June 16, 1959 R. E. DUMAS 2,890,886

BOWLING PIN SPOTTING MACHINE CONTROL MECHANISM

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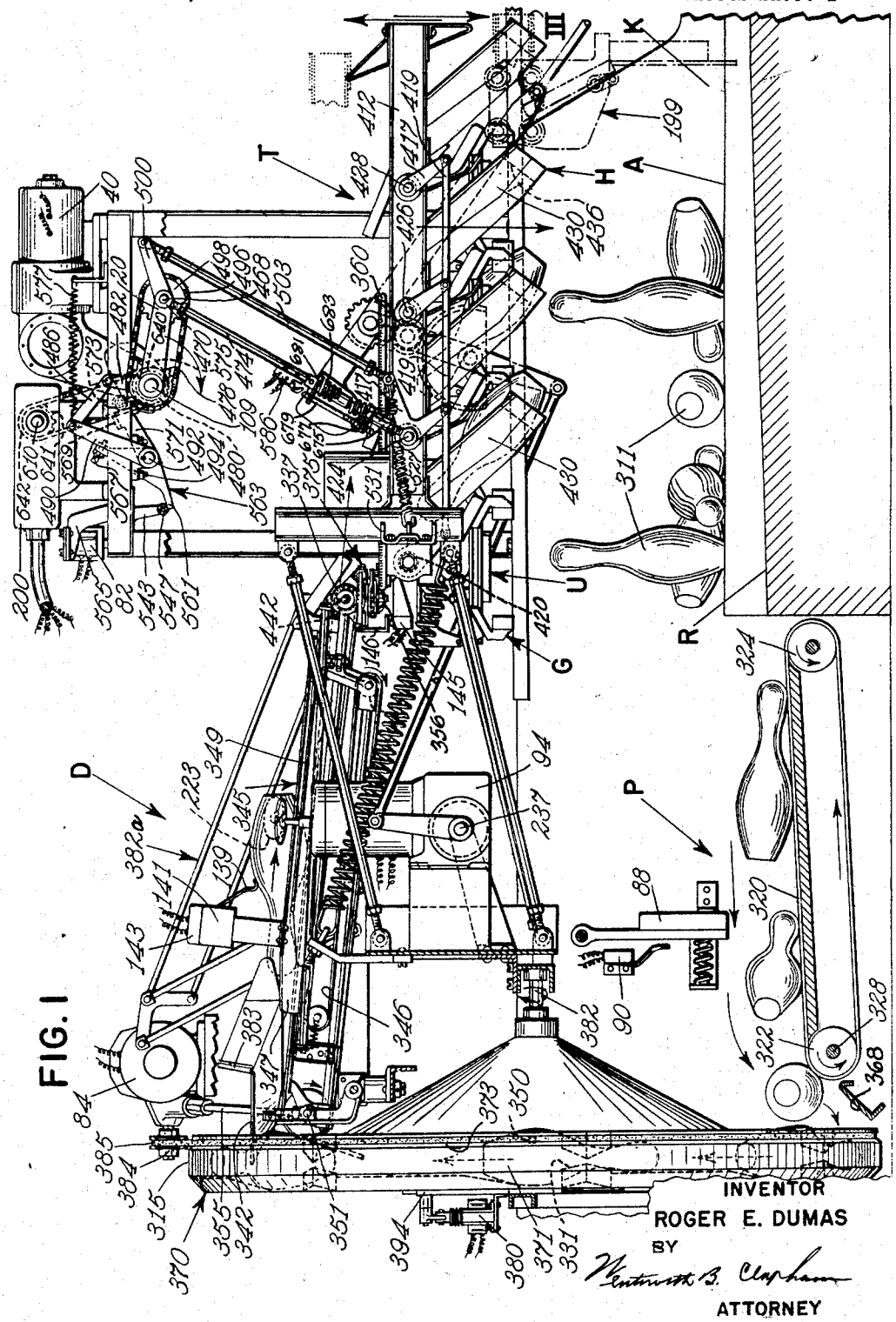


FIG. 1

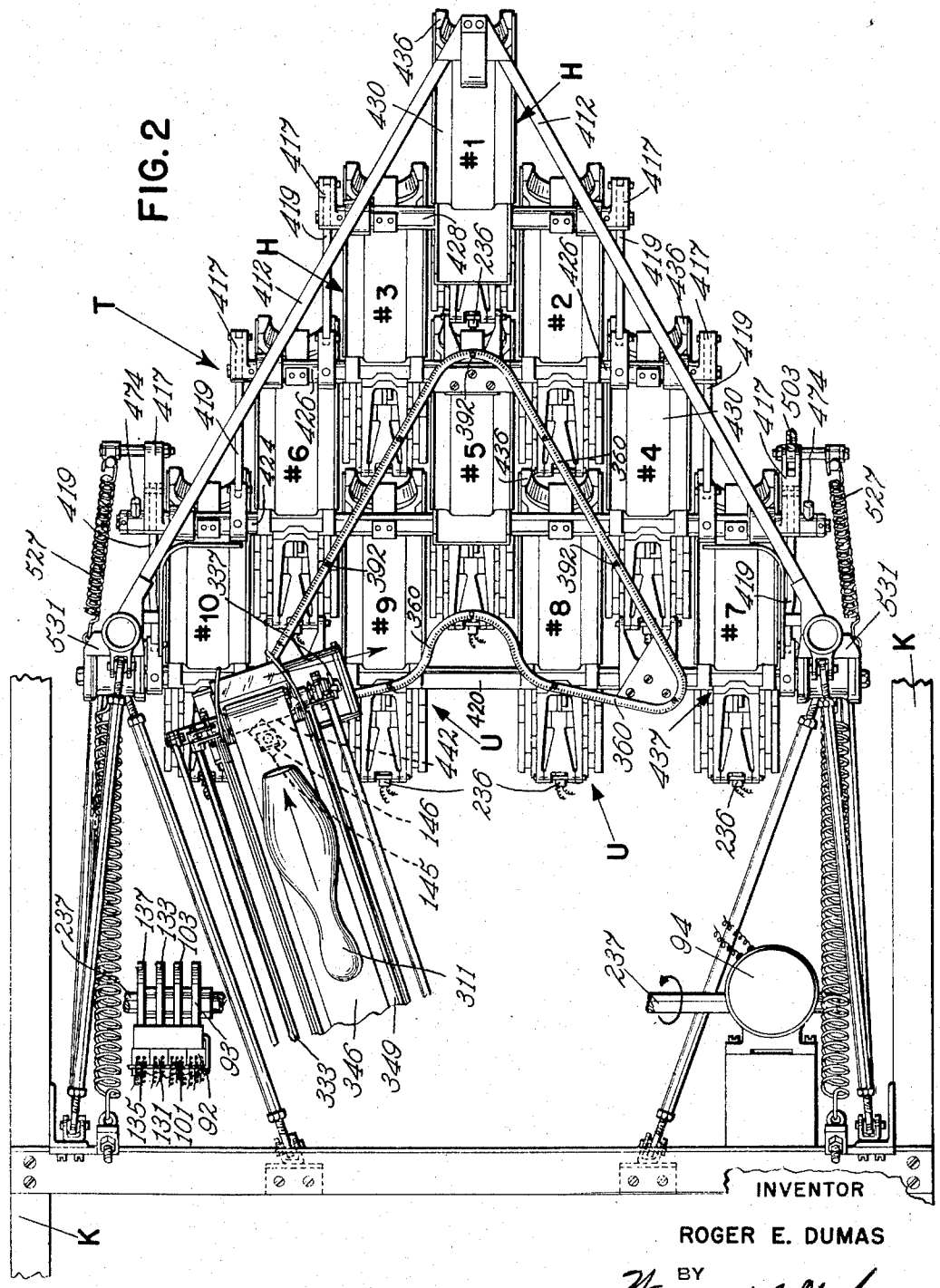
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BOWLING PIN SPOTTING MACHINE CONTROL MECHANISM

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FIG. 2



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BOWLING PIN SPOTTING MACHINE CONTROL MECHANISM

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FIG. 10

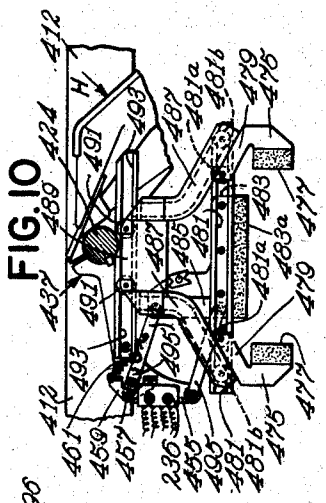


FIG. 3

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BOWLING PIN SPOTTING MACHINE CONTROL MECHANISM

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FIG. 5

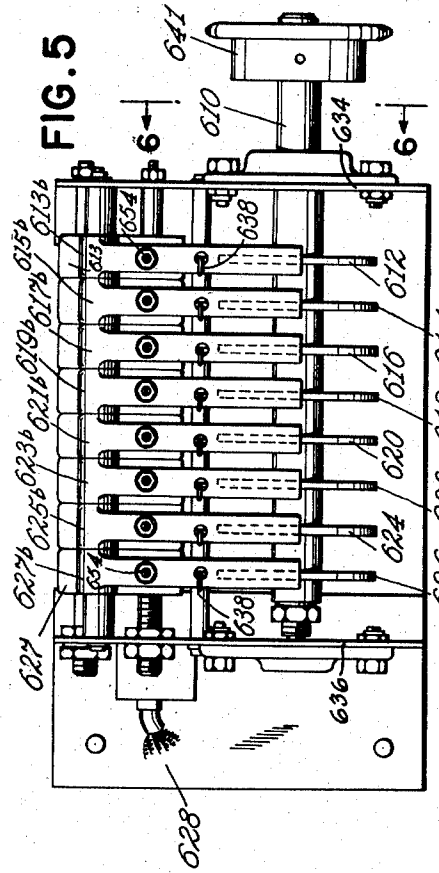


FIG. 6

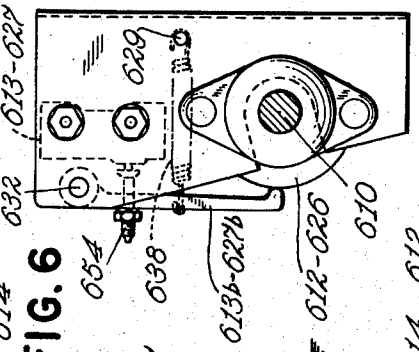


FIG. 7

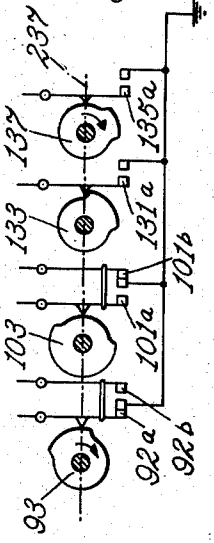


FIG. 8

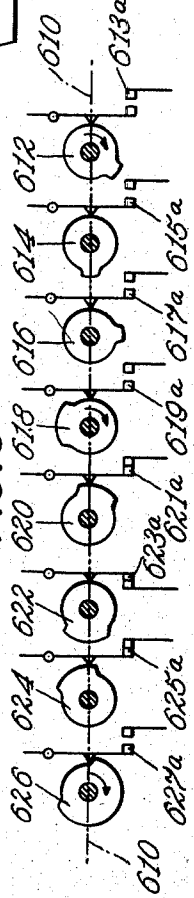


FIG. 4

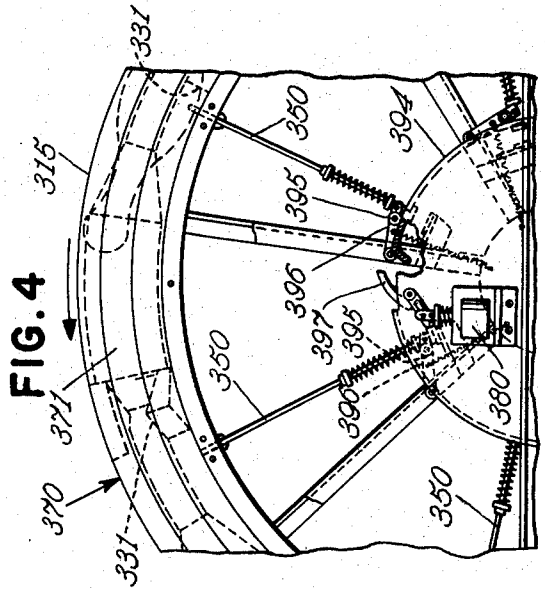
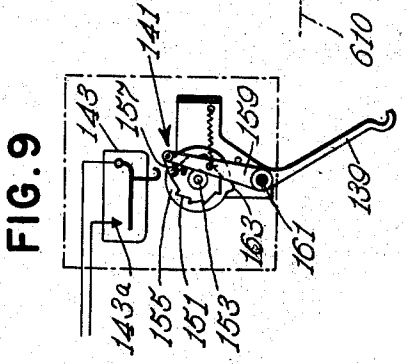


