with the gear 92 is a disk 93 provided with two slots 95 spaced 180° apart with which in either spotting or respotting position engages the nose of a spring mounted lock arm 97 which is pivoted on one of the pin setter table guide shoes 86. Lock arm 97 is provided with a control arm 99 which carries on its free end a roller 101, which when contacted and depressed

by a control finger 103 causes the nose of lock arm 97 to disengage from the slot 95 of disk 93. Upon release the spring mounted lock arm rides on the periphery of the control disk 93 until a slot 95 contacts the nose of said lock arm and a spring effects an engagement of the latter with said disk. The control finger 103 is mounted on a short shaft 105 supported by a suitable bearing bracket attached to the frame of the machine. Shaft 105 is actuated by a lever 107 which by means of an adjustable link 109 is connected to an arm 111 mounted on a short shaft 113 to which is also secured a cam lever 115 which by means of a cam roller 117 engages with a cam track 74.

The up and down motion of frame N and grippers 68 carried thereby is effected by the motions of a bell crank type cam lever 70 carrying an arm 71. A cam follower 72 on arm 71 runs in a suitable track in cam 74 loosely mounted on main cam shaft 28. The hub of cam 74 is provided with a suitable solenoid operated one-revolution clutch K_4, such as a well known Bliss clutch, which effects an engagement or disengagement of cam 74 with or from rotating main cam shaft 28. Arm 73 of lever 70 is connected by link 76 to arm 78 which imparts the vertical up and down motion to frame N and pin grippers 68. Cam lever 70 is loosely mounted on cam lever supporting shaft 80 supported at each end by suitable bearing brackets 82 secured to the frame of the machine.

Cam 74 is also provided with two additional cam tracks. One of these tracks is designed to effect the turning operation of the pin setter table T at the proper time in the sequence of operations of the machine. The other cam track controls the above mentioned locking mechanism of pin setter table T. These cam tracks are shown in detail in co-pending application, Serial No. 636,737, filed December 22, 1945, by G. J. Schmidt for Bowling Pin Setting Machine. Since they form no specific part of the present invention, detailed description thereof is omitted. It will be evident from the foregoing that the clutching and unclutching of cam 74 with or to shaft 28 due to the operation of solenoid actuated clutch K_4, controls the up and down movement of frame N and the turning of table T and the operation of the locking mechanism therefor.

The pin setter-resetter table T illustrated may be of the same general construction as that shown in Nejedly patent, No. 2,298,718, granted October 13, 1942. This table is provided with support members 90 which are mounted loosely for turning movement on hollow shaft 84. The ends of shaft 84 are secured to shoes 86 which are slidably supported in vertical guide channels 88 forming a part of the frame work of the machine.

The gear 92 formed integrally on one of the support members 90 (Figure 2) meshes with a gear segment 94 pivotally mounted on a stud 96 secured to a bearing plate 98 attached to one of the vertical guide channels 88. Gear segment 94 is provided with an actuating arm 100 (Figure 1) connected by rod 102 with one arm of lever 104. The other arm of lever 104 carries a cam follower 106 which engages a cam track 107a in cam 74. The rocking motion imparted by lever 104 to gear segment 94 effects a turning of the pin setter table T 180° back and forth in the directions indicated by arrow AA (Figure 1). Table T carries on one side ten pin spotting cups

110 and on the opposite side ten individually laterally movable respotting cups 112.

The construction of the setter cups 110 and resetting cups 112 is generally the same as those disclosed in Rundell patent, No. 2,310,996 and Schmidt patent, No. 2,283,613, with certain changes in detail. Pin grippers 114 of the supporting cups 110 are all identical in construction and only one is described. Grippers 114 are actuated by fluid means, such as suction, which is supplied thereto by ducts 116 connecting the several pin supporting cups 110 from a source of supply conduit in which is mounted a magnet-operated suction control valve 343 of conventional design supported on the table T. Each suction cup 110 is provided with a normally closed pin actuated contact (Figure 6) so that when a pin is delivered by a transfer gripper 68, the contact 118 is forced open. Obviously, if desired, normally open contacts could be used. In the illustrated embodiment, all contacts 118 (as shown in Figure 4) are in multiple and all contacts 118 must be opened by pins in order to prevent clutch K_1 from being disengaged, thereby stopping the machine.

The respotting cups 112 on the opposite side of table T are also supplied with suction through an interconnected series of conduits 120 (Figure 3) from a source of supply conduit in which is mounted a magnet operated suction control valve 339 of conventional design secured to table T. Suction valves 339 and 343 are connected to a conduit 122 (Figure 3) leading to a suitable source of suction such as a suction pump of known design (not shown).

Each respotting cup 112 is provided with a switch operating member 320. When the setter-resetter table T is lowered into pin lifting position adjacent the alley after the throwing of a ball, any standing pins on the alley will cause a closing of contacts 323 (Figure 7) in the same general manner as disclosed in Nejedly patent, No. 2,298,718, issued October 13, 1942.

All other mechanisms of the machine, such as the sweep F and associated guard G, the pin lifting pit apron A, ball cradle L, the means for effecting the down and up movement of table T to and from the alley, and the means for effecting the back and forth movement of pin grippers 68 on frame N are actuated by means of suitable cams secured to the main cam shaft 28, as described hereinafter.

The operations of frame N and transfer grippers 68 carried thereby are resolved into two distinct motions: the back and forth movement of the grippers 68 between magazine M and the pin delivery position above setter table T, and the up and down movement of the frame N and the grippers 68 for removing pins from the magazine M and for delivering the same into the spotter cups 110 on the table T.

The back and forth motion of the pin grippers 68 on transfer frame N is effected by means of cam lever 124 provided with cam follower 126 engaging a suitable cam track in cam 128 mounted on cam shaft 28. Cam lever 124 is provided with an arm 130 to which is pivotally connected a gear rack 132 engaging with a gear 133 loosely mounted on stud 134 supported in a suitable bracket secured to bracket 82 on the side frame.

Gear 133 is formed integral with a gear 136 meshing with gear 138 integral with sprocket 140 driving a chain running on a sprocket 144 on shaft 146. It will be seen that the rotation of cam 128 and its coaction with cam follower 126 on

cam lever 124 effects the oscillation of shaft 146 rotatably mounted in arms 78 attached to the side frames of the machine. Shaft 146 is provided with several driving gears of different diameters (not shown) which mesh with driven gears (not shown) fixed to shafts (not shown) carried by frame N, each mounting a pulley (not shown). When shaft 146 is rotated, these driving gears cause the pulleys to revolve and cause differential movement of pin gripper carriages 68 along rails 265 from alignment into triangular arrangement above, and ready for pin delivery to, spotter cups 110. After frame N has been moved downwardly to effect the delivery of pins held by grippers 68 into cups 110, grippers 68 are returned to aligned arrangement adjacent magazine M where a dwell in the cam 128 positions them until in the cycle of operation of the machine a new set of pins is to be removed from the magazine and transferred to the setter table T.

A detailed description of the structure and operation of the grippers 68 on frame N is not deemed necessary in the present case since it is described and claimed in co-pending application, Serial No. 636,737, filed by Gottfried J. Schmidt.

The movement of table T to and from the pin supporting bed of the alley for setting and/or resetting pins is effected by means of a cam 148 which as shown is formed integrally with cam 128. Cam 148 is tracked by a follower 150 on lever 152, which lever is fulcrumed on shaft 80. One arm of lever 152 is pivotally connected to a rod 153 which supports a gear rack 154 meshing with a gear 156 mounted on a horizontal shaft 158 supported by suitable bearings attached to the main frame of the machine. On each end of shaft 158 is secured a pulley 160 to which is attached one end of a cable 162, the other end of each cable being secured to a pin setter table guide shoe 86, mentioned heretofore.

