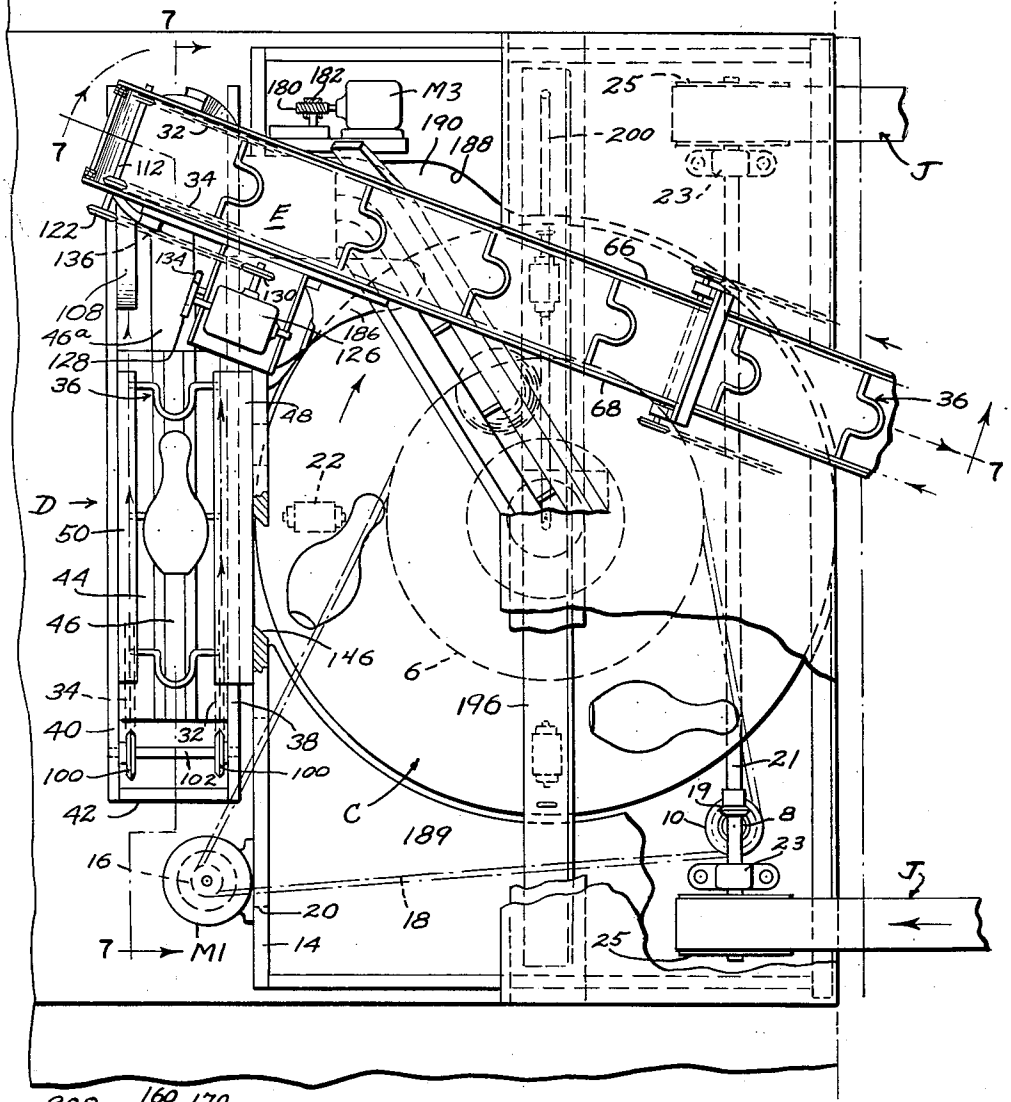
Nov. 13, 1962 H. M. DOWD ET AL 3,063,716

AUTOMATIC BOWLING PIN SETTING MACHINE

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FIG. 1a



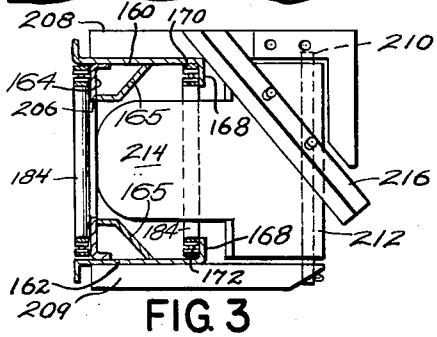


FIG. 3

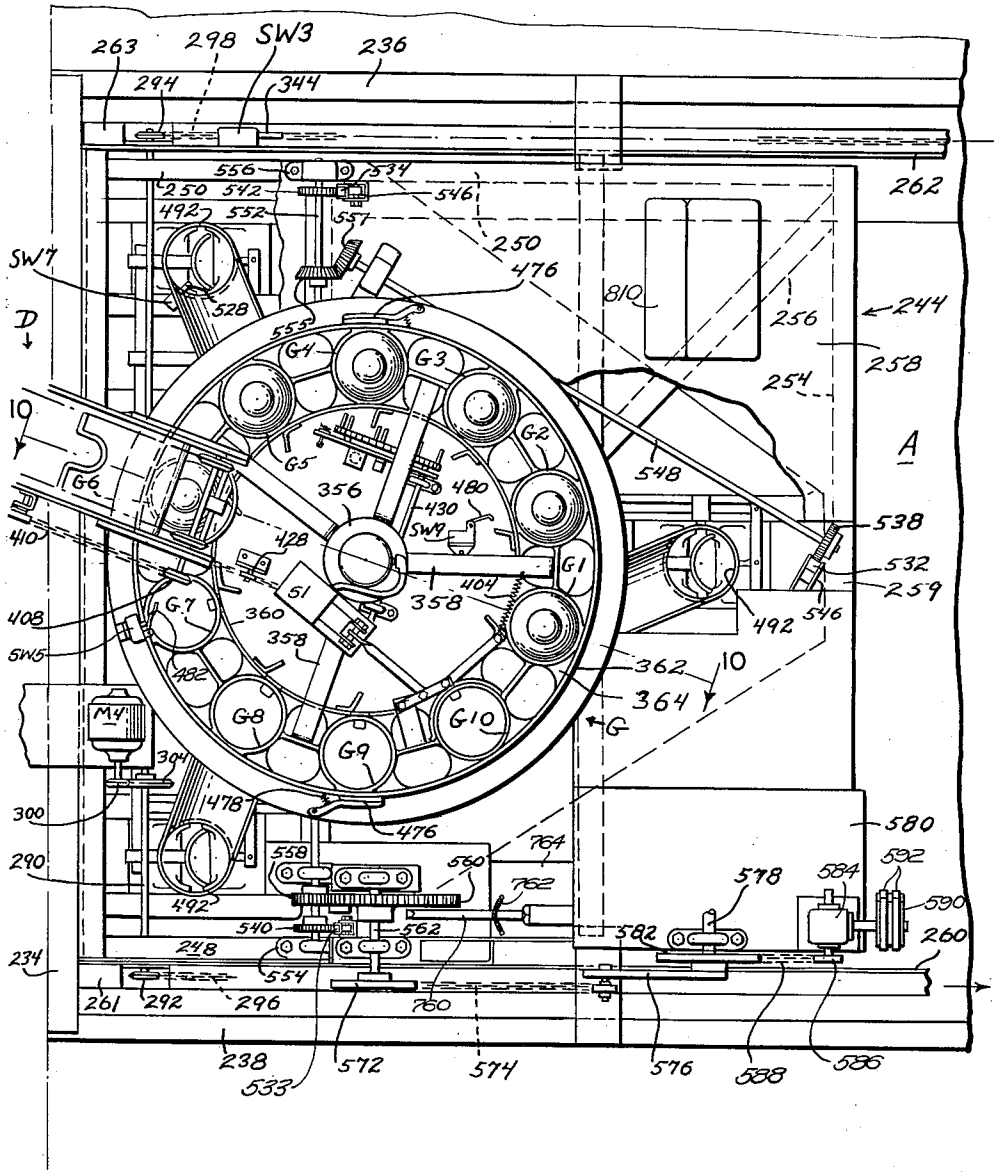
INVENTORS.
HOWARD M. DOWD
ROYAL L. BARROWS
BY
Porter, Chittick & Russell
ATTORNEYS