FIG. 9



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2,890,886

BOWLING PIN SPOTTING MACHINE CONTROL MECHANISM

Roger E. Dumas, Snyder, N.Y., assignor to American Machine & Foundry Company, a corporation of New Jersey

Application February 24, 1954, Serial No. 412,187

11 Claims. (Cl. 273—43)

This invention relates to bowling pin spotting machines, and more particularly to bowling pin spotting machines for automatically spotting and respotting bowling pins upon the playing bed of a bowling alley, and to an improved control system for controlling the automatic and sequential operation of the coacting mechanisms of an automatic bowling pin spotting machine under all conditions of play.

In accordance with the invention, my improved apparatus consists in a bowling pin spotting machine having apparatus for removing pins from the pit of a bowling alley and delivering them to a distributor which in turn conveys them in succession to a pin spotting device wherein pins are held in substantially triangular arrangement for placement on the playing bed of an alley. The machine also includes a sweep device having its operation controlled in such manner that it is actuated at proper times during the play of the game to sweep deadwood and unwanted pins from the alley into the pit for delivery to the apparatus mentioned above. The machine also includes devices for lifting and respotting pins standing upon an alley in the position each occupied before being lifted after the rolling of the first ball of a frame, in order that the sweep device may remove deadwood or fallen pins, after which the lifted pins are respotted in the position each occupied prior to being lifted above the alley pending further play.

In accordance with the invention, there is provided an improved automatic control apparatus for operating the bowling pin spotting machine of which it forms a part under all conditions of play such that pins are spotted and respotted for frame to frame play as the game proceeds. The invention includes an electrical control apparatus having mechanisms associated therewith which selectively operate the several interconnected units of the machine in order to feed pins from the elevating mechanism to the distributor and the pin spotting units. The invention also includes selectively actuated control mechanism for effecting the proper spotting and respotting of pins in a normal two ball frame, or after a spare is made, and after a strike is made, thereby causing the pin setting device to place a new set of pins on the alley bed pending the throwing of the first ball of the next frame, and also to cause the spotting mechanism to place a new set of pins on the alley if a foul is made on the first ball.

In accordance with the invention, there is provided a machine cycling system which uses a program control having means for effecting one normal first ball and two normal second ball cycles. For normal play, the first occurring second ball cycle is by-passed or skipped. If a foul is made or occurs on the rolling of the first ball, the first ball cycle is by-passed and two second ball cycles are executed in succession. If a strike is made, only the last second ball cycle is executed. This arrangement of cycles permits all possible combinations of cycles occurring in a tenpin bowling game to be handled by one control element, i.e. a multi-position switching relay.

Thus my novel control system is simple in construction, efficient and rapid in operation.

It is an object of the invention to provide a novel control mechanism for a bowling pin spotting machine having a multi-position switching relay which effects the non-repetitive sequences of the basic operating cycles required for playing the game.

The invention consists in the provision of a bowling pin spotting machine having a novel control system which allows a repetitive type of control mechanism to be used in a non-repetitive sequence of four basic cycles required in the playing of the game.

The invention also consists in a novel control system for a bowling pin spotting machine wherein stoppage of the machine because of power failure does not affect the phase or cycle of operation of the machine, or any cycle thereof because of the provision of novel control mechanism which makes possible the resumption of operation of the machine in its correct cycle when power is restored.

The invention also consists in a bowling pin spotting machine having novel control mechanism which enables the machine to operate under all conditions of play in accordance with a built-in program system.

A further object of the invention is the provision of means for preventing damage to the machine, and especially the pin respotting units thereof in the event that pins have moved too far off-spot, or parts of the respotting units are not properly positioned at the beginning of a respotting cycle.

A further object of the invention is the provision of a stepper relay which permits one manually controlled switch in the operating circuit to reset the machine ready for a first ball condition. This is effected by the provision of one set of contacts which when closed, causes a self-cycling of the machine to a condition ready for a first ball of a frame.

The invention also consists in a novel control mechanism provided with a master control element which makes possible the reduction in the number of control cams on the shaft which operates the pin spotter-respotter table, since only one electromagnetically operated unit is required to be energized in order to obtain successive specific arrangements of controls in the control mechanism, and each energization of the electromagnetically operated unit makes available a new and distinct contact for the next energization of the master control unit because the master control unit provides its own switching for its control circuit.

The invention also consists in a novel bowling pin spotting machine control system having a stepper relay which simplifies and reduces the number of circuit arrangements necessary to prevent multiple paths to the controlling magnet thereof, which reduces the number of contacts necessary in the circuit to other elements of the control system to a minimum in order to effect the required non-repetitive sequences of the four basic cycles required in playing the game in accordance with rules of play.

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

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

Fig. 1 is a side elevation of a bowling pin spotting machine provided with a preferred embodiment of the invention;

Fig. 2 is a plan view illustrating the spotting and respotting mechanisms of the machine;

Fig. 3 is a wiring diagram illustrating the preferred form of the electrical control system in accordance with the invention;

Fig. 4 is a fragmentary rear view of the pin elevating mechanism control;

Fig. 5 is a plan view of the cam switch unit of the control mechanism;

Fig. 6 is a view taken on line 6—6 in Fig. 5;

Fig. 7 is a schematic view of the several cams which are operative in response to the rotation of the sweep operating shaft;

Fig. 8 is a schematic view of the several cams shown in the switch-cam unit in Fig. 5;

Fig. 9 is a view showing a detail of the control mechanism; and

Fig. 10 is a side elevation of a respotting unit showing an electrical control element associated therewith.

In the embodiment of the invention illustrated herein, the improved control mechanism is associated with and forms an operative part of a bowling pin spotting machine provided with mechanisms for removing or elevating pins from the pit of a bowling alley, and delivering them in succession to a distributor associated therewith from which pins are delivered in succession and conveyed one by one to a pin spotting device having means for supporting and spotting pins and also for respotting pins during the course of play, when such is desired.

The mechanism illustrated for removing pins from the pit of a bowling alley is similar in construction and operation to that disclosed in Holloway et al. Patent 2,767,983, issued October 23, 1956 for Bowling Pin Elevating Mechanism. Pins delivered by the device which removes or elevates them from the pit of the alley are discharged therefrom into a distributing device operatively associated therewith, and which may be similar in construction and operation to that disclosed and described in Zuercher Patent 2,767,984, issued October 23, 1956 for Pin Distributing and Spotting Mechanism for Bowling Pin Spotting Machines. Operatively associated with the distributing mechanism is a bowling pin spotting and respotting device, which may be similar in constructon and operation to that illustrated and described in Robert L. Holloway et al. Patent 2,781,195, issued February 12, 1957 for Bowling Pin Spotting and Respotting Mechanism. These mechanisms which form coacting and selectively actuated parts of the bowling pin spotting machine with which the control mechanism of the invention is operatively connected, are controlled thereby in such manner that all sequential and cyclical operations of the machine are carried out automatically in proper timed order, in spotting and respotting pins upon the playing bed of a bowling alley during the entire course of play of a game, after each normal two ball frame, or after a strike, or when a foul is rolled. The present invention contributes an improvement to that shown in my Patent 2,821,395 for Control Mechanism for Bowling Pin Spotting Machine, issued January 28, 1958 and represents a simpler, more accurate and more easily maintained mechanism for effecting automatically all of the operations necessary to the automatic setting of pins in accordance with prescribed playing rules.

While reference is made to the above referred to patents, the present invention may be used with other types of bowling pin spotting machines with which it is adaptable, and therefore it is not to be considered as limited in use with the structures shown in the above referred to patents.

As shown in Figure 1, bowling pins **311** struck by a ball, fall from or are removed from alley A and gutters R by means of a sweep and guard designated generally **199**. The mechanism for actuating sweep and guard **199** is operated after each ball is rolled by a bowler. After the last ball of a frame is rolled, all pins either standing or fallen, are swept into pit P.

In the illustrated embodiment, pins falling from alley A or delivered into pit P, drop onto a conveyor or travelling apron, designated generally **320**, similar in construction and operation to that disclosed in Holloway et al. Patent 2,767,983, issued October 23, 1956, and my Patent 2,821,395. This conveyor is pit wide, and is continually in motion, whereby pins are moved out of pit P beneath cushion **88** and delivered to pin elevating mechanism **370** described more in detail hereinafter.

Conveyor **320** runs upon driving and driven pulleys **322** and **324** respectively, mounted at the front and rear of pit P, as shown in Fig. 1. Pulley **322** is mounted on shaft **328** provided at one end with a sprocket (not shown), tracked by a sprocket chain (not shown), which runs on a sprocket (not shown) secured to a continuously driven drive shaft (not shown) operated by motor **84**. Bowling balls dropping upon conveyor **320** roll and are carried downwardly by conveyor **320** to one corner of pit P for delivery therefrom by suitable ball lifting mechanism (not shown) onto a return runway of conventional design (not shown) for return to a bowler. Since the ball return mechanism forms no part of this invention, further description and showing thereof are omitted in the interest of brevity.

Pins **311** are delivered from conveyor **320** by a guide chute **368** and side guides (not shown) into pockets **331** formed in and spaced equidistantly along a flange or channel **315** forming the rim of rotary disc **371** of mechanism **370**. Disc **371** is mounted for rotation on a horizontal shaft **382**, and in the illustrated embodiment is continuously driven by pulley **384** and belt **385** by motor **84**. Belt **385** tracks a pulley **373** formed integrally in the rim of disc **371**. The speed of rotation of disc **371** is such that pins **311** are not hurled or thrown about in channel **315** while being seated in pockets **331** for delivery from pit P upwardly to a position substantially directly thereabove where each pin is discharged into pin receiving and aligning device **342** of distributor D.

In the illustrated embodiment, disc **371** is provided with seven pin holding and conveying pockets, and is constructed and operated in the same general manner as the mechanism shown and described in Holloway et al. Patent 2,767,983, issued October 23, 1956. Therefore further showing and description are deemed unnecessary herein because this mechanism does not form a specific part of the invention.