A balance spring 164 encircling shaft 158 (Figure 3) is provided to counterbalance the weight of the pin setter table T. One end of spring 164 is anchored to the frame of the mechanism; the other end is attached to a flange 166 secured to shaft 158. Pin setter table T carries a cam wedge 168 (Figure 2) employed for the purpose of closing the pin setter table limit switch 298 when the table reaches its lowermost or pin engaging and lifting position.

Main cam shaft 28 mounts a cam 170 provided with cam tracks on both faces. The cam track on one side is tracked by a cam follower 172 on cam lever 174 which operates the ball lift or cradle L. The cam track on the other side is tracked by a cam follower 176 on cam lever 178 which operates the pit or pin lifting apron A. Apron A and ball lift L are of the same general construction and operation as disclosed in co-pending application, Serial No. 425,318, filed January 1, 1942 by Gottfried J. Schmidt, now Patent 2,389,643, issued November 27, 1945. The front end of the pit apron A is elevated by means of a pair of cables 180, each of which is secured to a pulley 182 mounted adjacent an end of horizontal shaft 184 which is oscillated by means of a gear 186 (Figure 1) actuated by a reciprocating gear rack 188, the free end of which is pivoted on cam lever 178. The rear end of the pit apron A is wound upon a cylindrical roller 190 mounted on a shaft 192. The latter is oscillated by means of a sprocket 194 and a chain 196 driven by a sprocket 198 mounted on the oscillating shaft 184. The ball cradle L is also raised and lowered by a pair of cables 200, each of which is secured to a pulley 202, both of which are mounted on a horizontal shaft 204, oscillated by means of a gear 206 which is actuated by a reciprocating gear rack 208 connected to the free end of cam lever 174.

Secured to main cam shaft 28 is a cam 210 having cam tracks 211, 213 provided on its opposite faces. The cam track 211 on one side is tracked by a cam follower 212 pivotally mounted on cam lever 214 which is responsible for the movement of guard G at proper times during the operation of the machine to and from the alley. The cam track 213 on the other side of cam 210 is engaged by a cam follower 216 on cam lever 218 which actuates the sweep mechanism of the machine. The guard as well as the sweep are of the same general construction as disclosed in Rundell patent, No. 2,250,503, issued July 29, 1941. The guard G consists chiefly of a guard plate 220 (Figure 1) attached at each end to an arm 222, each of which is mounted on a bracket 224 one of which is pivoted to a stud 226 held by a bearing bracket 228 (Figure 2), while the other is pivoted to a short shaft 230 also held by a bearing 228. Both brackets 224 are connected to each other by a tie bar 232 to which are fastened two cables 233, which in turn are connected to a common third cable 234 which runs over an idler or guide pulley 235 and is anchored to the free end of cam lever 214. Guide pulley 235 is loosely mounted on a horizontal shaft 236 supported by suitable bearings secured to the frame of the machine.

Sweep F (Figure 1) is interconnected with the guard G and consists of a sweep board 237 which at each end is supported by a bracket 238 each of which is pivoted to a stud projecting from an endless chain 239, the chains being reciprocated by sprockets 240, 240a mounted on horizontal shaft 241 supported by a pair of suitable bearing brackets attached to arms 222. Both chains 239 run over idler sprockets 242 pivotally mounted on studs, each held by one end of a link 243 while the other end of each link is pivoted to a suitable supporting bracket 244 secured to the frame of the machine. Shaft 241 is oscillated by means of a sprocket 246 (Figures 1, 2 and 3) mounted on shaft 230 to which one of the sweep arm brackets 224 is pivoted (Figure 2). To shaft 230 is furthermore secured a sprocket 247 which through a chain 248 is driven by a sprocket 249 mounted on the horizontal shaft 236. The latter carries a gear 250 the hub of which is provided with a solenoid operated sweep control clutch K_3 by means of which the gear 250 is engaged with or disengaged from the shaft 236, thereby providing means for making the sweep inoperative when a pin or pins walk or move out of the range of the descending respotting cups 112 of the pin setter table T. Gear 250 is oscillated by a gear rack 251 the free end of which is pivoted to the heretofore mentioned cam lever 218.

All cam levers 124, 152, 174, 214 and 218 are loosely mounted on the cam lever supporting shaft 80. To the main cam shaft 28 is also secured a sprocket 252 which by means of a chain 253 drives a sprocket 254 secured to the electrical control cam shaft 255 on which all electrical control cams 428, 362, 406, 341, 334, 354, 344, 332 and 414 (Fig. 4) are mounted. These cams, as well as their electrical contact fingers are enclosed in a housing H (Figures 2 and 3). Sprockets 252 and 254 driving the control cam shaft 255 are a 1:th 2 ratio, i. e., for every two revolutions of the main cam shaft 28, the control cam shaft 255 makes only one revolution. Or in other words,

for every two balls, the control cam shaft 255 makes one revolution.

The electrical equipment which I embody in the machine and which makes up the control is formed of commercial relays, switches, parts and accessories readily available to the trade. For ease and simplicity in design and manufacture, the relays are contained in a relay box 8 mounted on a cross frame member (Figure 2). The wires which connect the relays and switches in the wiring diagram are enclosed in suitable conduits such as conduit 11 projecting from box 8.

The operation of the machine can best be appreciated by a reference to the wiring diagram shown in Figure 4. The description covers the several possibilities resulting from throwing the allotted number of balls per frame.

At the start of playing all relays and solenoids are in released position; only the driving motor and vacuum pump are running and control power is applied between wire 303 and ground.

First ball, one or more pins remain standing

The ball dropping into pit 5 effects a closing of switch 300 connected by wire 301 to a delayed closing relay 302. This type of relay preferably is provided in order to allow a few seconds, say three or four, before the ball and pin handling mechanisms begin operating. In this way any pin movement on the alley or gutters has ceased; and all pins standing are at rest before the machine operation starts and table T moves down.

At the end of the delay period contact 304 closes, completing a circuit from line 303, through normally closed contact 348*b*, manually closed switch 305, wire 306 and normally closed contact 402*a*, energizing relay 308, thereby closing contact 308*a* which through wire 310 energizes solenoid 312 controlling the operation of clutch K_1. Clutch K_1 may be of the well known Bliss type. The energization of solenoid 312 causes armature 514 to swing lever 516 out of engagement with clutch actuating arm 518 whereupon gear 24 is coupled to shaft 22 and the machine operation is started.

Following the actuation of clutch K_1, rotation of cam shaft 255 of the control mechanism causes cam 362 to close normally open contact 362*a* which shunts contacts 304 and 348*b* and holds in clutch K_1 until the end of the cycle. Guard G is moved to operative position adjacent the alley, and ball cradle L removes the ball from the pit and delivers it to runways 6, 7 for return to the player. Pin transfer device N is operated by cams 74, 128 to deliver ten pins from magazine M to setters 110.