Nov. 13, 1962 H. M. DOWD ET AL 3,063,716

AUTOMATIC BOWLING PIN SETTING MACHINE

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FIG. 1b



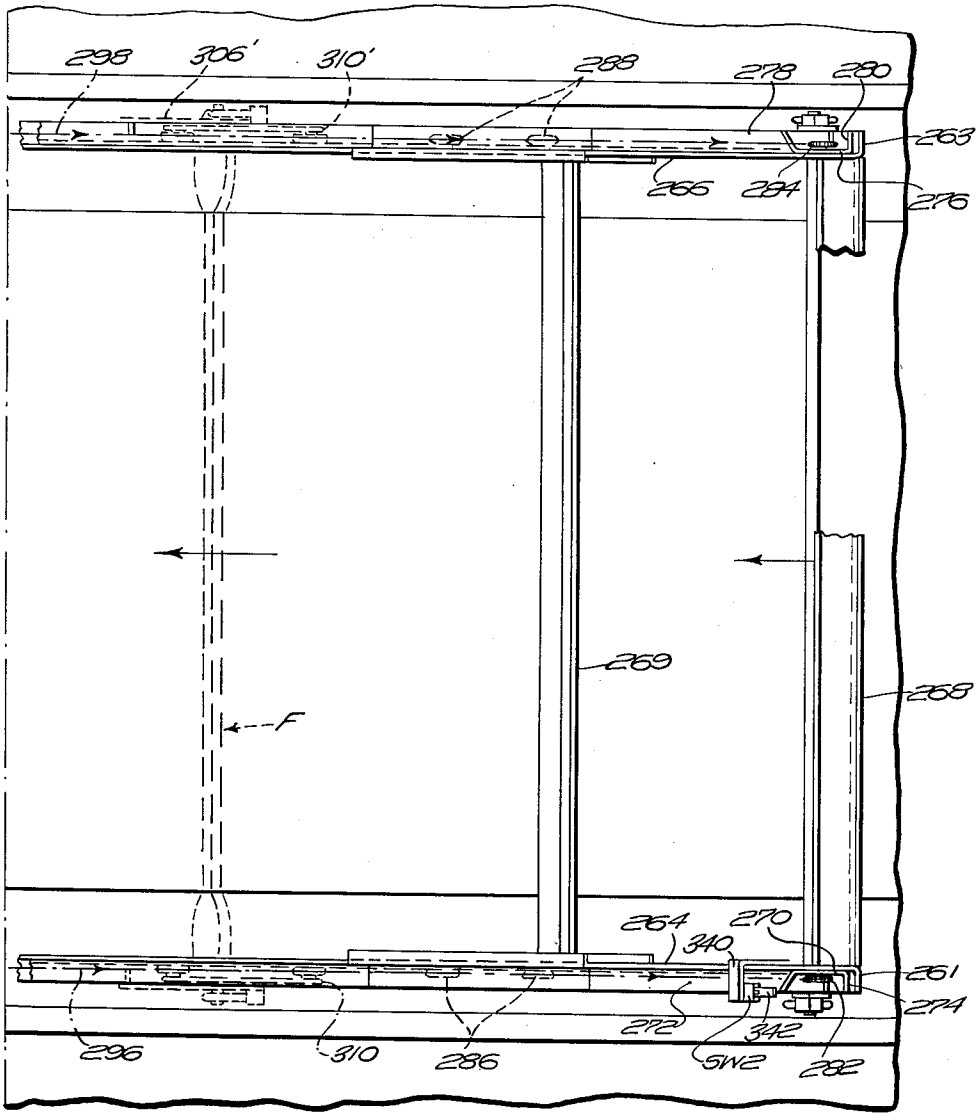
INVENTORS.
HOWARD M. DOWD
ROYAL L. BARROWS
BY
Porter, Chittick & Russell
ATTORNEYS