Each pin after being seated in a pocket **331**, is held therein by a gripper rod **350** mounted for radial movement into and out of engagement therewith. A stationary cam **394** of suitable shape mounted on the frame of the machine is tracked by a cam follower **395** on a lever **396** connected to each rod **350**. Hence, as disc **371** rotates, rods **350** are moved into engagement with pins in pockets **331** and are held in engagement with pins seated therein until the latter are to be disengaged therefrom to effect their discharge into device **342**. In this manner, all pins received in pit P are elevated by mechanism **370** and delivered thereby in succession to distributor D. The specific details of construction and operation of pin elevating mechanism **370** do not form a part of this invention, and the description herein has therefore been limited to only as much as is considered necessary to an understanding of its operation. Reference is made to Holloway et al. Patent 2,767,983, issued October 23, 1956, for a complete disclosure.

Distributor D, which includes an elongated telescopic generally U-shaped chute or channel **345**, is mounted for lateral movement back and forth across the machine, and also for vertical movement. This arrangement makes it possible to deliver pins **311** in succession from pin elevating mechanism **370** selectively into spotters H on table T not only when table T is stationary, but also as it is moving to and from alley A.

Each pin **311** discharged from a pocket **331** in disc **371** rolls or drops into receiving and aligning device **342**, which extends partly into channel **315**. Each pin aligned

by engagement with one of two spaced upstanding pins 383 located at opposite sides of device 342, is conveyed by continuously driven conveyor belt 346 through chute 345 and discharged from part 349 thereof into a spotter H in table T for subsequent placement on alley A. Pin-spotters H are mounted in substantially triangular arrangement on table T, a pattern conforming with the conventional arrangement of pins on a bowling alley.

As each pin is fed by belt 346 through channel member 345, it passes beneath a trip arm 139 which actuates a counting device 141. After ten pins have actuated trip arm 139, a switch 143 in counter 141 is closed which de-energizes solenoid 380. Solenoid 380 is connected to a movable gate portion 397 of cam 394, and when solenoid 380 is de-energized, this gate portion of cam 394 is closed and clamping rods 350 remain in engagement with pins in pockets 331, and pins are not delivered therefrom into receiving and aligning device 342. On the other hand, until ten pins have actuated trip arm 139, switch 143 remains open (see Figs. 3 and 9). The movable gate portion 397 of cam 394 also is open and clamping rods are disengaged from pins in pockets 331 which, at the point of discharge relative to device 342, drop or roll into receiving and aligning device 342 and are delivered thereby onto belt 346. The construction and operation of cam 394 and its movable gate portion 397 are substantially the same as that shown and described in Zuercher Patent 2,767,984, issued October 23, 1956, and my Patent 2,821,395, above referred to, and a detailed description is not deemed necessary herein.

During the course of operation of distributor D, the latter moves both laterally, and vertically and longitudinally as described hereinbefore, until at #10 position, see Figure 2, an arm 146 mounted on the distributor engages and operates a switch 145 supported by a bracket attached to track 360 on table T. The operation of switch 145 is described more in detail hereinafter in the description of Figure 3.

The front end of distributor D, which includes telescopically movable chute 349, is supported and guided by means of an intermittently operated driving mechanism designated generally 375, which is similar in construction and operation to that shown and described in Zuercher Patent 2,767,984, issued October 23, 1956, referred to above. This mechanism includes a bevelled disc 356, and a guide roller (not shown) which engage opposite sides of track 360, suitably attached to table T. As shown in Figure 2, track 360 is generally heart shaped and is provided with ten stop pins 392, one of which is located adjacent each spotter H. These stop pins interrupt the movement of distributor D for delivery of a pin into each empty spotter H, and also insure that the discharge end of distributor D is positioned properly for delivery of a pin therefrom. Track 360 is provided with teeth with which engage complementary teeth on disc 356 such that when the latter is rotated, the distributor D is moved laterally and extended longitudinally as disc 356 moves stepwise along track 360.

As shown and described in the above referred to Zuercher patent, bevelled disc 356 is driven intermittently as the result of the engagement of a bowling pin 311 on belt 346 with a trip 223 secured to the shaft 333 (Fig. 2). When shaft 333 is rocked, a clutch 337 operatively connected to the shaft of pulley 442, is thrown in, and bevelled disc 356 is rotated. This movement of disc 356 travels the discharge end of distributor D to the next empty spotter H for delivery of a pin thereto when the stop pin adjacent this spotter causes the clutch to be thrown out, and further movement of distributor D stops until trip 223 is again actuated.

When each of the spotters H contains a pin, further movement of distributor D is arrested until it is again necessary to feed pins to spotters H. Conveyor belt 346, the upper lap of which travels in guide chutes 347 and 349, runs on suitable driving and driven pulleys. These pulleys are supported in such manner that the pin carrying lap in chutes 347 and 349 is lengthened or shortened in accordance with the longitudinal movement of chute 349 relative to chute 347. Conveyor belt 346 is driven continuously from motor 84 by shaft 355 through conventional driving connections to shaft 351. Since the specific details of the mechanism for operating distributor D do not form a part of the present invention, and are fully shown and described in the above referred to Zuercher patent, there has been described hereinabove only so much as is deemed necessary for an understanding of its coaction with pin elevating mechanism 370 and its delivery of pins to spotters H.

Since the distributor is designed to deliver pins to spotters H not only when table T is stationary, but also when it is moving, there is provided a parallelogram system which may be similar in construction and operation to that shown and described in the above referred to Zuercher patent, and my patent. This mechanism is designated 382*a* and maintains the discharge end of the distributor, or that part which supports bevelled disc or driving member 356 in a substantially horizontal position at all times although chutes 347 and 349 comprising channel 345 may be in upwardly or downwardly inclined position.

Table T, which is supported in a suitable frame mounted on alley kickbacks K, is moved in a controlled and selective manner to and from alley A whenever pins are to be spotted or respotted thereon. As shown, table T is generally triangular in form and supports ten triangularly arranged spotters H, and ten complementary respotter units U. It is so mounted and stabilized that it is maintained in a substantially horizontal parallel relationship with alley A at all times. The construction of table T, and its operating support means, may be substantially the same as shown and described in the above referred to Zuercher patent, and my Patent 2,281,395. Further detailed description is therefore omitted in the interest of brevity.

Table T is moved to and from alley A by means of motor 40 which is selectively operated in order to spot and respot pins on the alley as the play of the game proceeds from frame to frame. After each ball is rolled, sweep 199 is operated in proper timed relation with the movements of table T to sweep deadwood or fallen pins from the alley, or to sweep deadwood and unwanted pins from the alley depending upon which ball of a frame is rolled. The construction and operation of the sweep 199 is substantially the same as that shown and described in my copending application, and since it forms no specific part of the invention, a detailed description herein of the elements of the sweep is deemed unnecessary.

In the operation of the machine, sweep 199, which also operates as a guard mechanism, is set in motion when a ball rolled by the player lands in pit P of the alley and effects the closing of the pit switch 90, the function and connections of which are disclosed in detail in the description of the control circuit described herein. The closing of pit switch 90 effects the starting of sweep motor 94, Figs. 2 and 3, which in turn causes shaft 237 to start rotating in the direction of the arrow shown in Fig. 2, and sweep 199 begins its downward movement, as described in detail hereinafter, into operative guarding and sweeping positions adjacent alley A.

Each cycle of operation of the machine requires one revolution of shaft 237, and in order to properly control the position at which the sweep mechanism must be arrested at the different intervals, shaft 237 carries four electrical control cams 93, 103, 133 and 137 which operate suitable switches and contacts, and form part of the electrical control circuit shown in Fig. 3 and described hereinafter.

Motor 40 is mounted in any suitable manner on a cross member of the machine frame, Fig. 1, and is provided with a conventional type of gear reduction for driving

shaft 109 having a crank arm 20 attached to each end. Each crank arm 20 supports in its free end a stud shaft 468 to which is pivotally attached an eye 470 to which is connected one end of a table supporting rod 474, the other end of which is pivotally connected to shaft 424. When, therefore, motor 40 is set into motion, as described hereinafter, and arms 20 are rotated by shaft 109, arms 20 will cause table T to be lowered and raised with respect to alley A for spotting and respotting pins thereon. The table T raising and lowering mechanism described above imparts a smoothly accelerated and decelerated substantially vertical motion to table T which performs spotting and respotting operations at substantially the same height above alley A.

In table T, the positions occupied by spotters H and respotting units U are indicated generally at #1–#10 inclusive, as shown in Fig. 2. Spotters #7–#10 inclusive and their complementary respotting units U are mounted on shaft 420 supported in side frame members 412. Spotters #4–#6 inclusive, and #2 and #3, and #1 are mounted on shafts 424, 426 and 428, respectively, also supported in side frame members 412 of table T. Each spotter H is suitably attached to a bracket designated generally 437 fixed to its respective support and operating shaft. Shafts 420, 424, 426 and 428 are each provided with crank arms 417, to the free ends of which are secured links 419 such that when shaft 424 is rocked when pins are to be spotted on alley A, all of the spotters H are swung from the inclined pin receiving and supporting position shown in Fig. 1 into substantially vertical pin delivering position and pins will be deposited thereby on alley A when table T is moved by crank arms 20 into lowered or pin spotting position relative to the alley. As shown in Figure 1, loosely mounted adjacent one end of shaft 109 is a sprocket 478 having a hub 480 provided with an upstanding lug 482 to which is pivotally connected one end of a link 486, the other end of which is pivotally connected to lever 490 keyed to stud shaft 492 mounted in bearing bracket 494 attached to the machine frame. Sprocket 478 is tracked by a sprocket chain 496 running on sprocket 498 fixed to shaft 468.

Attached to shaft 468 is a crank arm 500 pivotally connected to one end of connecting rod 503. The other end of rod 503 is connected to one arm of bell crank lever 417 on shaft 424. Springs 527 perform the function of balancing the weight of the several pin spotters H, and assist in returning them to their pin receiving and holding positions, shown in Figure 1, after they have spotted a set of pins on alley A. The ends of springs 527 are attached to brackets 531 on the frame of table T and to arms of bell crank levers 417 on shaft 424, respectively.

The several spotters H are essentially the same in construction, and it is deemed necessary to describe only one. As shown in Figures 1 and 2, a typical spotter H includes an elongated, generally U-shaped trough-like member 430 somewhat greater in length than the length of a pin. Adjacent and attached to the lower or free end of member 430 is a half-ring support 436, which coacts with the walls and bottom of member 430 in guiding and supporting a pin for proper placement on alley A, as spotters H are swung to spotting position adjacent alley A, and then rearwardly therefrom to clear spotted pins due to the movement of crank arms 500 during the movement of table T to and from alley A. Reference is made to Holloway et al. Patent 2,781,195, for a full description and showing of spotters H, and apparatus for operating them.

Each bracket 437 also supports a respotting unit U. There are ten respotting units employed in the mechanism illustrated. Since each is identical in construction and operation, only one is described briefly herein, reference being made to the above referred to Holloway et al. Patent 2,781,195 for a full and complete disclosure. Since the details of construction of respotters U do not constitute a part of the present invention, a complete description herein is deemed unnecessary.

As shown in Figures 1, 2 and 10, each unit U is provided with a pair of grippers designated generally G. Each gripper G includes an elongated gripping member 475 preferably faced with a resilient pin gripping surface 477. Each member 475 is provided at its ends with a pair of upstanding arms 479 on each of which are mounted horizontally spaced rollers 481*a* and 481*b*, each unit comprises a double roller 481*b* and a single roller 481*a*. Rollers 481*a* are adapted to run in substantially horizontal tracks 481 each attached to one end of a substantially vertically movable clamping plate 483 having a resilient pin head clamping surface 483*a*. One of the rollers 481*b* runs in tracks 481, while the other roller 481*b* runs in cam tracks fastened to the carriage 489. Carriage 489 at its ends is provided with rollers 491 running in horizontal tracks 493 attached to bracket 437. Pivotally attached to an upwardly extending flange 485 formed integrally with plate 483 and to bracket 455 forming a part of bracket 437 are a pair of parallel links 495. The action is such that when table T is lowered after the rolling of the first ball of a frame, and any pins are standing on alley A, the heads of such pins will be engaged by surfaces 483*a*. Continued downward movement of table T results in an upward movement of plates 483, and a concurrent inward movement of grippers G to grip on or off-spot standing pins.