Rotation of main cam shaft 28 causes table T to be lowered into pin lifting position for lifting and resetting standing pins in on-or-off-spot position. Movement of the table to this position causes first of all the closing of table limit switch 298, through the engagement of cam 168 (Figure 2) with cam follower 297. This energizes relay 366, closing contacts 366*a* and 366*c* and opening contact 366*b* as long as the table is in lowered position. Continued downward movement of the table causes the heads of the standing pins to engage switch actuating members 320 (see Figure 7) which are raised in respotting cups 112 so that contacts 321 engage switch members 323 and close one or more circuits 322—324 in which are connected ten multi-contact locking-in relays 326. Each of the relays 326 which is energized as a result of the presence of a standing pin closes a relay hold-in circuit through relay contact 326*b* and contact 362*a* of cam 362 and thereby maintains contacts 326*a* and 326*c* closed. The closing of each of contacts 326*a* lights a signal lamp corresponding to the position of the particular pin remaining standing. These relays 326 remain locked in for the remainder of the cycle, after which the light circuits are broken by deenergization of relays 326 through the opening of cam contact 362*a*, and the light or lights, as the case may be, are extinguished.

In order to insure that neither the strike nor spare signal lamp shall be lighted inadvertently or at the wrong time when pins remain standing after the first or second ball of a frame is thrown, there is provided a circuit-controlling relay 328 which is connected by wire 330 in a circuit controlled by ten contacts 326*c* in multiple, so that whenever any of the relays 326 are energized, closing of a contact 326*c* energizes relay 328 breaking normally closed contact 328*a* and interrupting circuit 330 to strike and spare cam contacts 332L and 332R operated by cam 332.

When table T is located in pin engaging and lifting position adjacent the alley, cam 334 on shaft 255 closes contact 334R, which closes circuit 336, thereby energizing solenoid 338 which opens valve 339 and creates suction in conduits 120 connecting the several respotter units 112 which grip any standing pins. In the meantime continued rotation of shaft 255 causes strike-spare cam 332 to close contact 332R, but since contact 328*a* is open, a strike control impulse is prevented. The table T starts its upward movement lifting the pins gripped by units 112 and continued rotation of cam 332 opens contact 332R.

While table T dwells above the alley, fallen pins or deadwood are swept therefrom by sweep F. The pin transfer device N is operated to deliver ten pins from magazine M to the spotter cups 110, and substantially simultaneously therewith solenoid 340 is energized as the result of the rotation of cam 341 on shaft 255 which closes contact 341R.

As described hereinabove, pin carrying grippers 68 of the transfer device N are moved by cam 128 back and forth once each cycle of the machine. The up and down movement which locates grippers 68 in position to grip and remove pins from magazine M, and after horizontal movement to delivery position above table T, lower and deliver the pins to spotters 110, is controlled by cam 74 loose on shaft 28 and clutch K_4, which is similar in construction and operation to clutch K_1.

Since shaft 28 is driven by gears 24 and 26 from shaft 22, when clutch K_1 is operating, shaft 28 is rotated. As shown diagrammatically in Figure 4 clutch K_4 is already in engagement and cam 74 is rotating when clutch K_1 is engaged as a result of the closing of switch 309 by a ball arriving in the pit. Therefore, after the first ball of a frame is rolled and in the first cycle of the machine in a normal two ball frame, solenoid 360, which is responsible for the engagement of clutch K_4, is not energized. This means that shaft 28 continues to rotate until clutch operating arm or dog 318 engages the throw-out arm of lever 314 thereby disengaging clutch K_4 and stopping the rotation of cam 74 on shaft 28. When the next ball of the same frame is rolled clutch K_4 remains disengaged until, as the result of the rotation of shaft 255, cam 354 closes contact 354R which makes a circuit pulling in relay 361, closing contacts 361*a*, thereby energizing solenoid 360. This results in

the disengagement of the throw-out arm of lever 316 with clutch dog 318. Hence clutch K_4 again is engaged and cam 74 is rotated.

Clutch K_4 is in engagement at the time the machine operation starts shortly after the arrival of the first ball of a frame in pit 5 and the desired up and down movement of grippers 68 takes place to remove pins from magazine M and place them in setter cups 110. As soon as the grippers have delivered pins to the spotter and have moved upwardly and clear thereof, clutch K_4 is thrown out, as solenoid 360 is not energized, and further up and down movement of frame N and grippers 68 carried thereby ceases until another set of pins is to be transferred from magazine M to setter cups 110. Table T is not turned in this cycle, as cam 74 remains stationary for the remainder of this cycle. This is because during this cycle cam 354 does not close contact 354R. Hence relay 361 and solenoid 360 remain disengaged, and clutch K_4 which couples cam 74 to shaft 28, remains disengaged, as explained above.

As described herein above, sweep F is actuated cyclically to clear the alley of fallen pins. Apron A removes any pins in the pit and delivers them into chamber 3 for distribution by pin elevator E and conveyor mechanism C, which in turn conveys the pins one by one, and in succession between spirals 38 of magazine M where they are aligned awaiting delivery by transfer N to spotters 110.

As a result of the removal of pins and balls from the pit 5, pit switch 300 opens, starting delay relay 302 is deenergized and resets for the next ball. The adjustment of switch 300 is such that preferably if there are less than three pins in the pit, the removal of the ball effects a resetting of relay 302.

Removal of a set of pins from magazine M by transfer N allows pin switch arms 66 to close contacts 342. Rotation of shaft 255 causes cam 344 mounted thereon to close contact 344R and through contact 350*d* and a circuit 346 including contacts 342 connected in multiple, relay 348 is energized to close contact 348*a*, thereby energizing solenoid 352 which actuates clutch K_2, which may be of the Bliss type, to start the conveying mechanism for transferring pins from chamber 3 and delivering them into magazine M between spirals 38. As each pin is located in proper position in the magazine, it moves a switch arm 66 which opens one of the contacts 342 in the multiple circuit. When a predetermined number of pins, eleven in the embodiment illustrated, has been fed into the magazine, all contacts 342 are opened, the circuit is broken, clutch K_2 is thrown out, and the conveying or magazine loading mechanism, including conveyors C and E and means for rotating spirals 38, is incapacitated. The magazine is then filled with pins awaiting the next removal of a set of pins by transfer N.

As the machine operations continue, the table T moves downwardly to pin resetting position and resets pins in on or off spot positions. The table T carries a full set of pins in spotters 110. As soon as the table T reaches pin resetting position, further rotation of cam 334 on shaft 255 opens contact 334R which deenergizes solenoid 338 of suction valve 339 thereby closing suction conduit 120 and effecting the release of pins from respotter cups 112 and their delivery in proper on or off-spot position on the alley.

At substantially the same time, one of the high portions on cam 341 on rotating shaft 255 moves out of engagement with contact 341R thereby breaking the circuit through solenoid 340 which closes valve 343 and cuts off suction in spotters 110. The operation of the machine continues until table T moves back to its normal rest position where it dwells above the alley awaiting the throwing of the next ball of the frame. As cam 362 returns to its zero position (Figure 1), normally open contact 362*a* returns to open position, thereby breaking the circuit through solenoid 312 which effects a disengagement of clutch K_1; the several signal lamp relays 326 and relay 328 are deenergized and accordingly all signal lamps are extinguished. Cam 344 opens contact 344R, deenergizing relay 348 which breaks the circuit formed by contact 348*a* to solenoid 352. With the deenergization of solenoid 352, clutch K_2 is thrown out and further movement of the pin distributing conveyor mechanism is interrupted.

Second ball—no spare

The initial operation of the machine caused by the second ball dropping into the pit is the same as described above. The table is moved down to test for standing pins. In the condition of play assumed since a pin or pins remain standing, selected signal lamps are lighted by the energization of corresponding signal lamp relays 326, as described above.

Only one or more of pin position lights 1—10 is lighted at this time. Spare light cannot be lighted because, although rotation of cam 332 causes contact 332L to close, relay 328 is energized and since contact 328*a* is open an impulse to spare lamp relay 370 is prevented.