Nov. 13, 1962 H. M. DOWD ET AL 3,063,716

AUTOMATIC BOWLING PIN SETTING MACHINE

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FIG. IC



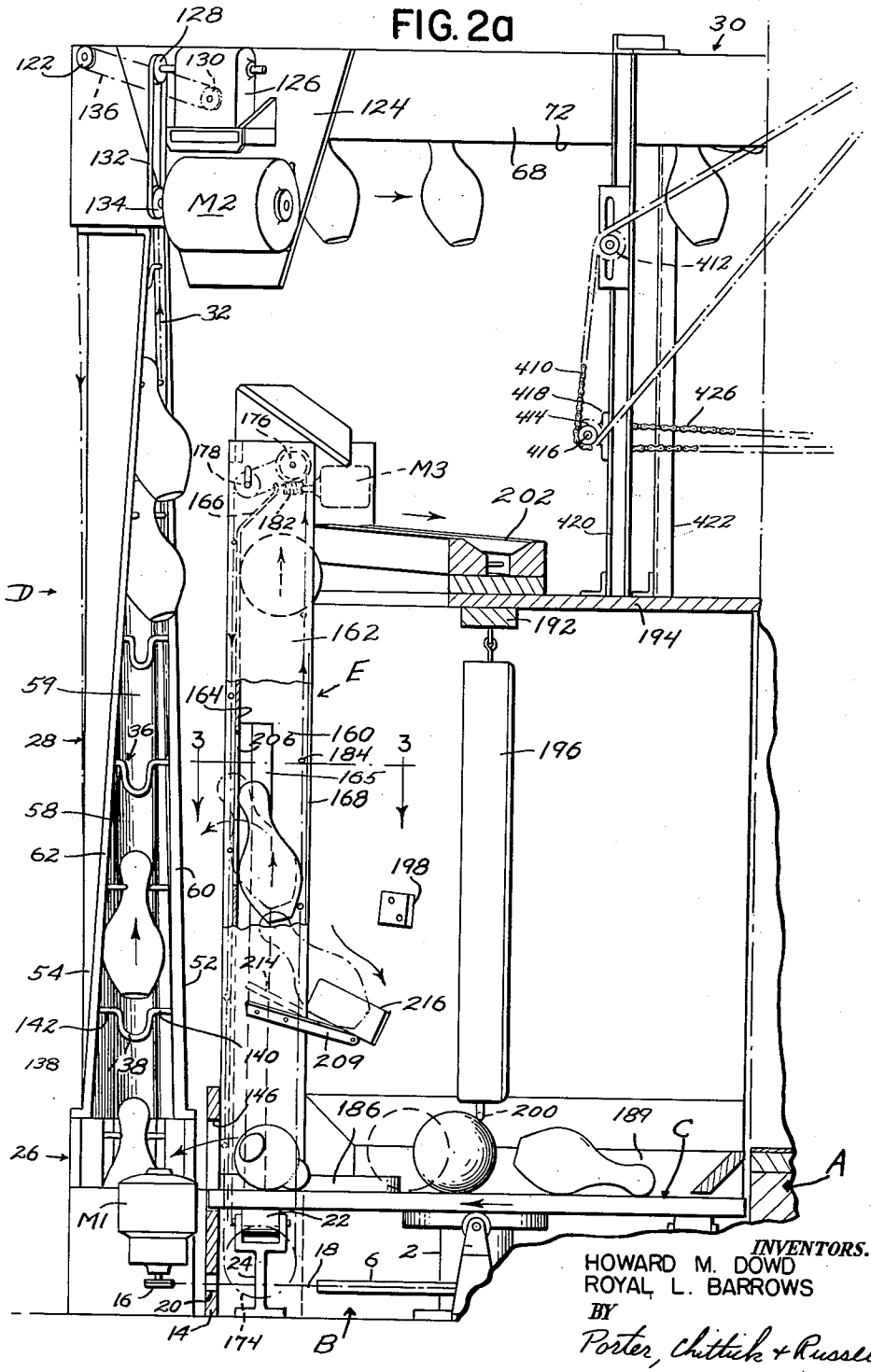
INVENTORS.
HOWARD M. DOWD
ROYAL L. BARROWS
BY
Porter, Chittick & Russell
ATTORNEYS

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AUTOMATIC BOWLING PIN SETTING MACHINE

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FIG. 2a



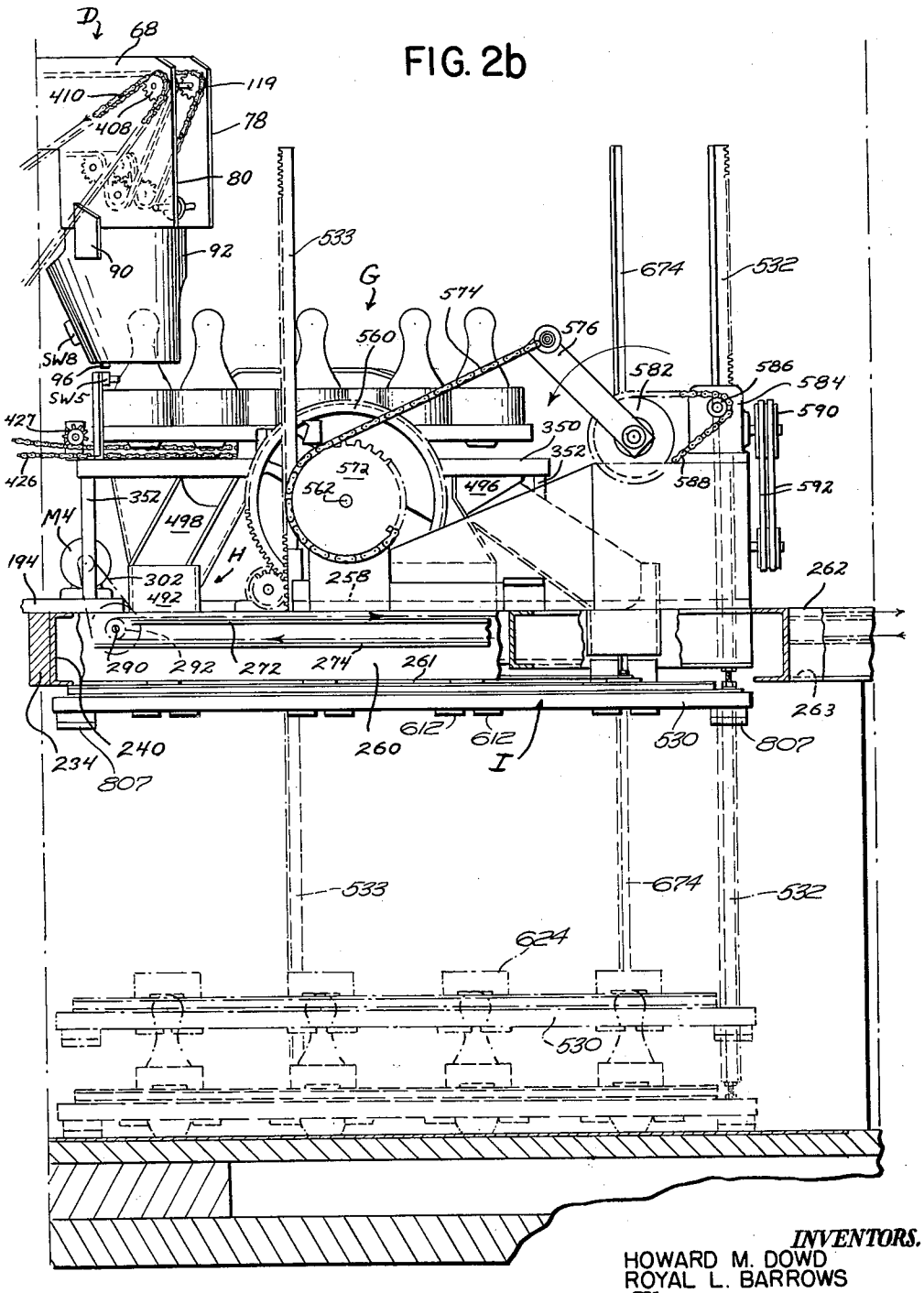
INVENTORS.
HOWARD M. DOWD
ROYAL L. BARROWS
BY
Porter, Chittick & Russell
ATTORNEYS