As indicated in Figures 3 and 10, when any plate 483 is raised, its respective switch 236 mounted on bracket 455, is operated to break a series circuit connecting the ten switches. One switch 236 is provided for each unit U. For this purpose, one end of each upper link 495 is attached to a shaft 457 to which is pivoted an operating lever 459, which, as plate 483 is moved upwardly relative to grippers 475, opens normally closed switch 236. Grippers 475 are automatically latched in closed gripping relationship by latch mechanism (not shown) and hold a pin for lifting and respotting. When each lifted pin is respotted in its respective on or off-spot position on alley A, the latch mechanism is automatically released, and upon upward movement of table T, such pins are left standing on alley A, pending rolling of the next ball of the frame. A spring 461 attached to lever 459 and to link 495 then returns switch lever 459 to its operative switch closing position.

When bowling pins are to be spotted on alley A, solenoid 82 is energized. This rocks bell-crank lever 543 connected to the armature of solenoid 82 and disengages cam follower 547 from latching engagement with a cam surface formed on lock arm 561 of lock lever 563 keyed to shaft 492. An adjustable set screw (not shown) mounted in bracket 565, which supports bell-crank lever 543, is provided in order to properly position cam follower 547 on arm 561. Lock lever 563 is provided with an adjustable screw 567 adapted to engage a lateral projection 569 on cam lever 571 loosely mounted on shaft 492. Cam lever 571 is provided with a cam follower 573 tracking a cam 575 attached to shaft 109.

A spring 577 having one end attached to lever 490 and its other end attached to a bracket mounted on the frame of the machine, pulls lever 490 to the right, as viewed in Fig. 1, when solenoid 82 is energized. This releases locking lever 563 allowing screw 567 to be pressed against projection 569 so that sprocket 478, attached to lug 482, is rotatably driven by the movement of cam follower 573 of lever 571 on cam 575. Movement of cam 575 with respect to cam follower 573, and the linkage and leverage described hereinabove, results in sprocket 478 being rotated in the direction of the arrow shown in Fig. 1. This results in the rocking of crank arm 500, thereby effecting a turning of shafts 420, 424, 426 and 428, which, when table T is located in position III as indicated in Figure 1, results in the delivery of ten pins in spotted arrangement on alley A.

The control mechanism selected for purposes of illustration, employed with the coacting pin handling and spotting and respotting mechanisms described hereinabove, may be termed a three cycle system, wherein there are provided three revolutions of table crank arms **20** or three down and up trips of table T for each normal frame consisting of a first ball or respot operation, and a second ball or spotting operation. Each of these operations (ball cycles) requires one complete cycle of operation of sweep **199** which removes deadwood and unwanted pins from alley A.

There are four basic types of machine cycles generated by the electrical control system constructed and operated in accordance with the invention. These are:

I. Normal two ball cycle:
   First ball—Respot operation, two trips of table T to and from alley A—machine resets to second ball.
   Second ball—Spotting operation, one trip of table T to and from alley A—machine resets to first ball.
II. Strike cycle: Mechanical and electrical intelligence notifies machine to spot a new set of pins and reset to first ball—two trips of table T to and from alley A.
III. First ball foul cycle: Spotting operation—one trip of table T to and from alley A—machine resets to second ball and a foul signal actuated.
IV. Second ball foul cycle: Same as a normal second ball operation except that a foul light indicates that a foul has been committed.

Referring to Fig. 3, when switches **522** and **524** are closed, power is supplied to the coil of relay CR1 which closes its contacts CR1*a*, thereby supplying power to the primary winding of transformer **521** energizing the secondary windings **526**, **528** and **530** which supply power to the control mechanism, as described hereinafter.

The closing of contacts CR1*a* also supplies power to pin elevating motor **84** which drives pin elevating mechanism **370** and distributor D. Current from winding **526** is rectified by a suitable conventional type of rectifier **532**, such as a dry selenium type. Rectified current from this power supply flows through normally closed contacts LR–1*a* to the coil of relay PR–1 closing normally open contacts PR–1*a* which supply power to solenoid **380** which opens cam gate **397** and pins are discharged from pin elevating mechanism **370** and forwarded by distributor D to table T. A light **11**, provided for indicating that the machine is ready for a first ball, is illuminated by current from winding **528** flowing through level #3 contact zero of stepper relay **100**.

Stepper relay **100** is used to develop the program required for the several sequences necessary to the types of cycles of operation listed above. A suitable stepper relay, such as shown and described herein, may be one made by Automatic Electric Company, Chicago, Illinois, and designated as type 44, Rotary Stepping Switch. In the stepper relay illustrated, six levels of contacts are used. These levels, see Figure 3, are designated #1–#6, inclusive. Each level is provided with a home or zero contact and ten contacts corresponding to successive positions of the rotary wiper arms **104–114** inclusive. The contacts of each level swept by the respective arms represent 120° of motion of ratchet wheel **116** secured to shaft **102**, to which shaft arms **104–114** are also secured. The contacts of each level, i.e. levels #1–#6, see Fig. 3, are equally spaced along an arc of 120°. Therefore each of the wiper arms **104–114** is provided with three sets of integral contact fingers **104***a, b, c*–**114***a, b, c*, spaced 120° apart, such that in the playing of each frame of the game, a selected finger of each level engages all contacts of its respective level in succession in rotating 120°.

Each level of contacts and its associated wiper arm selectively control the operation of particular parts of the machine. For example, in the illustrated embodiment of the invention, disclosed herein, as follows:

Arm **104** of level #1 and its associated contacts controls the starting of motor **94** and hence the operation of the sweep mechanism which is driven by motor **94**.

Arm **106** of level #2 and arm **112** of level #5 and their respective associated contacts control the operation of the machine corresponding to pinfall resulting from a normal two ball frame, or a strike, and also insure the correct cycling of the machine when a foul is made.

Arm **108** of level #3 and its associated contacts provide means for indicating to the bowler pinfall resulting from each first ball of a frame rolled, and for showing which ball of a frame is to be rolled, and also for indicating the occurrence of a strike.

Arm **110** of level #4 and its associated contacts initiate the operation of the delivery of pins by the pin elevating mechanism to distributor D after table T has spotted a set of pins on alley A.

Arm **114** of level #6 and its associated contacts control the starting of motor **40** which lowers and raises table T.

Stepper relay **100** is provided with a rotary cam **118** fixed to shaft **102** having three lobes **120** spaced 120° apart, adapted to operate a cam switch **123** having a spring arm **124**, which lobes **120** move contact **126** on arm **124** out of engagement with contact **128**. Lobes **120** are in axial alignment with the wiper fingers of arms **104–114** such that contacts **126**, **128** are open whenever the wiper fingers are in engagement with the zero contacts of levels #1–#6. Cam **118** and cam switch **123** serve to stop the action of solenoid **130** when stepper relay **100** is operated in a self-stepping sequence for insuring the engagement of one of the wiping fingers of each wiper arm **104–114** with a zero contact corresponding to the beginning of a bowling frame cycle. Push button switch PB1 is provided for the purpose of starting this self-stopping sequence.

Stepper relay **100** is provided with an interrupter switch **132** having an arm **134** adapted to be engaged by armature **136** of solenoid **130**. When armature **136** engages and moves arm **134** upwardly, as viewed in Fig. 3, it separates normally closed contacts **138**, **140**, breaking the circuit through the coil of solenoid **130**, whereupon spring **142** pulls arm **144** downwardly, and causes pawl **146** to turn ratchet wheel **116**, which is formed with thirty-three teeth, one tooth or an angular distance corresponding with the spacing between contacts on levels #1–#6. Spring **148** maintains pawl **146** in constant engagement with the teeth of ratchet wheel **116**. Stop **150** limits the downward movement of pawl **146**. It will be seen that spring **142** stores a fixed amount of energy for each operation of solenoid **130** and actually produces the rotation of wiper arms **104–114** upon the de-energization of solenoid **130** by exerting a fixed operating force on the ratchet wheel **116** irrespective of variations in the force exerted by solenoid **130** due to changes in voltage or temperature.

As stated hereinabove, each of the stepper relay levels #1–#6 has a zero position contact and ten additional equally spaced contacts aligned in an arc of 120°. For each 120° of rotation the wiper arms, eleven operations of solenoid **130** occur. The eleven actuations of solenoid **130** constitute a frame cycle in the bowling pin spotting machine operations.

Wiper arms **104**, **106** and **108** of levels #1, 2 and 3, respectively, are bridging type wiper arms. In operation, each of these bridging type wipers engages the next adjacent contact of its respective level before moving out of engagement with the contact previously engaged. Wiper arms **110**, **112** and **114** of levels #4, 5 and 6, respectively, are non-bridging wiper arms which disengage completely from one contact before engaging the next. The use of bridging type wiper arms maintains

continuity in a circuit when it is necessary to actuate solenoid **130** during the time that the circuit through one of the wiper arms **104**, **106** or **108** is conducting current to some element of the control circuit such as a relay, other than the coil of solenoid **130**.

The bridging type wiper arm levels #1–3 are furnished with a zero position contact immediately following contact **10** of these levels, which permits the bridging type operation described above to occur between contacts **10** and zero. All of the levels are provided with a fixed contact **15**, located at the zero position at the left of contact **1**, as viewed in Fig. 3. This fixed contact extends radially into the center of the wiper arm and engages the wiper arm continuously. This construction, which functions as a radial slip ring, provides means for continuously maintaining contact between the rotating wiper arm and an external circuit. This contact arrangement is shown schematically in Fig. 3 as a conductor line connected between each contact **15** and the center of each associated wiping arm.

Not all of the contacts of levels #1–6 are used. Each contact or step can be considered as representing a certain period of time in the pinspotting machine cycle or sequence of operations. For example, as shown in Fig. 3, when corresponding fingers of wiper arms **104–114** engage contacts **15**, the machine is ready for the rolling of the first ball of a frame. Each succeeding step position or contact engaged can be considered as representing a period of time in the bowling machine frame cycle during which the control elements of the machine remain in a particular operative relationship. When it is necessary to change the operative relationship of the control elements of the machine, relay **130** is energized to advance or move wiper arms **104–114** one or more steps. In general, circuits energized by the wiper arms **104–114**, initiate or start operations of elements of the machine. Cams and associated switches, or switches in the control circuit stop the operations of these elements. Stepper relay **100** thereby functions to coordinate and control the cyclic operations of the elements of the machine in accordance with the prescribed rules of play. The eleven actuations of solenoid **130** during a frame cycle, result in the movement of ratchet wheel **116** and wiper arms **104–114** through an arc of 120° whereby each of the contacts of each level is engaged successively by a corresponding wiper arm finger. These eleven contact engagements provide one normal first ball sequence of operations, and two second ball sequences of operation.

If the contact positions are numbers **0** to **10**, as shown in Fig. 3, the following contact positions are used to provide the four basic machine cycles described hereinabove:

Normal first ball	Steps 0, 1, 2, 3, 4, 5 ,6.
Normal second ball	Steps 7, 8, 9, 10.
First ball foul	Steps 0, 3, 4, 5, 6.
Strike cycle	Steps 0, 1, 2, 8, 9, 10.