Since in the two ball game discussed herein the second ball is the last allotted for a frame, resetter cups 112 remain inoperative. Due to the fact that control cam shaft 255 makes one-half revolution for each complete revolution of main cam shaft 28, contact 334R is open when table T moves down and locates resetter cups 112 in pin gripping position adjacent the alley. Therefore, at this time circuit 336 including solenoid 338 is not closed, and valve 339 remains closed; suction is not cut into respotter units 112, and table T travels upwardly, after which any pins standing and any fallen pins are swept from the alley into the pit 5 by sweep F. Contact 332L which had been closed momentarily by the high portion of cam 332 on rotating shaft 255 opens.

While the table was being lowered to the alley and raised again, pin transfer grippers 68 moved horizontally thereabove under the action of cam 128, as described hereinabove. Grippers 68 are not operative to deliver a set of pins to the spotters 110 because clutch K_4 disengaged cam 74 from cam shaft 28 during the previous cycle, and also spotters 110 are already filled with pins. The ball has been returned to the player as described above, and the pins in pit 5 have been removed therefrom by apron A and discharged into chamber 3 for return to magazine M by conveyors E and C. Pit switch 300 returns to open position, as described above, awaiting the next ball of the game which is the first ball of the next frame.

Continued rotation of control cam shaft 255 results in closing contact 341R which energizes solenoid 340 and opens suction valve 343 creating suction in conduits 116 connecting spotter cups 110. In this manner pins are firmly held in spotters 110 during subsequent rotation of table T.

Continued rotation of cam 334 results in clos-

ing contact 334 R, and the energization of solenoid 338 which opens suction valve 339. This operation creates suction in conduits 120 and causes respotter cups 112 to be locked against movement or shifting on table T while the latter is turned through 180° in placing the set of pins held in spotter cups 110 on the alley, and while the table T is swung back to pin receiving position. Following the opening of valve 339, cam 354 closes contact 354R, which through contact 350*e*, wire 356 and noramlly closed switch 358 energizes relay 361 and closes contact 361*a* thereby actuating solenoid 360 allowing clutch K_4 to reengage cam 74 with cam shaft 28 and turn table T through 180° prior to its second downward movement. The mechanism for holding respotter cups 112 by suction against lateral movement on table T when the latter is turning, can be similar in construction and operation to that shown and described in Rundell Patent 2,383,017. Since this specific mechanism forms no part of the invention, further showing and description are omitted in the interest of brevity.

When table T reaches pin delivery position relative to the alley, contact 341R opens, and the pins held in spotters 110 are released and placed in playing arrangement on the alley. This is effected by a deenergization of solenoid 340 and the resulting closing of suction valve 343.

After ten pins have been placed in playing arrangement on the alley, the machine operation continues until the end of the cycle. After the table reaches its upper position, it turns 180° in reverse direction. Cam contact 362*a*, as shown in Figure 4, opens, releasing clutch K_1, the signal lamp relays 326 and relay 328. At the end of the cycle the position of cam 334 allows contact 334R to open, thereby deenergizing solenoid 338 which closes valve 339 and releases the respotter units 112. Cam contact 344R, however, remains closed permitting the pin elevating conveyor to reload magazine M. When the required number of pins has been delivered, all switches 342 are opened, releasing relay 348 and solenoid 352, disengaging clutch K_2 and stopping conveyors E and C and rotation of spirals 38.

Second ball—spare

The operation is generally the same as in the case of the second ball when pins remain standing, with certain exceptions. In this case table T moves downwardly after the second ball is thrown, but since all pins have been knocked down, all signal lamps 1—10 remain extinguished. All contacts 326*c* remain open and relay 328 is not energized so that contact 328*a* remains closed.

Movement of table T to its down position results in the closing of contact 366*c*, as described above. Contact 332L is closed by cam 332 and through contact 350*a*, contact 366*c* of relay 366, contact 368*b* of relay 368, relay 370 is energized and contacts 370*a* and 370*b* are closed. When contact 370*a* is closed, spare light SP is lit and the player is appraised visibly of the results obtained by the second ball of a particular frame. Contact 370*b* is a lock-in contact for relay 370 so that light SP remains lit until the end of the cycle.

Other operations of the machine are the same. A new set of pins is placed on the alley and further play is in order as for the first ball of the next frame.

Strike

In this case all pins are knocked down by the first ball of a frame, and a new set of ten pins is placed on the alley awaiting delivery of the first ball of the next succeeding frame. The initial operations resulting from the first or strike ball falling into pit 5 are the same as described above.

In the sequence of operations table T moves downwardly, cam 168 carried thereby closes limit switch 298 and energizes relay 366, momentarily closing contact 366*a*. Since no pins are standing, switches 320 which act as detecting means, are not closed, and lamp relays 326 are not energized. So also relay 328 is not operated.

Rotation of timing cam 332 causes contact 332R to close. Contact 328*a* being closed, current flows through wire 339', relay 350 is energized through contacts 332R and 350*b*, wire 372, and contact 366*a*. Relay 350 is an alternating relay such as a ratchet relay or equivalent so that each time it is energized it causes a shifting of contacts 350*a*—*f*, inclusive, back and forth from full line positions indicated diagrammatically in Figure 4 to dotted line positions.

Relay 350 may be of any suitable conventional type, such as Series S—125, manufactured by Guardian Electric Manufacturing Company, Chicago, Illinois. The relay selected for illustration is shown diagrammatically in Figure 4. It consists of a suitably mounted shaft 378 having fixed thereto a six-sided cam 380 and a twelve tooth ratchet 382. A pawl 386 is pivotally mounted on a lever 388 connected to armature 390 of relay 350. A spring 384 urges pawl 386 into engagement with the teeth of the ratchet 382. Spring 392 returns lever 388 and armature 390 to the position shown in Figure 4 after each operation of relay 350.

Running on cam 380 is a cam follower 394 on one arm of bell crank lever 396; the other arm of which is pivoted to a link 398 pivotally connected to shiftable contacts 350*a*—*f*. It will be evident that for each movement of ratchet 382, cam 380 is turned to engage follower 394 with either a high portion 395 or a low portion 397 of cam 380. Therefore, this operation results in a shifting and holding of contacts 350*a*—*f*, in shifted positions.

The shifting of contact 350*b* to dotted line position (Figure 4) interrupts the current through the coil of relay 350 thereby releasing armature 390 almost as soon as it was pulled up. The momentary closing of contact 350*g* by this movement of armature 390 energizes relay 368 from the live side of the power supply through contacts 414*a*, contact 350*g*, and wire 376, the other side of coil 368 being connected to ground through contact 412*d*. Relay 368 locks in through its holding contact 368*c* and cam contact 362*a* till the end of the cycle, lighting strike lamp ST through contact 368*a*. The opening of contact 368*b* prevents energizing of spare lamp relay 370 which would otherwise result from the shifting of contact 350*a* to dotted line position.

The shifting of contact 350*c* to dotted line position prevents the opening of respotting suction valve 339 at this time.

The remainder of this cycle is the same as for any second ball. Contacts 350*a* to 350*f*, having shifted to dotted line position all functions controlled by them are now also controlled by the closing of the left contacts 332L, 334L, 344L and 354L by the second ball halves of their respective cams. Clutch K_4 remains engaged as relay 361 is energized through cam contact 354L and relay contact 350*e*. The table turns and ten new pins are set on the alley. At the end of this cycle the relay contacts 350*a*—*f* remain in dotted line position and the operation of the next cycle will be

as described above for a first ball, substituting 332L, 334L, 344L and 354L for 332R, etc.

The next time a strike is made, relay 350 is again energized, returning contacts 350*a*—350*f* to full line positions.