Nov. 13, 1962 H. M. DOWD ET AL 3,063,716

AUTOMATIC BOWLING PIN SETTING MACHINE

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FIG. 2b



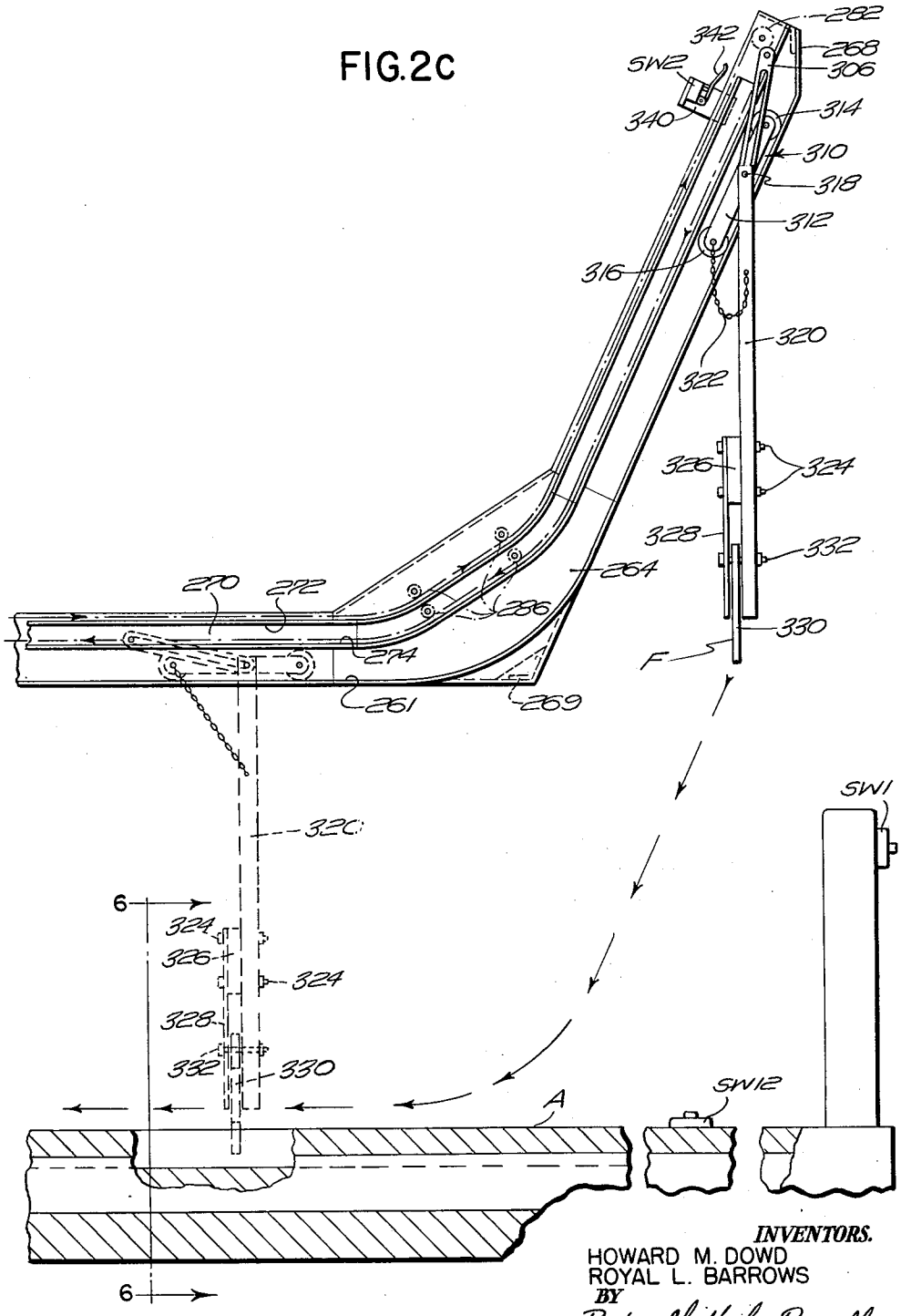
INVENTORS.
HOWARD M. DOWD
ROYAL L. BARROWS
BY
Porter, Chittick & Russell
ATTORNEYS

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AUTOMATIC BOWLING PIN SETTING MACHINE

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FIG. 2c



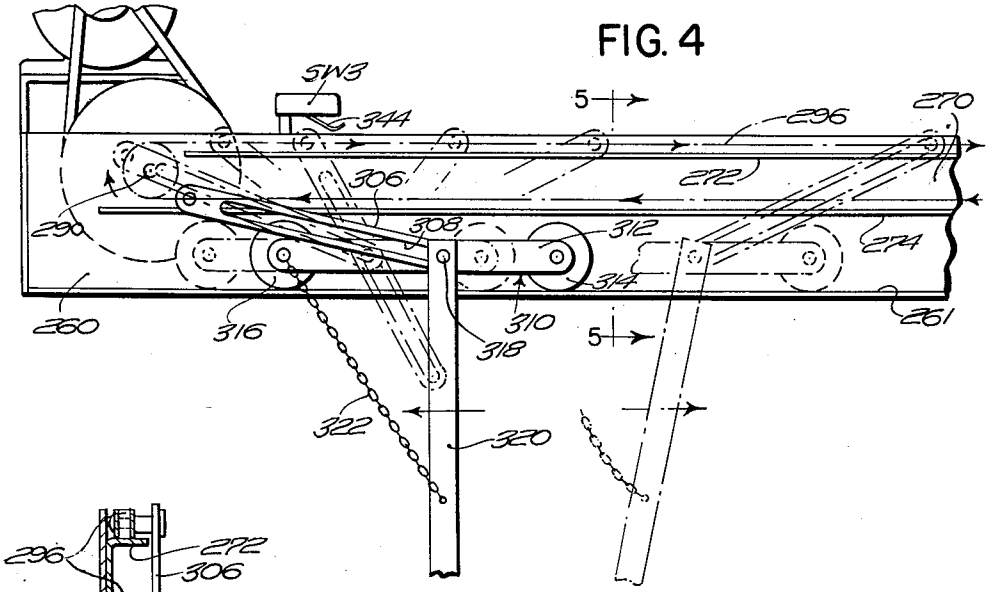
INVENTORS.
HOWARD M. DOWD
ROYAL L. BARROWS
BY
Porter, Chittick & Russell
ATTORNEYS

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AUTOMATIC BOWLING PIN SETTING MACHINE