Step 0 is ready for the first ball and step 7 is ready for second ball.

On a first ball foul cycle, although normal second ball spotting functions are executed, the machine completes its sequence, ready for another second ball sequence, whereas on a strike cycle, where normal second ball spotting functions also are executed, the machine completes as ready for first ball. Both of these sequences, as well as a normal first ball cycle, start with contact or step zero. Hence a discrimination is made by the control system as to both the type of machine functions executed and the status of the machine at the completion of the cycle.

In the description of the operation of the control mechanism which follows, the wiper arm fingers, which are moved into and out of engagement with the several contacts of the several levels of contacts, are designated **104***a*–**114***a*. The wiper arm fingers, which at the beginning of the cycle are moved out of engagement with contacts **0**, are designated **104***b*–**108***b*.

NORMAL TWO BALL CYCLE

First ball

The bowler rolls the first ball of a frame which upon arriving in pit P (Fig. 1) strikes cushion **88** and moves it rearwardly to engage and actuate starting switch **90** suitably mounted at the rear of cushion **88**. The closing of contacts of switch **90** establishes a circuit which energizes solenoid **130** causing pawl **146** to turn shaft **102** and advance ratchet wheel **116** one step, and thereby advance all of the wiper arms one step. This circuit, starting at the center tap of winding **526** of transformer **521**, which is the positive terminal of the D.C. power supply, consisting of winding **526** and rectifier **532**, includes normally closed contacts **92***a* of sweep cam switch **92**, switch **90**, contact **0** of level #2, interrupter contacts **138**, **140** of stepper relay **100**, and the coil of solenoid **130** to the center tap of rectifier **532**, which constitutes the negative terminal of the power supply, referred to hereinabove. Thus as the result of this energization of solenoid **130**, the contact energizing fingers **104***a*–**114***a* of wiper arms **104–114** are resting on their respective contact **1**.

Solenoid **130** is immediately energized a second time by a circuit consisting of contacts **101***b* of cam switch **101**, normally open contacts PR5*a* now being closed, as described hereinafter, contact **1** of level #2, interrupter contacts **138** and **140** to the coil of stepper relay solenoid **130** which, as described hereinabove, results in a stepwise movement of all arms **104***a*–**114***a*. In the description, the energization of the coil of solenoid **130** involves the passing of current through interrupter contacts **138**, **140**, inasmuch as these contacts are in series with coil **130**. This arrangement is provided to produce the pulsing action of stepper relay solenoid **130**, as described hereinabove.

Switches **236 (1–10)** are mounted on each of the pin respotting units U (Fig. 2) and are used to detect the presence or absence of standing pins after the rolling of a first ball, as described fully in my Patent 2,821,395. The description given herein is limited to that which will make their functions clear. These switches are provided with both a normally open and a normally closed set of contacts **236***a* and **236***b*, respectively. The normally open contacts **236***a* are connected in circuits to indicating lamps L which are energized by standing pins after the rolling of a first ball of a normal two ball cycle to show which pins are standing. The normally closed contacts **236***b* of these ten switches **236** are connected in a series circuit which energizes the coil of relay PR5 at all times when pin clamping elements **483** of respotting units U are in their lowermost positions. The normally closed series circuit, consisting of normally closed contacts **236***b* and the associated coil of PR5, provides intelligence to the control circuit that at the beginning of a normal first ball cycle, all pin clamping elements are in proper position for the pin respotting operation. If any of the pin grippers G are clamping elements are not properly positioned, its associated switch contacts **236***b* will be opened and the series circuit to the coil of relay PR5 will be broken, thereby de-energizing relay PR5 and causing its contacts PR5*a* to open. When this occurs, there is no stepping operation of fingers **104***a*–**114***a* to contact two of the levels #1–#6, and table T does not move downwardly until this condition has been corrected. Conversely, when all grippers G and pin clamping elements 483 are properly positioned at the beginning of a normal first ball cycle, contacts **236***b* will be closed and the coil of relay PR5 will be energized, thereby closing contacts PR5*a*. The normally closed series circuit mentioned above also provides intelligence when all pins have been knocked down by the first ball rolled, when table T has moved to locate units U in pin gripping position, and no pins remain standing.

When wiper finger 104*a* engages contact 1, 2, or 3 of level #1, a circuit is established consisting of contacts 92*a* of sweep cam switch 92, and contact 1 of level #1 to the coil of relay CR3 which energizes this relay and closes normally open contacts CR3*a*. When contacts CR3*a* close, power is supplied to sweep motor 94 which results in the sweep designated generally 199 moving from its upper or dwell position into its lowered or guarding position adjacent alley A, as shown in broken lines in Fig. 1. When sweep 199 reaches this position, contacts 92*a* are opened by the operation of cam 93 which de-energizes relay CR3, thereby opening contacts CR3*a* and stopping motor 94.

When normally closed contacts 92*a* are opened by the action of cam 93, normally open contacts 92*b* are closed. A timer, designated generally 596, is provided to delay the start of the downward movement of table T after the first ball of a frame is rolled in order to allow time for standing pins to come to an equilibrium position. Timer 596 also delays the start of the sweep run-through on the second ball for the same reason. This timer employs a resistance-capacity network operating on the grid of a triode or three element electron tube. When the contact controlling the timer is open, the grid is charged negatively during the time that the A.C. voltage supplied the circuit is of such a phase that the cathode is negative with respect to the grid. This charge is stored on the capacitor. When the contact is closed, the cathode is connected to the opposite side of the A.C. line. Since the grid of the tube is at a negative potential with respect to the cathode, no plate current can flow. The charge on the capacitor is dissipated by the resistance connected across the capacitor. Depending on the value of this resistance, a finite time is required to reduce the value of negative grid voltage to the point where the tube will conduct. When this point is reached, plate current flows between the cathode and plate of the tube during the time that the A.C. voltage makes the plate positive with respect to the cathode. This results in pulses of plate current through the timer relay energizing this relay. Another capacitor, shunted or paralleled across the relay, stores a charge during the period of these pulses of current and tends to smooth out the current through the relay, preventing it from chattering. When the contact controlling the timer (between the cathode and one side of the A.C. supply) is opened, the plate and cathode are then connected to the same side of the A.C. line. Since these two elements of the tube are at the same voltage, no current flows between them. The relay then de-energizes and the charging operation starts in preparation for the next timing cycle.

More specifically, timer 596 consists of a triode or three element vacuum tube 597. In addition to the tube, timer 596 consists of an adjustable resistor 596*a* and a fixed resistor 596*b* in series. Adjustable resistor 596*a* permits setting of the timer's operating point to desired time values by compensating for tolerances of the particular tube, relays, and capacitor used.

In the plate circuit of tube 597 is the coil of relay 560 shunted by a capacitor 596*e* which smoothes the pulsating plate current flowing in the plate circuit of tube 597 when it is conducting and prevents the relay from chattering. Heater power for tube 597 is supplied by one winding, 528, of transformer 521. A.C. plate power for tube 597 is supplied by winding 530 of transformer 521. Lead 530*a* of winding 530 is connected to one end of the coil of relay 560; the other end of this coil is connected to the plate of tube 597. Lead 530*a* is also connected to the cathode of tube 597 through a resistance 596*d*. The cathode of tube 597 is connected to one side of contacts 92*b* of sweep cam switch 92. The other side of contacts 92*b* is connected to lead 530*b* of winding 530 of transformer 521. The grids of tube 597 are connected to resistance 596*a* and to timing capacitor 596*c*. The opposite side of timing capacitor 596*c* is connected to resistance 596*b* and to lead 530*b* of winding 530 of transformer 521.

When closed, contacts 92*b* serve to connect the cathode of tube 597 to lead 530*b* of winding 530. Conversely, when contacts 92*b* are open, the cathode of tube 597 is connected to lead 530*a* of winding 530 through resistance 596*d*. In this condition tube 597 has the grid connected to lead 530*b* of the transformer and the cathode and plate, through the resistor 596*d* and the coil of relay 560, respectively, are connected to lead 530*a*. In this condition no current flows between the cathode and plate, but the grid and cathode are connected as a diode or rectifier circuit and electrons flow from the cathode to the anode (grid) making the grid negative with respect to the cathode. This voltage between the grid and cathode charges timing capacitor 596*c* to a D.C. potential approaching the peak value of the A.C. voltage across winding 530. Resistors 596*a* and 596*b* act as a small load on this rectifier circuit. When contacts 92*b* of cam switch 92 close to start the timing period, the cathode of tube 597 is connected through these contacts to lead 530*b* of winding 530. Resistor 596*d* is then connected across this winding in addition to the plate-cathode circuit of tube 597. Under these conditions, current would normally flow between the plate and cathode of tube 597. However, the charge stored on timing capacitor 596*c* biases the grid negatively with respect to the cathode and prevents the tube from conducting from plate to cathode. The grid and cathode no longer act as a diode rectifier, and the charge stored on the timing capacitor dissipates itself exponentially with time through resistances 596*a* and 596*b*. When the potential applied to the grid, equal to the voltage across the timing capacitor, falls below the cutoff value for the triode, current flows between the cathode and plate and energizes relay 560. Relay 560 will remain energized until contacts 92*b* are opened by the operation of cam switch 92, at which time the charging circuit previously explained is set up and relay 560 is deenergized since no current flows in the plate circuit of triode tube 597 when the cathode and plate are both connected to the same side of winding 530.

As described above, timer 596 starts operation when contacts 92*b* are closed. Timer 596 completes its timing operation after a suitable time interval, say two seconds, and relay 560 is energized, thereby closing contacts 560*a* and 560*b*. The closing of contacts 560*a* establishes a circuit through the coil of relay CR2 consisting of contact 2 of level #6 and contact 560*a*, thereby energizing relay CR2 and closing contacts CR2*a* supplying power to motor 40. The starting of motor 40 causes shaft 109 to rotate and through crank arms 20, attached thereto, to move table T downwardly towards alley A.

First revolution of control cam shaft 610

Shaft 610 is driven from shaft 109 by suitable sprockets and a chain in a one to one ratio. Secured to shaft 610 are cams 612, 614, 616, 618, 620, 622, 624, and 626. These cams are enclosed with other components of the control mechanism in a control box designated generally 200 suitably, detachably mounted on the machine, and preferably on top of the frame (Fig. 1), where it is readily accessible for replacement or repair.

The several cams 612–626 and the switches 613–627 operated thereby are mounted on a plate member 628 suitably detachably mounted in control box 200. Each switch has an operating arm 613*b*–627*b* pivotally mounted on shaft 632. One end of shaft 632 is secured in flange 634 formed integrally with plate member 628. The other end of shaft 632 is supported in an arm of an angle bar 636 suitably attached to plate member 628. Springs 638 having one end attached to respective arms 613*b*–627*b* and the other ends thereof secured to a cross bar 629 mounted on plate member 628 maintain the cam follower ends of arms 613*b*–627*b* constantly in engagement with cams 612–626, respectively. Each arm 613*b*-

627*b* is provided with an adjustable switch operating pin **654**. Shaft **610** is driven in a one to one ratio from sprocket **640** on shaft **109** through a sprocket chain **642** running on sprocket **640** and on sprocket **641** fixed to shaft **610**.

As table T descends, the rotation of shaft **610** causes contacts **613***a*, operated by cam **612**, to close and keep relay CR2 energized. As the result of the movement of table T into pin gripping position relative to pins standing on alley A, the grippers of respotting units U are moved automatically to gripping position to grip any pins left standing for lifting and respotting. If there is at least one standing pin, then the switch contacts **236***b* associated with the unit U, corresponding to such pin, will be opened. The opening of one of switch contacts **236***b* de-energizes relay PR5 and causes the opening of contacts PR5*a* and PR5*b*.