At the start of any first ball cycle (also strike) the loading rack must be full as the pin transfer mechanism N will remove ten pins immediately after the start. Therefore, as long as relay 348 is energized, indicating that the loading is not completed, contact 348*b* is open and prevents the energizing of relay 308 even after the delayed closing relay 302 has closed contact 304.

At the start of the second ball cycle, there are already ten pins in the spotting cups. Cam contact 344 (R or L) being open, relay 348 is released, contact 348*b* is closed and the machine can start as soon as the delay period is up.

Off-center pins (full downward movement of table T prevented) (first ball of a frame)

It is well known that pins have a tendency to "walk" or move as the result of being hit or moved by the ball or other pins when or after the ball travels over the alley. On quite infrequent occasions a pin may move so far with reference to its spotted position that it cannot be picked up and reset. When this condition occurs, table T in moving towards the alley comes into engagement with the handle end of such abnormally located pin or pins and its downward travel is arrested. In such case, switch 298 cannot close. Therefore relay 366 is not energized and hence contact 366*a* remains open and contact 366*b* remains closed.

If this condition occurs on the first ball of a frame, the closing of cam contact 332R or 332L by cam 332, results in energization of relay 400 which closes contact 400*a* and energizes solenoid 364 thereby throwing out clutch K_3, normally continuously operating while the machine is in motion. Clutch K_3 is of the same type as clutches K_1, K_2 and K_4. In this manner sweep F is rendered inoperative and cannot sweep standing pins from beneath table T.

Energization of relay 400 also closes contact 400*b* and pulls in relay 402, which locks in through its holding contact 402*b*, and normally open cam contact 362*a*. Energization of relay 402 opens normally closed contact 402*a* which results in the deenergization of solenoid 308 and disengagement of clutch K_1, and a stopping of the machine. Even if the machine should overrun enough to cause cam 332 to rotate an amount sufficient to open contact 332R, relay 402 remains locked in.

Relay 350 cannot be energized because contact 366*a* is open. Hence, strike lamp relay 368 does not operate either. No score is shown.

While the machine is stopped, all fallen pins can be removed manually and thrown in the pit.

Momentarily opening and reclosing manual control switch 395 releases relay 402 and energizes relay 308 controlling the main or starting clutch K_1 which restarts the machine. As sweep F is disengaged, it is evident that standing pins are not swept from the alley, and the machine completes its normal first-ball cycle. The sweep clutch throws in automatically at the end of the cycle.

Off-center pins (second ball of frame)

On the second ball, cam contact 332L or R closes under the actuation of cam 332, depending on the position of cam portions 395 and 397 with respect to cam follower 394. Relay 366 is not pulled in and contact 366*c* in the spare light relay (370) circuit is open so that light SP is not lighted. The remainder of the cycle is the same as for a normal second ball when standing pins remain on the alley. Since on a second ball, as previously decribed, the circuit through cam contacts 332L and R, and relay contacts 350*a* and 350*b*, is such that power is applied through contact 350*a* to contact 366*c*, and not through contact 350*b* to contacts 366*a* and 366*b*, there is no possibility of relay 400 being energized even though contact 366*b* is closed. That is, sweep F operates, and removes both standing and fallen pins. The table T sets a new set of pins; the ball is returned to the playing position, and eleven pins are conveyed to magazine M for delivery to the setters 110.

Switch 298 is preferably so located that for a normal cycle of operation, relay 366 is energized during the entire time that cam contact 332R or 332L is closed.

Spotter safety mechanism

It may happen that because of long use the handle ends of pins become worn, cracked or split so that such pins can be handled only with some difficulty. This may result in pins being improperly transferred to or held in the spotters 110. Under such conditions insufficient pins may be transferred to setters 110 or possibly such pins might be moved by transfer grippers 68 towards magazine M, or even drop from spotters 110 when the table is delivering a set of pins to the alley. Damage or jamming of the machine might result The present spotter safety mechanism is designed to prevent any of the above possibilities from happening and to insure that the required number of pins, usually ten, will always be set on the alley.

Each of the spotters 110 is provided with a normally closed switch 118, the contacts 119 of which are connected in multiple between contact 341L and relay 402. Therefore, if each spotter 110 is filled with a pin, the multiple circuit is broken and relay 402 is not energized. If on the other hand a single switch remains closed, as where insufficient pins are transferred to spotters 110 or where a pin drops during turning of table T, relay 402 is energized and locked in through contact 402*b*, contact 402*a* is broken and relay 308 throws out thereby effecting a disengagement of clutch K_1 and the machine stops. After correcting the cause of the failure, the machine is restarted by momentarily opening and then closing manual control switch 305.

It should be noted that both contacts 341L and 341R are closed at the same time by symmetrical cam 341. This means that contact 341L is closed only when spotting suction valve 343 is open and whenever this valve is open there must be ten pins in the spotters 110.

Guard safety

It may happen that a fallen pin may lie in such a position on the alley as to prevent guard G and sweep F from moving downward their full stroke adjacent the alley after a ball is thrown. In such case, limit switch 404 which is normally open when the guard and sweep are down, remains closed. Cam contact 406*a* is closed by cam 406 and a circuit is made through switch 404 which pulls in relay 402 which is locked in by its own contact 402*b*; relay 308 is thrown out, clutch K_1 is disengaged because of the deenergization of solenoid 312 and the machine stops. The pin or pins which prevented full movement

of the guard and sweep to down position is or are removed by hand. The machine is restarted by opening and closing switch 305 as described above.

Inching or jogging mechanism

Manually controlled switch 305 mounted at any convenient position on the machine or at any other suitable position may be used to inch or jog the machine. Opening and closing switch 305 controls the operation of relay 308, solenoid 312 and clutch K_1 for stopping or starting the machine. As mentioned hereinabove, opening switch 305 also interrupts the holding circuit of relay 402 and therefore acts as a reset switch if the machine stops for any of the reasons stated above. If desired, a second pole can be added to switch 305 in series with the clutch K_2 control so that in this way the loading mechanism can also be stopped when desired.

Practice ball

In order to allow players to roll practice balls without pins on the alley, a switch 350 may be inserted in the line 356 to relay 361. This prevents engagement of clutch K_4 and thereby prevents the setting of new pins, but allows the machine to operate and return the ball to the player.

Foul control

According to the American Bowling Congress, certain rules of play govern when and if a foul is rolled. If a foul is made on the first ball, a new set of pins must be placed on the alley, and no score is counted. If a foul occurs on the second ball of a two ball game, the machine runs through its normal cycle, but no score for that ball is counted.

A foul is indicated in any suitable manner, either automatically by an automatic foul detector which controls the further operation of the machine, or by a manually operated indicator and control. In Figure 4 there is illustrated a suitable electrically controlled fully automatic foul indicator and machine control mechanism. This mechanism includes a suitable automatic foul indicator control 406, such as a photoelectric cell operated device located adjacent the head end of an alley so that any unauthorized movement of a player beyond the foul line results in the operation of the control. When a foul, therefore, is made a relay 409 is pulled in, momentarily closing a contact 410 which makes a circuit through normally closed cam contact 362*b* to relay 412 which is locked in by contact 412*b* and cam contact 414*a*. Contact 412*a* on being closed by-passes delayed-closing contact 304 as soon as pit switch 308 closes because the number of pins standing is of no consequence as ten pins must be reset before the next ball, in this case the second ball, is played. Normally closed contact 412*d* opens the circuit on the ground side to all lamp relays preventing any of the lamps from lighting except foul lamp FL. The foul lamp circuit is closed by contact 412*f*, and this lamp is lighted.