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FIG. 4



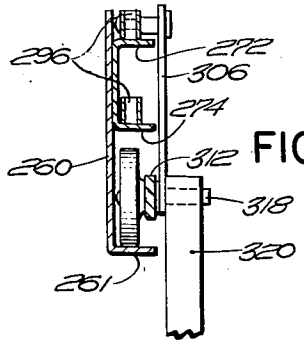


FIG. 5

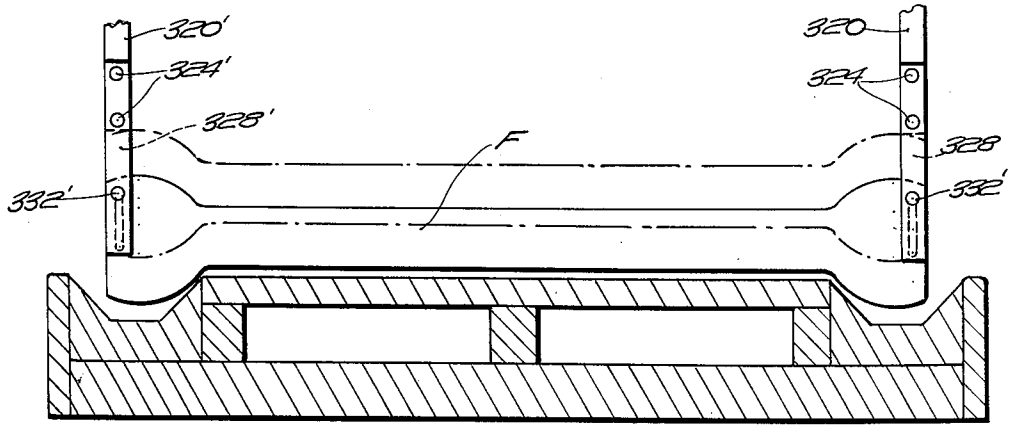


FIG. 6

INVENTORS.
HOWARD M. DOWD
ROYAL L. BARROWS
BY
Porter, Chittick & Russell
ATTORNEYS

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AUTOMATIC BOWLING PIN SETTING MACHINE

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FIG. 7

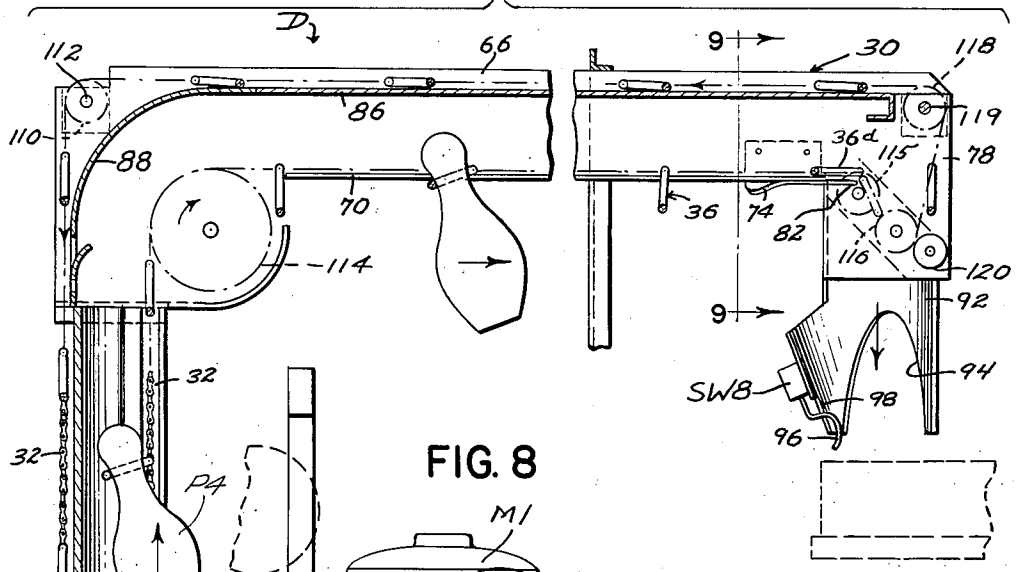
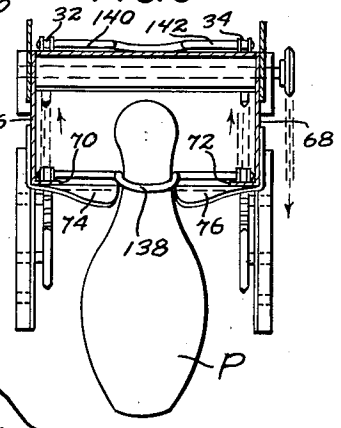


FIG. 8

FIG. 9



INVENTORS.
HOWARD M. DOWD
ROYAL L. BARROWS
BY
Porter, Chittick & Russell
ATTORNEYS

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AUTOMATIC BOWLING PIN SETTING MACHINE

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FIG. 10

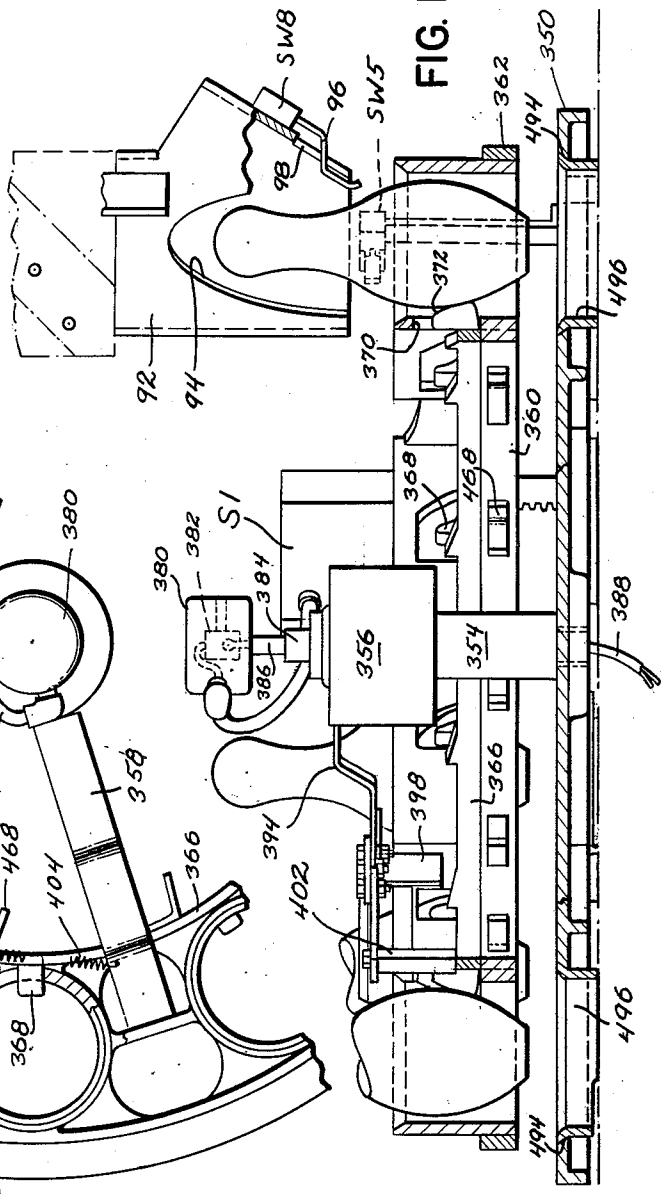
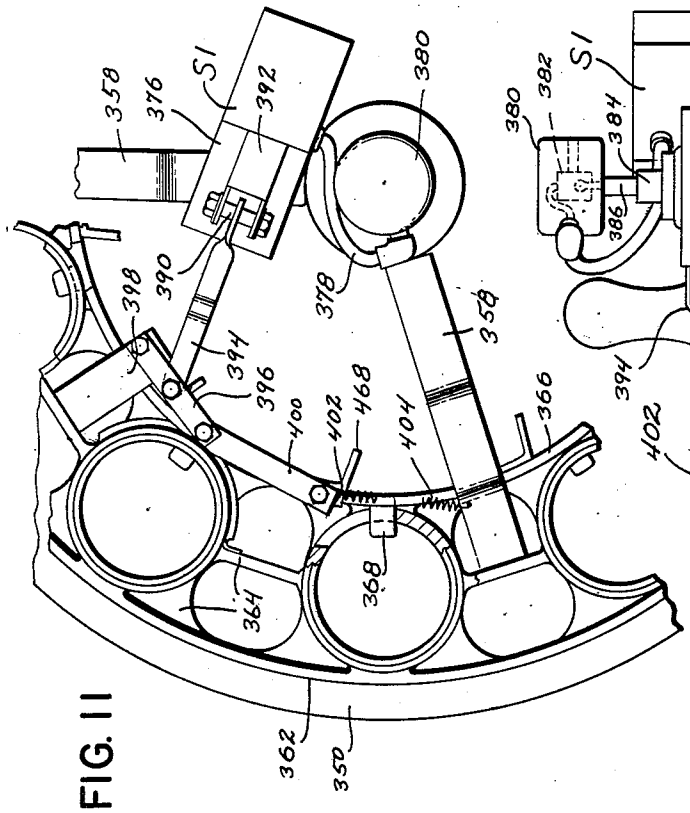