As shaft **610** continues to rotate, contacts **625***a* are closed by cam **624**, establishing a circuit to solenoid coil **130** of stepper relay **100**. This consists of contacts **101***a* of sweep cam switch **101**, previously closed by the movement of the sweep **199** to its guarding position shown in broken lines in Fig. 1, contacts **625***a*, and contact **2** of level #5. Therefore, wiper fingers **104***a*–**114***a* move from contact **2** to contact **3**. This movement results in the establishment of a circuit to solenoid **130** consisting of contacts **92***b* of sweep cam switch **92**, and contact **3** of level #2, which energizes solenoid **130** and causes fingers **104***a*–**114***a* to move to contact **4**. This operation establishes a circuit through sweep cam switch contacts **101***a*, contacts **625***a*, contacts **4** and **5** of level #5, which results in the movement of wiper fingers **104***a*–**114***a* to contact six of their respective levels where they remain during the completion of the first revolution of crank arms **20**, and until solenoid **130** is again energized during the second revolution of shaft **109**.

Second revolution of control cam shaft 610

As shafts **109** and **610** continue to rotate during the first revolution of shaft **109**, contacts **617***a* are closed by cam **616** which makes a circuit to the coil of relay CR3 consisting of contacts **101***a* of sweep cam switch **101**, contacts **617***a*, contact **6** of level #1 energizing relay CR3 and closing contacts CR3*a* again starting sweep motor **94**. Sweep **199** therefore moves through its operative sweeping stroke and removes deadwood from the alley. When sweep **199** returns to its "down" position, shown in broken lines in Fig. 1, cam **103** operates cam switch **101**, opening contacts **101***a* and closing contacts **101***b* which de-energizes relay CR3 and stops motor **94**. Table T then moves downwardly, due to the second revolution of arms **20**, respots pins which were lifted prior to the operation of sweep **199** and then moves upwardly. The control circuits which accomplish these results are as follows:

Near the conclusion of the first revolution of arms **20**, shaft **109** and shaft **610**, wiper fingers **104***a*–**114***a* are still on contacts **6**. Contacts **615***a* are closed at this time because of the rotation of cam **614** completing a circuit consisting of contacts **615***a* and contact **6** of level #6 to the coil of relay CR2 which continues the energization of relay CR2 after the opening of contacts **613***a* at the end of the first revolution of shaft **610**. Cam **614** maintains contacts **615***a* closed for a limited initial period of the first part of the second revolution of shaft **610** (about 75°). When the position of table T when crank arms **20**, and shafts **109** and **610** have rotated this limited amount, is such that pins held by grippers G are immediately above but clear of the path of travel of sweep **199**, if sweep **199** has completed its sweeping operations, contacts **101***b* will be closed and contacts **101***a* will be open.

Conversely, if the sweep has not completed its sweeping operation when table T reaches the above described position, contacts **101***b* will be open and contacts **101***a* will be closed. If contacts **101***b* are open when shaft **610** has completed this limited portion of its rotation, contacts **615***a* will be opened by any further rotation of shaft **610**, due to further descent of table T. This will interrupt the current to the coil of relay CR2, de-energizing this relay, opening contacts CR2*a* and stopping table motor **40**. On the other hand, if sweep **199** has completed its normal sweeping operations when the above described table T position is reached, contacts **101***b* of sweep cam switch **101** will be closed. If these contacts **101***b* are closed prior to the opening of contacts **615***a*, a circuit is established consisting of contacts **101***b*, and contacts **621***a* of cam switch **620** which are closed immediately prior to the opening of contacts **615***a* by rotation of shaft **610**, contact **6** of level #6 to the coil of relay CR2 which will then remain energized under these conditions after the opening of contacts **615***a*, and continue the movement of table T by the continued energization of table motor **40** to complete the respotting of pins held by grippers G in their on or off-spot positions on alley A.

Contacts **621***a* will remain closed to continue the energization of relay CR2 and hence table motor **40** continues to operate until contact **613***a* again is closed by cam **612** during the second revolution of shaft **610**. Contacts **613***a* remain closed until the conclusion of the second revolution of shaft **610**, at which time the opening of contacts **613***a* by the action of cam **612** results in the de-energization of relay CR2 and the stopping of table motor **40** because of the opening of contacts CR2*a*.

At substantially the same time table T is moving upwardly after the respotting of pins, contacts **623***a* are closed by cam **622**, resulting in the establishment of a circuit consisting of contacts **101***b* of sweep cam switch **101**, contacts **623***a* and contact **6** of level #2 to the coil of solenoid **130** of stepper relay **100** which moves all wiper fingers **104***a*–**114***a* to contacts **7**. This movement of the stepper wiper fingers **104***a*–**114***a* completes a circuit consisting of contacts **131***a*, which are closed at the completion of the sweeping operation described above, and contact **7** of level #1 to the coil of relay CR3 energizing this relay and closing contacts CR3*a*, thus again starting sweep motor **94** which moves sweep **199** from its "down" or guarding position upwardly to its "up" or dwell position. When sweep **199** reaches its "up" position, contacts **131***a* of cam switch **131** are opened by the action of cam **133** which de-energizes relay CR3 and stops motor **94**.

The movement of the wiper fingers to contacts **7** interrupts the flow of current to first ball signal light **11** which had been energized during the preceding operations by contacts **1**–**6** of level #3, and establishes a circuit to signal light **12** through contacts **7**–**10** inclusive of level #3, and normally closed contacts PR4*c* to winding **528** of transformer **521**, thereby indicating that the machine is ready for the second ball of the frame.

The machine is now ready for the rolling of the second ball in a normal two-ball sequence.

Second ball

In a normal second ball cycle, the machine operates as follows: As with the first ball, the second ball strikes or rolls against backstop **88** and operates pit switch **90** closing its contacts. This completes a circuit consisting of contacts **92***a* of sweep cam switch **92**, switch **90** contacts, contact **7** of level #2 to the coil of solenoid **130** which advances wiper fingers **104***a*–**114***a* to contacts **8**. This movement of wiper fingers **104***a*–**114***a* energizes a sweep "down" circuit consisting of contacts **92***a*, and contact **8** of level #1 to the coil of relay CR3, energizing this relay, closing contacts CR3*a* and starting sweep motor **94**. When sweep **199** reaches its "down" position, contacts **92***a* open, and de-energize relay CR3, opening contacts CR3*a* and stopping sweep motor **94**.

When contacts **92***a* open, as described above, contacts

92*b* are simultaneously closed by the rotation of cam 93 on shaft 237. The closing of contacts 92*b* initiates the operation of timer 596 described hereinabove. At the conclusion of the timed period, contacts 560*b* of timer relay 560 close, which completes a circuit consisting of contacts 619*a*, which are closed at this time due to the position of a contact closing lobe on cam 618 on shaft 610, contact 8 of level #2 to the coil of solenoid 130, causing the movement of wiper fingers 104*a*–114*a* to contacts 9.

The movement of the wiper fingers to contacts 9 establishes a sweep run-through circuit, including contacts 101*a*, which are now closed, contacts 617*a*, which are also closed at this time, and contact 9 of level #1 to the coil of relay CR3 which energizes this relay, closing contacts CR3*a*, and starting sweep motor 94 for the sweeping operation. At the conclusion of this operation, cam 103 actuates cam switch 101, opening contacts 101*a* and closing contacts 101*b* which de-energizes relay CR3 and stops motor 94.

Prior to the conclusion of the sweeping operation described above, cam 137 actuates cam switch 135 and closes contacts 135*a*.

As soon as ten pins delivered by distributor D from elevating mechanism 370 to spotters H of table T have tripped lever arm 139 of counter 141, the contacts 143*a* of counter switch 143 are closed and latch coil LR1L of latch relay LR1 is energized by current from rectifier 532 through the closed contacts 145*a* of distributor switch 145 and contacts 143*a* of counter switch 143. This relay latches itself in, opening contacts LR1*a* and closing contacts LR1*b* and LR1*c*, which de-energizes relay PR1 opening its contacts PR1*a* which in turn de-energizes solenoid 380. De-energization of solenoid 380 results in the movement of gate 397 into coincidence with cam 394, whereupon grip rods 350 are held in clamping engagement with pins in pockets 331. This prevents additional pins from being delivered by elevating mechanism 370 to distributor D until such time as spotters H have spotted their ten pins and are in receiving position. When distributor D after delivering a pin to each of the spotters H again, as shown in Fig. 2, reaches #10 position, the contacts 145*b* of the distributor switch 145 are closed by suitable operating means (not shown).

Counter 141 is provided with a ten tooth ratchet 151, Fig. 9, mounted on shaft 153 having secured thereto a one tooth trip cam 155. Ratchet 151 is actuated by a spring mounted pawl 157 pivoted on ratchet arm 159 supported on stud shaft 161 to which is also secured pin actuated trip finger 139. Each pin passing trip finger 139 results in the advance of one tooth of ratchet 151. A nose 163 on trip cam 155 turning intermittently with ratchet 151 is so arranged that it will close switch 143 when the tenth pin passes trip finger 139. The zero position of ratchet 151 and the position assumed by the distributor after delivery of ten pins to the spotters H of table T correspond.

The closing of contacts 135*a*, contacts 145*b* and contacts LR1*c* described above, completes a circuit through contact 9 of level #6 to the coil of relay CR2 closing contacts CR2*a* which in turn starts table motor 40 for the spotting operation.

Simultaneously with the operation described in the preceding paragraph, a circuit is completed consisting of contacts 101*b*, now closed, contact 9 of level #4, contacts LR1*b* to the coil of relay PR2 from the power source consisting of transformer winding 526 and rectifier 532, which energizes relay PR2 thereby closing contacts PR2*a*. When contacts CR2*a* close to start table motor 40, power is also supplied through contacts PR2*a* to spotting solenoid 82 which when energized, releases the spotting mechanism so that when table T descends to spotting position, the ten pins in spotters H will be spotted on alley A.

The initial operation of table motor 40 during the spotting operation, through the circuit consisting of contacts 135*a*, 145*b*, LR1*c* and contact 9 of level #6 to the coil of relay CR2 continues the operation of shafts 109 and 610 until contacts 613*a* are closed by cam 612. The closing of contacts 613*a* establishes a holding circuit to the coil of relay CR2, which continues the operation of the table motor until the conclusion of the spotting operation and the return of table T to its "up" or dwell position. At that time contacts 613*a* are opened, de-energizing relay CR2 and stopping table motor 40.

During the time contacts 613*a* are closed, other circuits are established. The first circuit is established immediately after pins have been spotted and table T is moving upwardly. This circuit includes contacts 627*a* which are closed at this time by cam 626 on shaft 610, normally closed contacts 101*b*, contact 9 of level #4 to the unlatching coil LR1U of relay LR1. This circuit effects the unlatching operation for relay LR1 opening contacts LR1*b* and LR1*c* and closing contacts LR1*a*. When contacts LR1*a* are closed, relay PR1 is again energized, resuming the delivery of pins to distributor D as described above. The opening of contacts LR1*b* de-energizes relay PR2 which in turn opens contacts PR2*a* and de-energizes spotting solenoid 82. This allows the latching mechanism controlled by solenoid 82 to remain engaged during the succeeding first ball cycle when pins are being fed into the spotters H.