Since a first ball foul is being described, the opening of the lamp relay circuit leaves all contacts 326*c* open and results in an impulse to relay 350, so that in effect the control operates as a strike cycle minus the lighting of strike lamp ST. As previously described, in a strike cycle, when all ten relay contacts 326*c* remain open, relay 328 is not energized, contact 326*a* remains closed, and relay 350 is energized when cam contact 332R (or 332L as the case may be) closes. In this case, the same result is accomplished by the fact that relay contact 412*d*, being open, prevents the operation of relays 326.

The respotting suction valve 339 operates as in any strike cycle, that is, it does not open until later and any standing or fallen pins are left on the alley, and swept therefrom by sweep F in the usual manner. Contact 412*c* connects relay 416 across the coil of relay 350 and hence relay 416 is energized along with relay 350 and locked in through its own contact 416*a* and normally closed contact 418*c*. Continued rotation of cam 414 opens contact 414*a* releasing relay 412 which in turn releases step relay 350; relay 416 remains locked in. At the end of the cycle relay 418 is pulled in through normally closed cam contact 362*b* and contact 416*c* and locks in through its own contact 418*a*.

Closing of contact 418*b* energizes relay 350 through contact 416*b*. Relay 416 is released when both contacts 418*c* and 350*h* are opened. The opening of contact 416*b* releases relay 350 which has been operated twice during this cycle thereby bringing the machine control to second ball position.

In the second ball position, the only difference from normal operation is that the clutch K_4 controlling the operation of cam 74 is engaged because the preceding cycle operated as a strike cycle. Since a set of pins was removed from the magazine, it must be reloaded before this second ball cycle is allowed to start. Relay 418 remains locked in and contact 418*d* holds in the loading clutch K_2 until the loading of magazine M is completed.

At the beginning of the second cycle, cam 362 opens contact 362*b* thereby releasing relay 418.

In case a first ball foul should coincide with a pin far off-center, it is necessary to by-pass the off-center protection in order to insure the removal of the pins. This is done by shunting contact 412*a* across the table limit switch 298, causing relay 366 to be energized in spite of the off-center pin.

Foul (second ball)

It will be noted that foul lamp FL is lighted so long as relay 412 is energized and contact 412*f* is closed. In case of a foul on the second ball, only relay 412 is energized which effects a lighting of lamp FL. The delay relay is shorted and none of the other signal lamps are turned on. Relays 416 and 418 are inoperative because step relay 350 is inactive. The cycle in this case continues as for any normal second ball.

Frame counter

In order to count the number of frames, a magnetic counter 420 can be connected across table turning clutch relay 361. A circuit is made through counter 420 every time relay 361 is pulled in by contacts 416*d* and wire 417, which energizes solenoid 422 and operates the counter to show that table T has delivered a set of pins to the alley.

If it is desired to prevent a count of a frame when pins are reset for a first ball foul, the counter 420 will remain inoperative because of breaking the circuit through normally closed contact 416*d* when foul relay 416 is pulled in.

Played balls signal

In order to apprise a player of the number of balls played, there are provided signal lights 424 (first ball), 426 (second ball), respectively, which are lighted in proper sequence. When the ma-

chine is at rest before the first ball of a frame is rolled, first ball light 424 is lighted through normally closed contact 428*a*, contact 350*f*, and normally closed contact 362*a*. As soon as the machine starts, cam 362 opens contact 362*a* breaking the circuit and the lamp is extinguished.

Between the first and second ball cycles, second ball light 426 goes on through normally open contact 428*b*. After a strike, the first ball light is lighted again through normally open contact 428*a*, normally closed contact 362*b*, and contact 350*f* which due to the operation of step relay 350 has been shifted to the other side.

The invention above described may be varied in construction within the scope of the claims, for the particular device, selected to illustrate the invention, is but one of many possible concrete embodiments of the same. It is not, therefore, to be restricted to the precise details of the structure shown and described.

What I claim is:

1. In an automatic bowling pin setting machine for use with a bowling alley provided with a pin supporting playing bed, mechanism for removing fallen pins from said alley after the first ball of a frame is thrown, mechanism for removing all fallen and standing pins from said alley after the second ball of a frame is thrown, means for returning the ball to the player, means for placing a set of pins on said bed pending the throwing of the first ball of a frame, electro-magnetically operated mechanism for controlling the operation of said machine in conformity with the number of pins knocked down by the first ball of a frame for spotting a new set of pins on said alley or respotting any standing pins thereon, electro-magnetically operated mechanism for controlling the operation of said machine after the second ball of a frame is rolled to spot a new set of pins on said alley, said two last-named mechanisms including a timing cam shaft, a plurality of timing cams mounted on said shaft, means for rotating said shaft after each ball is thrown, a selectively actuated electric circuit operatively connected with said control mechanisms, sets of contacts in said circuit constructed and arranged to be operated by selected cams on said shaft for connecting selected contacts with said circuit, a plurality of switches, each of said switches being connected in series with one of said contacts, and an actuating device for operating selected switches for placing said switches in series with another of said contacts.

2. In an automatic bowling pin setting machine having a movable table supporting pin setter and resetting units, means for moving said table to and from the bed of a bowling alley to set and reset pins thereon and pin handling devices for placing pins in said setter units on said table; electro-magnetically operated mechanism for controlling the operation of said table and devices in conformity with the number of pins knocked down by the first ball of a frame for spotting a new set of pins on said alley or respotting any standing pins thereon, electro-magnetically operated mechanism for controlling the operation of said table and devices after the last ball of a frame is thrown for spotting a new set of pins on said alley, said mechanisms including a timing cam shaft, a series of timing cams mounted on said shaft, means for rotating said shaft a partial revolution for each ball thrown, sets of contacts operated by said cams, a control circuit operatively associated with said control mechanisms, a plurality of switches, each of said switches being connected in series with one of said contacts and connecting a selected set of contacts into said control circuit, and an actuating device operating selected switches for transferring power from one set of contacts connected operatively with said first-named mechanism through a series circuit connecting said switches and said other contacts to said second-named mechanism to actuate said second-named mechanism for placing a new set of pins on said alley, if a strike is made on the first ball of a frame.

3. In an automatic bowling pin setting machine having a movable table supporting pin setter and resetting units, means for moving said table to and from the bed of a bowling alley to set and reset pins thereon and pin handling devices for placing pins in said setter units on said table; electro-magnetically operated mechanism for controlling the operation of said table and devices in conformity with the number of pins knocked down by the first ball of a frame for respotting standing pins on said alley bed, electro-magnetically operated mechanism for controlling the operation of said table and devices after the second ball of a frame is thrown for spotting a new set of pins on said alley bed, said mechanisms including a timing cam shaft, a series of timing cams mounted on said shaft, means for rotating said shaft one-half revolution for each ball thrown, two sets of contacts operated by said cams and resting on points 180° apart on said cams, a control circuit operatively associated with said control mechanisms, a plurality of double throw switches each having a pole connected in series with one of said contacts of said sets of contacts, and an actuating device for said double throw switches for breaking the circuit through said one of said contacts of said sets of contacts and establishing a series circuit through said other contacts of said sets of contacts if a strike is made on the first ball of a frame, to operate said second-named mechanism and means operated by said last-named mechanism for actuating said first-named means for placing a new set of pins on said alley bed.