FIG. 11



INVENTORS.
HOWARD M. DOWD
ROYAL L. BARROWS

BY Porter, Chittick & Russell
ATTORNEYS

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AUTOMATIC BOWLING PIN SETTING MACHINE

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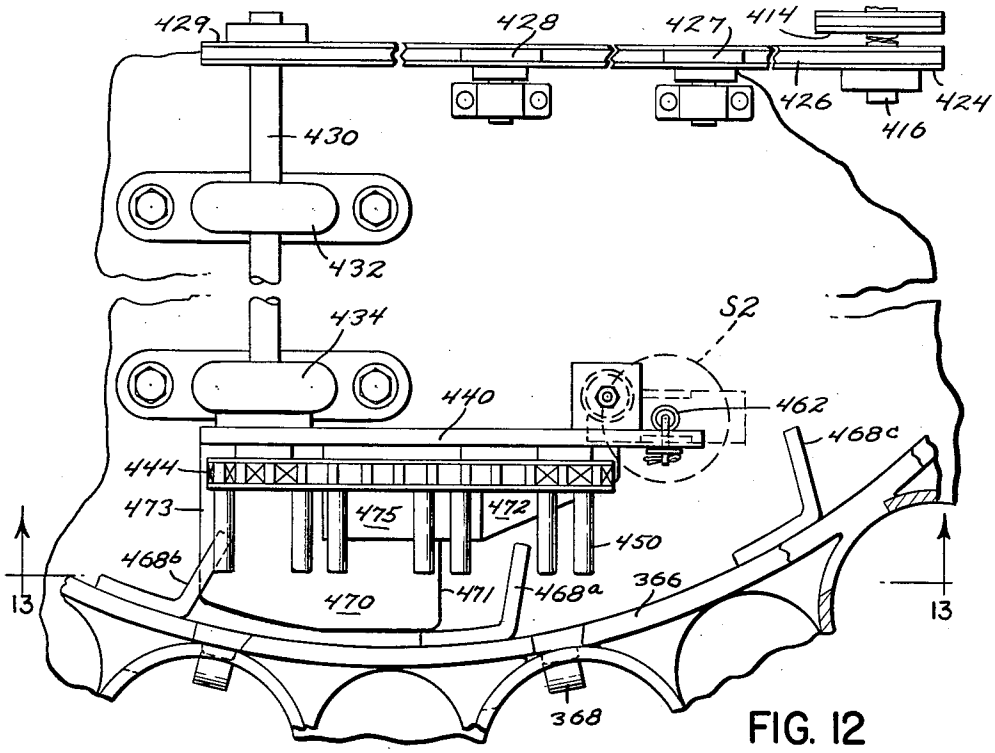
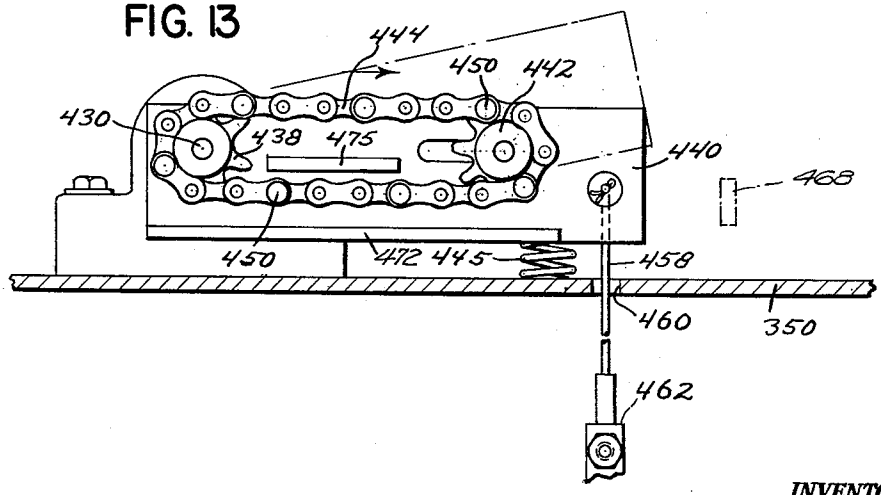