Subsequent to the de-energization of solenoid 82, contacts 623*a* are closed by cam 622 which completes a circuit consisting of contacts 101*b* of sweep cam switch 101, and contact 9 of level #2 to the coil of solenoid 130 which in turn moves wiper fingers 104*a*–114*a* to contacts 10. This operation results in the completion of a circuit including contacts 131*a* of sweep cam switch 131, and contacts 10 and 0 of level #1 to the coil of relay CR3 energizing this relay, thereby closing contacts CR3*a* and starting sweep motor 94 which thereupon returns sweep 199 to its "up" or dwell position at which time contacts 131*a* are opened de-energizing relay CR3 and stopping motor 94.

During the time sweep motor 94 is returning sweep 199 to its "up" position, sweep cam 93 operates cam switch 92 opening contacts 92*b*, closing contacts 92*a*. The closing of contacts 92*a* establishes a circuit consisting of contacts 92*a*, and contact 10 of level #2 to solenoid coil 130 which moves the wiper fingers 104*a*–114*a* to zero contacts, or zero position. The machine is now again in readiness for the first ball of the next frame, having completed a normal two-ball cycle.

STRIKE CYCLE

The strike cycle occurs when a bowler knocks down all ten pins with the first ball rolled of a frame. The initial operations are the same as for a first ball of a normal two-ball game, but since there will be no pins standing when table T is moved downwardly, no grippers G will be operated and hence the series circuit through contacts 236*b* will remain closed and relay PR5 will be energized, thereby closing contacts PR5*a* and PR5*b*. The operations of the machine up to the stage where wiper fingers 104*a*–114*a* engage contacts 2, are the same as described for a normal first ball cycle. Simultaneously with the closure of contacts 625*a* and the first revolution of shaft 610 during the first ball cycle, and because relay PR5 is energized as the result of the closure of all contacts 236*b*, a circuit is established consisting of contacts 101*a*, contacts 625*a*, and contacts PR5*b* to the coil of relay PR4, energizing relay PR4, which closes contacts PR4*a*, PR4*b*, and PR4*d* and opens contacts PR4*c*. Contacts PR4*a* provide a holding circuit for the coil of relay PR4 through contacts 92*b*, until contacts 92*b* are broken by the subsequent operation of sweep 199. When wiper fingers 104*a*–114*a* are moved to contacts 6, as previously described, for a normal cycle, the closed condition of contacts PR4*d* results in the completion of a circuit to

the coil of solenoid **130** consisting of contacts **92***b*, contacts PR4*a*, contacts PR5*b*, arm **112***a* to contacts **6** and **7** of level #5 and contacts PR4*d*, resulting in the movement of wiper fingers **104***a*–**114***a* to contacts **8**.

The closed condition of contacts PR4*b*, and the open condition of contacts PR4*c* when wiper finger **108***a* of level #3 reaches contact **7**, cause signal light ST to be energized, and signal light **12** to be de-energized during the time wiper fingers **104***a*–**114***a* are on contacts **7**–**10** inclusive.

Subsequent to the movement of wiper fingers **104***a*–**114***a* to contacts **8**, the continued rotation of shafts **109** and **610** effects the closure of contacts **619***a* by cam **618** establishing a circuit energizing solenoid **130**, including contacts **560***b* of timer relay **560**, contacts **619***a*, and contact **8** of level #2 which advances the wiper fingers **104***a*–**114***a* to contact **9**. This movement of wiper fingers **104***a*–**114***a* completes a sweep run-through circuit consisting of contacts **101***a*, contacts **617***a*, and contact **9** of level #1 to the coil of relay CR3, starting motor **94** and the sweeping operations of sweep **199**.

During the time sweep **199** is in operation, table T continues to move upwardly until contacts **613***a* are opened by the rotation of cam **612** on shaft **610**. When this occurs, relay CR2 is de-energized, stopping table motor **40** and the movement of table T, until sweep **199** completes its sweeping operations. As soon as sweep **199** has completed its sweeping operations and a set of pins is supported in spotters H, resulting in the closure of contacts **145***b*, and the latching operation of relay LR1 caused by the completion of the delivery of ten pins into spotters H, as described hereinabove, has been effected, a table starting circuit for a spotting cycle is established. This circuit includes contacts **145***b*, contacts **135***a*, contacts LR1*c*, and contact **9** of level #6 which energizes relay CR2 and starts table motor **40**.

Simultaneously with the establishment of the table starting circuit for the spotting cycle, as described directly above, another circuit is established through contacts **101***b*, contact **9** of level #4, and contact LR1*b* to the coil of relay PR2. This energizes relay PR2 and energizes spotting solenoid **82** by the closing of contacts CR2*a* and PR2*a* as previously described in the spotting sequence for a normal second ball cycle.

After the spotting of a set of pins and the ascent of table T has begun, contacts **627***a* are closed by the action of cam **626** due to the continued rotation of shaft **610**. Closure of contacts **627***a* results in the establishment of a circuit through unlatching coil LR1U of relay LR1 including contacts **101***b*, contact **9** of level #4, and contacts **627***a*, resulting in the unlatching of relay LR1 and the de-energizing of the spotting latch solenoid **82** and the energizing of relay PR1 to initiate the pin delivery operation from pin elevator **370** to distributor D as previously described during a normal second ball cycle.

Subsequent to the unlatching of relay LR1, contacts **623***a* operated by cam **622**, are closed, resulting in the movement of wiper fingers **104***a*–**114***a* from contacts **9** to contacts **10**, as previously described, for a normal second ball cycle. The operations incident to the movement of wiper fingers **104***a*–**114***a* from contacts **10** to zero and the upward motion of sweep **199** are effected by circuits previously described for the concluding operations in a normal second ball cycle.

The closure of contacts PR4*b*, as described above, results in the establishment of a circuit energizing a strike signal light ST. This circuit includes contacts **7**, **8**, **9** and **10** of level #3 and contacts PR4*b*. This signal remains energized until relay PR4 is de-energized by the opening of contacts **92***b*, at the conclusion of the upward movement of sweep **199** at the end of the strike cycle. The machine is now ready for the next first ball cycle, with the wiper arms **104**–**114** in zero position.

FIRST BALL FOUL CYCLE

When a foul is committed on the first ball of a frame, relay PR3 in the control circuit will be energized by the closure of foul switch **654**. If desired, relay PR3 may be energized by the receipt of a signal from an automatic foul detecting and signalling unit (not shown), such for example as shown and described in Dumas et al. Patent 2,683,602, issued July 13, 1954, for Foul Detecting and Signalling Mechanism. Energization of relay PR3 results in the closure of contacts PR3*a*, connected to contact **1** of level #2, and the closure of contacts PR3*b* connected to contact **2** of level #2.

When a ball is rolled resulting in the operation of switch **90**, as described previously, stepper relay **100** is operated to advance wiper fingers **104***a*–**114***a* from contacts zero to contacts **1**. Upon movement to contacts **1**, and as a result of the closed condition of contacts PR3*a*, a circuit is established which energizes solenoid **130** including contacts **92***a*, contacts PR3*a*, and contact **1** of level #2. This results in the immediate movement of wiper fingers **104***a*–**114***a* to contacts **2**. As a result of the closed condition of contacts PR3*b*, another circuit energizes solenoid **130**, including contacts **92***a*, contacts PR3*a*, and PR3*b*, and contact **2** of level #2, resulting in the movement of wiper fingers **104***a*–**114***a* to contact **3**.

During the movements of wiper fingers **104***a*–**114***a* from contacts **1** to **3**, a circuit is established for the sweep "down" motion consisting of contacts **92***a*, contacts **1**, **2** and **3** of level #1, to the coil of relay CR3 resulting in the energization of motor **94**, as previously described. When sweep **199** has moved to its "down" position, as shown in Fig. 1, cam switch **92** is operated by cam **93** on shaft **237** and contacts **92***a* are opened and contacts **92***b* are closed, as described previously. When contacts **92***b* are closed, a circuit is established energizing solenoid **130** including contacts **92***b*, and contact **3** of level #2 which results in the movement of wiper fingers **104***a*–**114***a* to contacts **4**.

When wiper fingers **104***a*–**114***a* reach contacts **4**, a sweep run-through circuit is completed including contacts **101***a*, contacts **617***a*, and contact **4** of level #1 resulting in the energization of relay CR3 and the starting of sweep motor **94**. The operation of sweep **199** thus effected results in the sweeping of all pins, standing or fallen, into pit P. Upon completion of the sweeping operation, cam switch **101** is actuated, resulting in the opening of contacts **101***a* and closing of contacts **101***b*. The opening of contacts **101***a* by cam **103** on shaft **237** results in the de-energization of relay CR3 and the stopping of sweep motor **94**. When contacts **101***b* close, a circuit is established energizing solenoid **130**, including contacts **101***b*, and contact **4** of level #2, resulting in the movement of wiper fingers **104***a*–**114***a* to contacts **5**.

As soon as wiper fingers **104***a*-**114***a* engage contacts **5**, a spotting cycle table start circuit is established for table T consisting of contacts **145***b*, **135***a*, LR1*c*, and contact **5** of level #6. This circuit energizes relay CR2 and starts table motor **40**.

Simultaneously with the completion of the spotting cycle table start circuit, another circuit is made including contacts **101***b*, contact **5** of level #4, and contacts LR1*b* of relay LR1, resulting in the energization of relay PR2 closing contacts PR2*a*. The simultaneous closing of contacts CR2*a* and PR2*a* effects the energization of solenoid **82** and the subsequent delivery of pins by spotters H to alley A.

After the delivery of pins to alley A, and during the upward movement of table T, contacts **627***a* close, resulting in the establishment of a circuit including the LR1U or unlatching coil of relay LR1, and contacts **101***b*, contact **5** of level #4, and contacts **627***a*. This circuit results in relay LR1 being actuated to its unlatched condition which in turn de-energizes relay PR2, and spotting

solenoid 82, and energizes relay PR1 and solenoid 380, as previously described.

Subsequent to the unlatching of relay LR1, cam 622 on shaft 610 closes contacts 623*a*, completing a circuit including contacts 101*b*, contacts 623*a*, and contacts 5 and 6 of level #2 which energizes solenoid 130 and advances wiper fingers 104*a*–114*a* from contacts 5 to contacts 7. As a result of wiper fingers 104*a*–114*a* engaging contacts 7, a sweep "up" circuit is established including contacts 131*a*, and contact 7 of level #1, which energizes relay CR3 starting sweep motor 94 which continues to operate until contacts 131*a* are opened by cam 133 on shaft 237, whereupon relay CR3 is de-energized and motor 94 stops. The table T continues to ascend until contacts 613*a* are opened by the movement of cam 612 on shaft 610. The opening of contacts 613*a* de-energizes relay CR2 and stops motor 40. When the table stops, the machine is in condition for the second ball of the same frame with the stepper relay wiper fingers engaging contacts 7.

SECOND BALL FOUL CYCLE

For a second ball foul, the operation of the machine is the same as in the case of a normal second ball cycle.

MANUAL CYCLING OF MACHINE

In order to operate the machine, as for test purposes, without the need for rolling a ball, the control circuit is provided with a manually operable switch 89 (Figure 3) having contacts 89*a* connected in parallel with contacts 90*a* of pit switch 90. When switch 89 is operated, the starting circuit of the machine is completed simulating the action normally effected by the arrival of a ball in pit P, as described hereinabove. If switch 89 is actuated twice, the machine operates through a normal two ball cycle.