4. In an automatic bowling pin setting machine having a movable table supporting pin setter and resetting units, means for moving said table to and from the bed of a bowling alley to set and reset bowling pins thereon, pin handling devices for placing bowling pins in said setter units on said table, driving means including a main cam shaft, said main cam shaft having cams for actuating said means and said bowling pin handling devices, electro-magnetically operated mechanism for controlling the operation of said table for respotting pins standing on said bed after the first ball of a frame is rolled, electro-magnetically operated mechanism for controlling the operation of said table to place a new set of pins on said alley bed after the last ball of a frame is thrown or a strike is made, said mechanisms including a timing cam shaft, a strike control timing cam on said timing shaft, a table movement control cam on said timing shaft, means for rotating said timing cam shaft after each ball of a frame is rolled in timed relation with the rotation of said main cam shaft, selectively operated sets of contacts operated by said cams, a selective control circuit operatively connecting said control mechanisms, a switch connected to one of each of said contacts of said sets of selected contacts, and an actuating device operative when a strike is made

by the first ball of a frame for actuating said switches to break the circuit through said first-named contacts of said sets of contacts, and establish a circuit through said switches and other contacts of said sets of contacts, and means operated thereby for actuating said second-named mechanism to control the operation of said machine, and effect the delivery of a new set of pins to said alley bed.

5. In a bowling pin setting machine having a pin setting and resetting table, and means for moving said table to and from said alley to set and reset pins in playing position thereon, electrically operated control mechanism for controlling the operations of said machine after the first ball of a frame is thrown if any pins remain standing on said alley, electrically operated control mechanism for controlling the operation of said machine to set a new set of pins on said alley after the last ball of a frame is thrown, and electrically operated strike control mechanism including detecting means operative in response to the absence of pins on said alley after the rolling of the first ball of a frame for transferring the operation from said first-named mechanism to said second-named mechanism in response to the occurrence of a strike when the first ball of a frame is rolled, said first and second-named control mechanisms comprising a timing cam shaft, a timing cam on said shaft, means for driving said shaft through a predetermined amount of rotation after each ball of a frame is rolled, and contacts closed by said cam and coacting with said detecting means for energizing said strike control mechanism to actuate said second-named control mechanism to effect the delivery of a new set of pins to said alley by said table.

6. In a bowling pin setting machine having a pin setting and resetting table, pin setters, and pin resetters mounted on said table, suction conduits connecting said setters and said resetters, an electro-magnetically operated valve in each of said conduits, means for lowering and raising said table after each ball is thrown, selective electrically operated means for energizing one or both of said valves to create suction in said conduits for holding pins in said setters and resetters, said means comprising a timing cam shaft, a circuit connecting said valve operating means, switches in said circuit, circuit closing cams on said shaft, including a setting valve operating cam and a resetting valve operating cam, and means for driving said shaft to rotate said cams to close said switches, control contacts coacting with said switches, means operative in response to the presence or absence of standing pins on an alley after the first ball of a frame is rolled, and operative in response to the last ball of a frame rolled for closing said contacts and for selectively closing the circuit to a selected valve or valves to operate said valves singly or simultaneously.

7. In a bowling pin setting machine for use with a bowling alley having a pit at one end thereof, said machine having mechanism for setting and resetting pins on said alley, a machine starting device in said pit, including a switch, a circuit into which said switch is connected, a pin storage, means for removing pins from said pit and delivering the same to said storage, and means for returning balls to a player; electrically operated control mechanism for controlling the operation of said machine after the first ball of a frame is thrown if any pins remain standing, to respot said standing pins pending throwing of the next ball of the same frame, selectively electrically operated control mechanism for effecting the delivery of a set of pins from said storage to said setting mechanism after the first ball of a frame is rolled, electrically operated control mechanism for controlling the operation of said machine to set a new set of pins on said alley after the last ball of a frame is rolled, electrically operated strike control mechanism for substantially instantaneously transferring the operation from said first-named mechanism to said second-named mechanism if a strike is made by the first ball of a frame, said control mechanisms being connected into said circuit, a timing shaft, means for driving said shaft during each cycle of operation of said machine to actuate said control mechanisms, a clutch, a shaft driven from said clutch, and means operated by the closing of said switch in said pit upon the arrival of a ball therein to actuate said clutch and start said machine.

8. In an automatic bowling pin setting machine having a pin setting and resetting table and means for moving said table to and from the playing bed of an alley to set and reset pins thereon after a ball is thrown, electrically operated control mechanism controlling the operation of said machine if less than ten pins are knocked down by the first ball of a frame, electrically operated mechanism for controlling the operation of said machine after the second ball is thrown for spotting a new set of pins on said alley bed, and electrically operated strike control mechanism including an alternating relay having a selectively operated coil and an actuating member, means operative in response to the occurrence of a strike for energizing said coil to move said actuating member for transferring the operation of said machine from said first-named mechanism to said last-named mechanism, and effecting the delivery of a new set of pins to said alley by said table if a strike is made on the first ball of a frame, and means for maintaining said coil deenergized until a strike is again made.

9. In a bowling pin setting machine having a pin setting and resetting table, and means for moving said table to and from said alley to set and reset pins in playing position thereon, automatically actuated electrically operated control mechanism for controlling the operations of said machine after the first ball of a frame is thrown if any pins remain standing on said alley, automatically actuated electrically operated control mechanism for controlling the operation of said machine to set a new set of pins on said alley after the last ball of a frame is thrown, automatically actuated electrically operated strike control mechanism for transferring the operation from said first-named mechanism to said second-named mechanism in response to the occurrence of a strike on the first ball of a frame, foul control mechanism, means for operating said foul control mechanism, and means actuated by said last-named means for operating said strike control mechanism to effect the delivery of a new set of pins to said alley in response to the occurrence of a foul when the first ball of a frame is thrown.

10. In a bowling pin setting machine having a pin setting and resetting table, and means for moving said table to and from said alley to set and reset pins in playing position thereon, automatically actuated electrically operated control mechanism for controlling the operations of

said machine after the first ball of a frame is thrown if any pins remain standing on said alley, automatically actuated electrically operated control mechanism for controlling the operation of said machine to set a new set of pins on said alley after the last ball of a frame is thrown, automatically actuated electrically operated strike control mechanism for substantially instantaneously transferring the operation from said first-named mechanism to said second-named mechanism if a strike is made by the first ball of a frame, foul control mechanism, a device for operating said foul control mechanism, means actuated by said device for operating said strike control mechanism to effect the delivery of a new set of pins to said alley if a foul is made when the first ball of a frame is thrown, and means operatively connected to said device and actuated thereby, for signalling to a player that a foul has been made.

11. In a bowling pin setting machine for use with a bowling alley having mechanism for removing fallen pins from said alley after the first ball of a frame is rolled, mechanism for removing all fallen and standing pins from said alley after the last ball of a frame is rolled, means for returning balls to a player, a device for placing pins in playing arrangement on said alley pending the rolling of the first ball of a frame, a respotting device for respotting pins on said alley bed pending rolling of the second ball of a frame, electrically operated control mechanism for controlling the operation of said machine after the first ball of a frame is rolled if any pins remain standing on said alley to actuate said respotter device, electrically operated control mechanism for controlling the operation of said machine to actuate said first-named device to place a new set of pins on said alley after the last ball of a frame is rolled, electrically operated strike control mechanism for substantially instantaneously transferring the operation of said machine from said first-named control mechanism to said second-named control mechanism to actuate said first-named device if a strike is made by the first ball of a frame for effecting the delivery of a new set of pins by said device to said alley pending the throwing of the first ball of the next frame, and means for operating said strike control mechanism to actuate said first-named device if a foul is made when the first ball of a frame is rolled regardless of the number of pins remaining standing on said alley to cause said device to set a new set of pins on said alley pending the rolling of the second ball of the same frame.