FIG. 12

FIG. 13



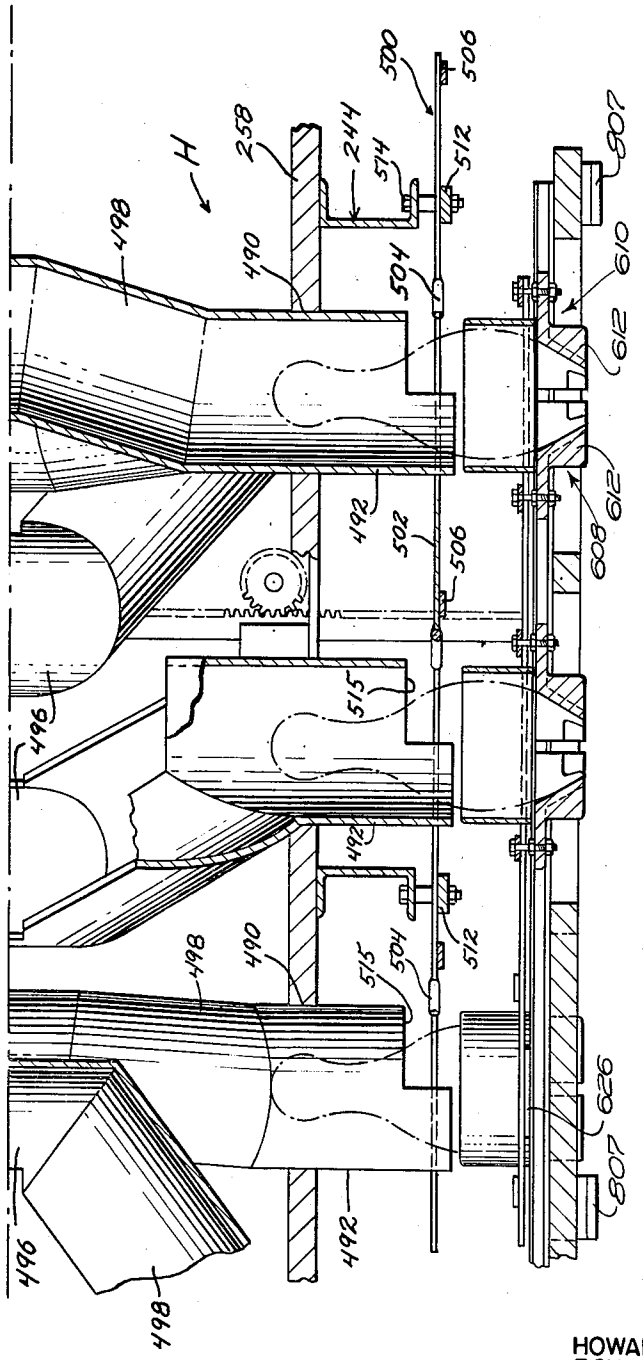
INVENTORS.
HOWARD M. DOWD
ROYAL L. BARROWS
BY
Porter, Chittick & Russell
ATTORNEYS

Nov. 13, 1962 H. M. DOWD ET AL 3,063,716

AUTOMATIC BOWLING PIN SETTING MACHINE

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FIG. 14



INVENTORS.
HOWARD M. DOWD
ROYAL L. BARROWS
BY
Porter, Chittick & Russell
ATTORNEYS

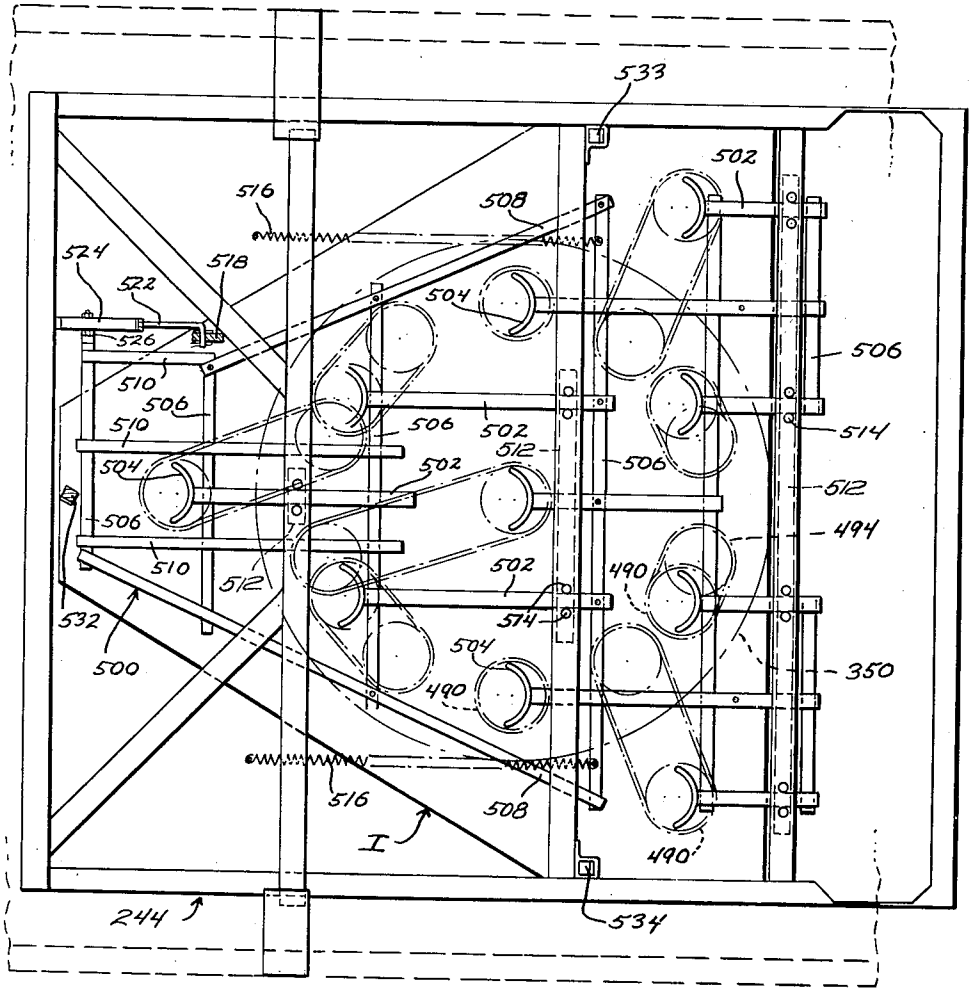
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AUTOMATIC BOWLING PIN SETTING MACHINE