TENTH FRAME SPARE

When a bowler makes a spare in the tenth frame of a game, he is entitled, under the rules, to an additional ball. As the result of rolling this ball, the machine goes through a normal first ball cycle and comes to rest as ready for the second ball of a frame. In order to manually cycle the machine and place it in readiness for the first ball of a frame, i.e. the first ball of the first frame of the next game, there is provided a manually operable switch 91 having normally open contacts 91*a* connected in parallel with contacts 90*a*. Thus when switch 91 is operated, the machine is cycled as described hereinabove without the necessity of rolling a second ball, which is not permitted under the rules. Switch 91 preferably is located adjacent the approach end of an alley where it is convenient to a bowler.

MACHINE PROTECTION CIRCUIT

When during a normal first ball cycle table T descends upon a standing pin which has been moved out of range of the grippers G and clamping element 483*a* (Fig. 10) either by the action of the ball or by other pins, mechanism for stopping the machine is operated. The details of this mechanism are shown in Figure 1. Rod 474 is provided with a telescoping member 675. Member 675 carries a bracket 677 in which is fixedly mounted an adjustable rod 679 having its free end extending upwardly through an opening in a plate 681 having a hub attached to rod 474. A spring 683, encircling rod 474 and rod member 675, bears against bracket 677 and plate 681, normally tending to urge them apart. If for any reason, such as described, downward movement of table T is prevented, due to the telescopic arrangement shown in detail in Fig. 1, spring 683 will be compressed and rod 679 will engage switch 586 which has normally open contacts 586*a* (Fig. 3) adapted to be closed by pressure from rod 679. The mechanism for actuating switch 586 is identical in construction and operation to that shown and described in detail in Holloway et al. Patent 2,781,195 for Bowling Pin Spotting and Respotting Mechanism. The closing of contacts 586*a* completes a grounding circuit across the D.C. power supply including winding 526 and rectifier 532, the coil of D.C. circuit breaker CB1 and contacts 586*a*. The large current through the coil CB1 of the circuit breaker trips this circuit breaker and opens contacts CB1*a* in the circuit supplying power to the coil of relay CR1, which de-energizes relay CR1 opening contacts CR1*a*, removing all power to the motors 94, 40 and 84 and the control system powered by transformer 521, thus protecting the machine from any danger to the respotting units U, especially grippers G.

RESPOTTER UNIT PROTECTION MECHANISM

Also provided are switch contacts PB2*a* which are paralleled with contacts 101*b* of cam switch 101. Contacts PB2*a* are used to manually cause wiper fingers 104*a*–114*a* of stepper relay 100 to move from contact 1 to contact 2 during a normal first ball cycle in the event relay PR5 is de-energized by the open condition of one of the sets of contacts 236*b* at the beginning of a normal first ball cycle. In this case, contacts 101*b* open at the conclusion of the sweep "down" motion of sweep 199, but wiper fingers 104*a*–114*a* do not move beyond contact 1. After the mechanical condition which caused one of switch contacts 236*b* to be opened, is corrected, and relay PR5 is energized closing contacts PR5*a*, contacts PB2*a* must be manually closed to permit resumption of the machine cycle by the movement of wipers 104*a*–114*a* from contact 1 to 2. This circuit resets the machine after the occurrence and correction of a condition which would permit the respotting units U to function incorrectly.

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 the 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 a bowling pin spotting machine, apparatus comprising a table mounted for movement to and from a bowling alley and having means for setting pins and picking up standing pins, driving means for moving said table to and from said alley to spot and respot pins thereon, a sweep, mechanism for operating said sweep including driving means, a multi-level stepper relay having ganged wiper fingers and at least a first, second, and third level, a plurality of spaced contacts on each of said levels, one of said wiping fingers being operatively associated with each of said levels and adapted to successively engage said contacts in response to the activation of said stepper relay, a control circuit for said table driving means connected to selected contacts of said first level and having active and passive states, a control circuit for said sweep driving means connected to selected contacts of said second level and having active and passive states, master control circuit means for said apparatus including said third level of contacts and operative to energize said relay and move said ganged fingers to engage selected contacts of said levels for simultaneously placing said table control circuit and said sweep control circuit in concurrent, active states to prepare said control circuits for subsequent energization, electrically interlocked devices operatively connected to said first and second levels for selectively controlling the operation of said activated table and sweep circuits to synchronize the movements of said table and said sweep in accordance with a predetermined bowling game playing cycle, and circuit means operative in response to the rolling of each ball of a frame and connected to said master control circuit means including said third level for indexing said relay fingers to cause said fingers to engage selected contacts of said first and second levels and activate said control circuits

for concurrent operation of said table and sweep driving means during each ball operating cycle of the machine.

2. The invention defined in claim 1 wherein said electrically interlocked devices include means operated by said table driving means and selected contacts of said second level of said stepper relay for selectively energizing said activated sweep control circuit in order to control operation of said sweep in a predetermined timed relationship with the movement of said table.

3. The invention defined in claim 2 wherein said electrically interlocked devices further include means operated by said sweep driving means for controling the movement of said table during the concurrent movement of said sweep along said alley.

4. The invention defined in claim 1 wherein said apparatus includes pin sensing means, and further includes means connected to said master control circuit means and operative in response to the rolling of a first ball of a frame and the occurrence of a strike detected by said sensing means for causing said master control circuit means to energize a predetermined sequence of contacts of said first and second levels to program said machine through a strike cycle including, programming said sweep through a sweep cycle to sweep all fallen pins from said alley and programming said table to descend towards said alley and spot a new set of pins thereon.

5. In a bowling pin spotting machine for use on a bowling alley having a pit at one end thereof, apparatus comprising a table mounted for movement to and from a bowling alley, a plurality of pins spotters mounted on said table, a plurality of similarly arranged pin respotting units mounted on said table, driving means for moving said table through an operating cycle including moving said table to and from said alley to spot and respot pins thereon, a multi-level stepper relay having ganged wiper fingers and at least a first, second and third level, a plurality of spaced contacts on each of said levels, one of said wiping fingers being operatively associated with each of said levels and adapted to successively engage said contacts in response to the activation of said stepper relay, a control circuit for said table driving means connected to selected contacts of said first level and having active and passive states, a control circuit for selectively actuating said spotters connected to selected contacts of said second level and having active and passive states, master control circuit means for said apparatus including said third level of contacts and operative to energize said relay and move said ganged fingers to engage selected contacts of said levels for simultaneously placing said table control circuit and said spotter control circuit in concurrent active states to prepare said control circuits for subsequent energization, circuit means operative in response to the rolling of a second ball of a frame connected to said third level for stepping said relay to cause said fingers to engage selected contacts of said first and second levels and activate said table drive control circuit and said spotter control circuit respectively, electrically interlocked devices connected to said table drive control circuit and said spotter control circuit and operative to concurrently energize said activated spotter circuit and said activated table drive control circuit to move said table downward towards said alley and cause said spotters to be actuated when said table reaches spotting position to spot a new set of pins on said alley, and means connected to said electrically interlocked devices and operative after said table has traveled a predetermined distance in its movement relative to said alley for disconnecting said spotter control circuit from said electrically interlocked devices to deenergize said spotter control circuit whereby said spotters are inactivated.

6. The invention defined in claim 5 including a pin distributor adapted to deliver a plurality of pins in succession to said spotters subsequent to the spotting of pins on said alley, a control circuit for actuating said pin distributor connected to selected contacts of a level of said stepper relay and having active and passive states, said distributor control circuit being placed in an active state by said master control circuit means concurrently with the activation of said spotter control circuit to prepare said distributor control circuit for subsequent energization, and means operative after said pins have been spotted for energizing said activated distributor circuit to cause said distributor to distribute a new set of pins while said table is moving from said alley.

7. The invention defined in claim 5 including a sweep, mechanism for operating said sweep including driving means, a fourth level on said stepper relay, a control circuit for said sweep driving means having active and passive states and connected to selected contacts of said fourth level, said sweep control circuit being placed in an active state by said master control circuit means, and means operated by said table driving means and including said selected contacts of said fourth level for selectively energizing said activated sweep control circuit to cause said sweep driving means to move said sweep to and from said alley concurrently and in synchronism with said table movement to remove all pins from said alley after said second ball is rolled.

8. In a bowling pin spotting machine a table mounted for movement to and from a bowling alley, pin sensing means, a plurality of pin spotters mounted on said table in an arrangement conforming substantially with the playing positions of pins spotted on said alley, a plurality of similarly arranged pin respotting units mounted on said table, driving means for moving said table to and from said alley to spot and respot pins thereon, a multi-level stepper relay having ganged wiper fingers and at least a first, second and third level, a plurality of spaced contacts on each of said levels, one of said wiping fingers being operatively associated with each of said levels and adapted to successively engage said contacts in response to the actuation of said stepper relay, a control circuit for said table driving means connected to selected contacts of said first level, control circuit means including said second level of contacts for selectively energizing said relay to move said ganged fingers to engage selected contacts of said levels for actuating said table control circuit, a programming circuit means connected to selected contacts of said third level and including electrically interlocked devices operatively connected to said first and second levels for controlling the operation of said table and said relay, said programming circuit including means for intermittently energizing said relay through contacts of said second level, circuit means connected to said programming circuit means and operative in response to the rolling of a first ball of a frame and the occurrence of a strike to cause said programming circuit means to energize said relay and advance said wiper arms to engage a predetermined sequence of contacts of said first and second levels to program said table through a strike cycle including programming said table through two successive cycles of operation, said table descending towards said alley to feel for and sense standing pins during said first cycle of operation and descending towards said alley to spot a new set of pins on said alley during said second cycle of operation.

9. In a bowling pin spotting machine, a table mounted for movement to and from a bowling alley, a plurality of pin spotters mounted on said table in an arrangement conforming substantially with the playing positions of pins spotted on said alley, a plurality of similarly arranged pin respotting units mounted on said table, driving means for moving said table to and from said alley to spot and respot pins thereon, a multilevel stepper relay having ganged wiper fingers and at least a first, second and third level, a plurality of spaced contacts on each of said levels, one of said wiping fingers being operatively associated with each of said levels and adapted to successively engage said contacts in response to the actuation of said stepper relay, a control circuit for said table

driving means connected to selected contacts of said first level, control circuit means including said second level of contacts for selectively energizing said relay to move said ganged fingers to engage selected contacts of said levels for actuating said table control circuit, programming circuit means connected to selected contacts of said third level and including electrically interlocked devices operatively connected to said first and second levels for controlling the operation of said table and said relay, said programming circuit means including means for intermittently energizing said relay through contacts of said second level, circuit means responsive to the rolling of a first ball foul connected to said programming circuit means for causing said programming circuit means to energize said relay and advance said wiper arms to engage a predetermined sequence of contacts of said first and second level to program said machine through a foul cycle including programming said table through one cycle of operation to deliver a new set of pins to said alley after the occurrence of a first ball foul.

10. The invention defined in claim 9 including a pin distributor adapted to move stepwise from one empty spotter to another to deliver a plurality of pins in succession thereto subsequent to the spotting of said pins on said alley, a fourth contact level on said relay, a control circuit for actuating said spotters and a control circuit for actuating said distributor connected to selected contacts of said fourth level and having active and passive states, said distributor control circuit being placed in an

active state concurrently with the activation of said spotter control circuit to prepare said distributor control circuit for subsequent energization, means operated by selected contacts of said fourth level of said stepper relay for actuating said spotters to spot a new set of pins on said alley whenever a first ball foul is rolled, said distributor control circuit including circuit means actuated by said contacts of said fourth level operative after said pins have been spotted for actuating said distributor to deliver a plurality of pins in succession to said empty spotters.

11. The invention defined in claim 8 and further including circuit means responsive to the rolling of a first ball foul connected to said programming circuit means for causing said programming means to energize a predetermined sequence of contacts of said first and second level to program said table through one cycle of operation to deliver a new set of pins to said alley after the occurrence of said foul.

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