12. In a bowling pin setting machine for use with a bowling alley having mechanism for removing fallen pins from said alley after the first ball of a frame is rolled, mechanism for removing all fallen and standing pins from said alley after the last ball of a frame is rolled, means for returning balls to a player, a device for placing pins in playing arrangement on said alley pending the rolling of the first ball of a frame, electrically operated control mechanism for controlling the operation of said machine after the first ball of a frame is rolled if any pins remain standing on said alley for respotting said standing pins on said alley, electrically operated control mechanism for controlling the operation of said machine to place a new set of pins on said alley after the last ball of a frame is rolled, automatic shifting means for said control mechanism, electrically operated strike control mechanism operated by said shifting means for substantially instantaneously transferring the operation of said machine from said first-named control mechanism to said second-named control mechanism if a strike is made by the first ball of a frame for effecting the delivery of a new set of pins by said device to said alley pending the throwing of the first ball of the next frame, means actuated by said shifting means for operating said strike control mechanism if a foul is made when the first ball of a frame is rolled regardless of the number of pins remaining standing on said alley to cause said device to set a new set of pins on said alley pending the rolling of the second ball of the same frame, and means for causing said strike control mechanism to operate a second time prior to the operation of said machine subsequent to the rolling of the second ball of the same frame.

13. In a bowling pin setting machine for use with a bowling alley having mechanism for removing fallen pins from said alley after the first ball of a frame is rolled, mechanism for removing all fallen and standing pins from said alley after the last ball of a frame is rolled, means for returning balls to a player, and a device for placing pins in playing arrangement on said alley pending the rolling of the first ball of a frame; electrically operated control mechanism for controlling the operation of said machine after the first ball of a frame is rolled if any pins remain standing on said alley for respotting said standing pins on said alley, electrically operated control mechanism for controlling the operation of said machine to place a new set of pins on said alley after the last ball of a frame is rolled, automatic shifting means for said control mechanism, electrically operated strike control mechanism for substantially instantaneously transferring the operation of said machine from said first-named control mechanism to said second-named control mechanism if a strike is made by the first ball of a frame for effecting the delivery of a new set of pins by said device to said alley pending the throwing of the first ball of the next frame, means actuated by said shifting means for operating said strike control mechanism if a foul is made when the first ball of a frame is rolled regardless of the number of pins remaining standing on said alley to cause said device to set a new set of pins on said alley pending the rolling of the second ball of the same frame, means for causing said strike control mechanism to operate a second time prior to the operation of said machine subsequent to the rolling of the second ball of the same frame, an annunciator, an electric circuit operatively connecting said annunciator with said electrically operated control mechanisms, a plurality of signals on said annunciator connected in said circuit and normally designating the pins remaining standing after each ball of a frame is thrown, and automatically actuated means for interrupting said circuit and preventing the operation of said signals whenever a foul is made when any ball of a frame is rolled.

14. In an automatic bowling pin setting machine having a movable table supporting pin setter and resetting units, means for moving said table to and from the bed of a bowling alley to set and reset pins thereon, pin handling devices for placing pins in said setter units on said table, a sweep for removing fallen and unwanted standing pins from said alley bed, electro-magnetically operated mechanism for controlling the

operation of said table and devices in conformity with the number of pins knocked down by the first ball of a frame, electro-magnetically operated mechanism for controlling the operation of said table and devices after the second ball of a frame is thrown, and mechanism for stopping said machine whenever an abnormally off-spot pin prevents downward movement of said table towards said bed, said mechanism including an electric control device, automatically actuated means for operating said device after the first ball only of a frame is rolled, a driving clutch disengaged by the actuation of said device to stop said machine, and means controlled by said device for selectively incapacitating said sweep.

15. In an automatic bowling pin setting machine having a movable table supporting pin setter and resetting units, means for moving said table to and from the bed of a bowling alley to set and reset pins thereon, pin handling devices for placing pins in said setter units on said table, a sweep for removing fallen and unwanted standing pins from said alley bed, electro-magnetically operated mechanism for controlling the operation of said table and devices in conformity with the number of pins knocked down by the first ball of a frame, electromagnetically operated mechanism for controlling the operation of said table and devices after the second ball of a frame is thrown, mechanism for stopping said machine whenever an abnormally off-spot pin prevents downward movement of said table towards said bed, said mechanism including an electric control device, automatically actuated means for operating said device after the first ball only of a frame is rolled, a driving clutch disengaged by the actuation of said device to stop said machine, means controlled by said device for selectively incapacitating said sweep, and manual means for restarting said machine in its normal cycle of operations pending delivery of the next ball of the frame.

16. In a bowling pin setting machine, mechanism for setting and resetting pins in playing positions on a bowling alley, electrically operated control mechanism for controlling the operations of said machine after the first ball of a frame is thrown if any pins remain standing on said alley, electrically operated control mechanism for controlling the operation of said machine to set a new set of pins on said alley after the last ball of a frame is thrown, electrically operated strike control mechanism for transferring the operation from said first-named mechanism to said second-named mechanism if a strike is made by the first ball of a frame, foul control mechanism, means operated by said foul control mechanism for actuating said strike control mechanism to effect the delivery of a new set of pins to said alley if a foul is made when any ball of a frame is thrown, a device operatively connected with said foul mechanism for counting the number of times ten pins are placed on said alley, and means operatively connected with said foul control mechanism for incapacitating said device in response to the occurrence of a foul when any ball but the last ball of a frame is thrown.

17. In an automatic bowling pin setting machine for use with a bowling alley provided with a pin supporting playing bed, means for removing fallen pins from said alley after the first ball of a frame is thrown and for removing all fallen and standing pins from said alley after the second ball of a frame is thrown, means for returning the ball to the player, mechanism for placing a set of pins on said bed after the second ball of a frame is rolled and after the occurrence of a strike pending the throwing of the first ball of the next frame, mechanism for respotting any pins standing on said bed after the first ball of a frame is rolled pending the rolling of the second ball of the same frame, electromagnetically operated devices for starting and stopping the operation of said mechanisms and means, including an operating circuit, two identical sets of cam operated contacts and cams for controlling said devices, each set of contacts and cams being operative to afford the proper sequential operation of said mechanisms and means for alternate first and second ball cycles of said machine, said two sets of contacts being offset one ball-cycle in timing relation to each other, a multiple-pole double-throw switch for disconnecting one set of contacts, and connecting the other set of contacts in said circuit for controlling said devices, and automatically operated means for throwing said switch once for each strike rolled.

18. In an automatic bowling pin setting machine for use with a bowling alley provided with a pin supporting playing bed, means for removing fallen pins from said alley after the first ball of a frame is thrown and for removing all fallen and standing pins from said alley after the second ball of a frame is thrown, means for returning the ball to the player, mechanism for placing a set of pins on said bed after the second ball of a frame is rolled and after the occurrence of a strike pending the throwing of the first ball of a frame, mechanism for respotting any pins standing on said bed after the first ball of a frame is rolled pending the rolling of the second ball of the same frame, electromagnetically operated devices for selectively starting and stopping the operation of each of said mechanisms and means, including an operating circuit, two sets of cam operated contacts and associated contact operating cams for controlling the operation of said devices, a multi-pole double-throw switch for disconnecting one set of said contacts and connecting the other of said sets of contacts in said circuit, and automatically operated means for actuating said switch in response to the occurrence of a strike or a first ball foul.

19. The invention defined in claim 18 including a main cam shaft, a cam shaft for said contact operating cams, and means for driving said last-named cam shaft in timed relation with said main cam shaft.

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