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FIG. 15

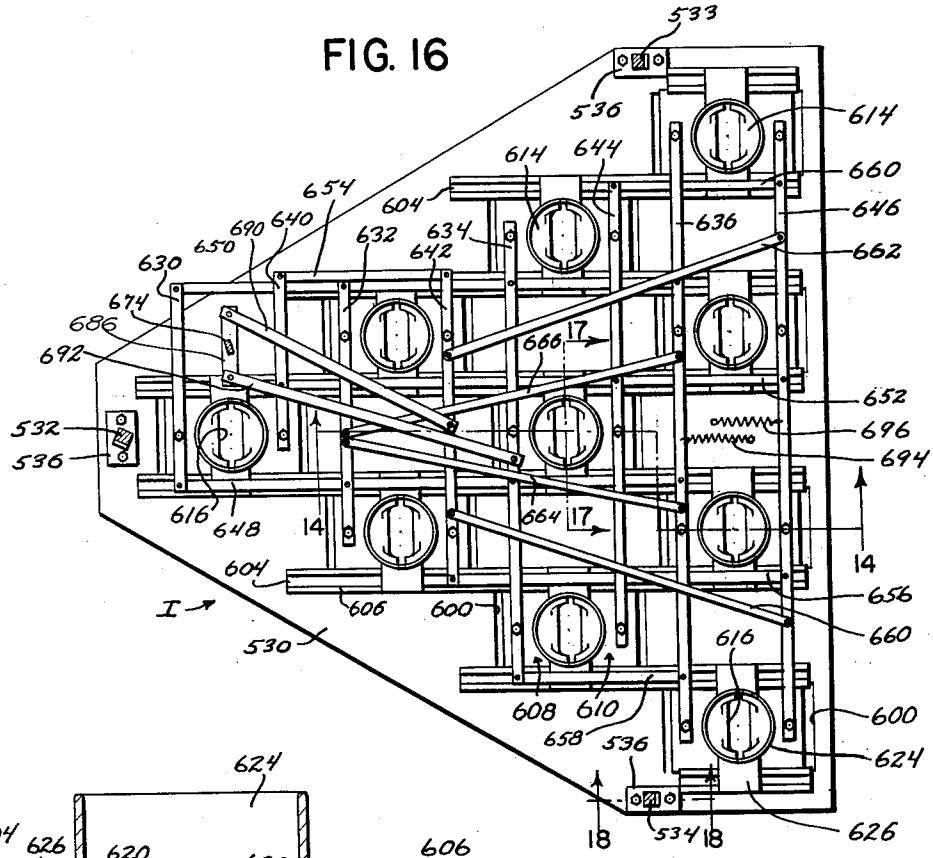


INVENTORS.
HOWARD M. DOWD
ROYAL L. BARROWS
BY
Porter, Chittick & Russell
ATTORNEYS

AUTOMATIC BOWLING PIN SETTING MACHINE

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FIG. 16



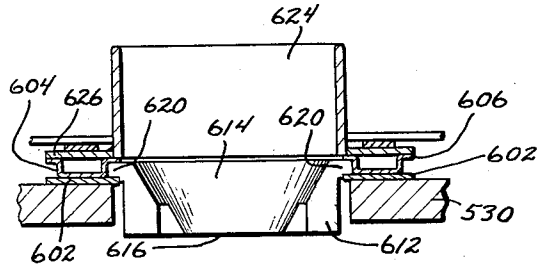


FIG. 17

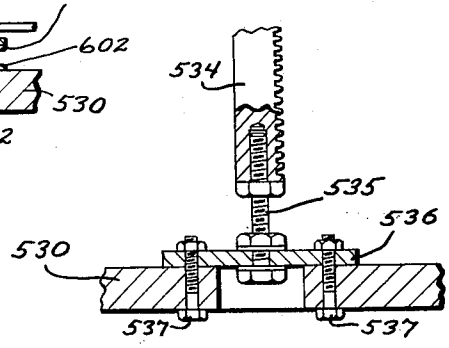


FIG. 18

INVENTORS.
HOWARD M. DOWD
ROYAL L. BARROWS
BY
Porter, Chittick & Russell
ATTORNEYS

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AUTOMATIC BOWLING PIN SETTING MACHINE

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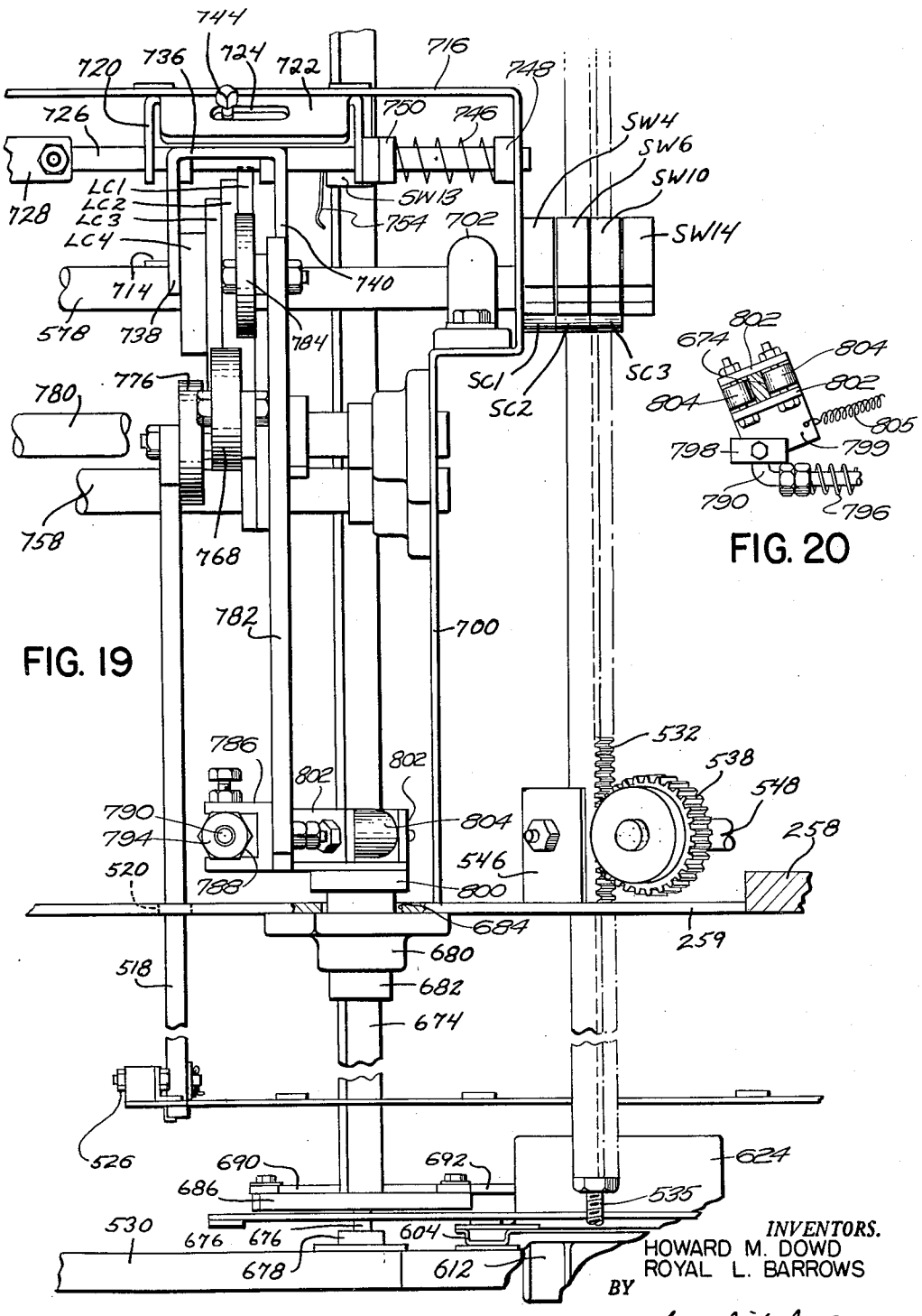


FIG. 19

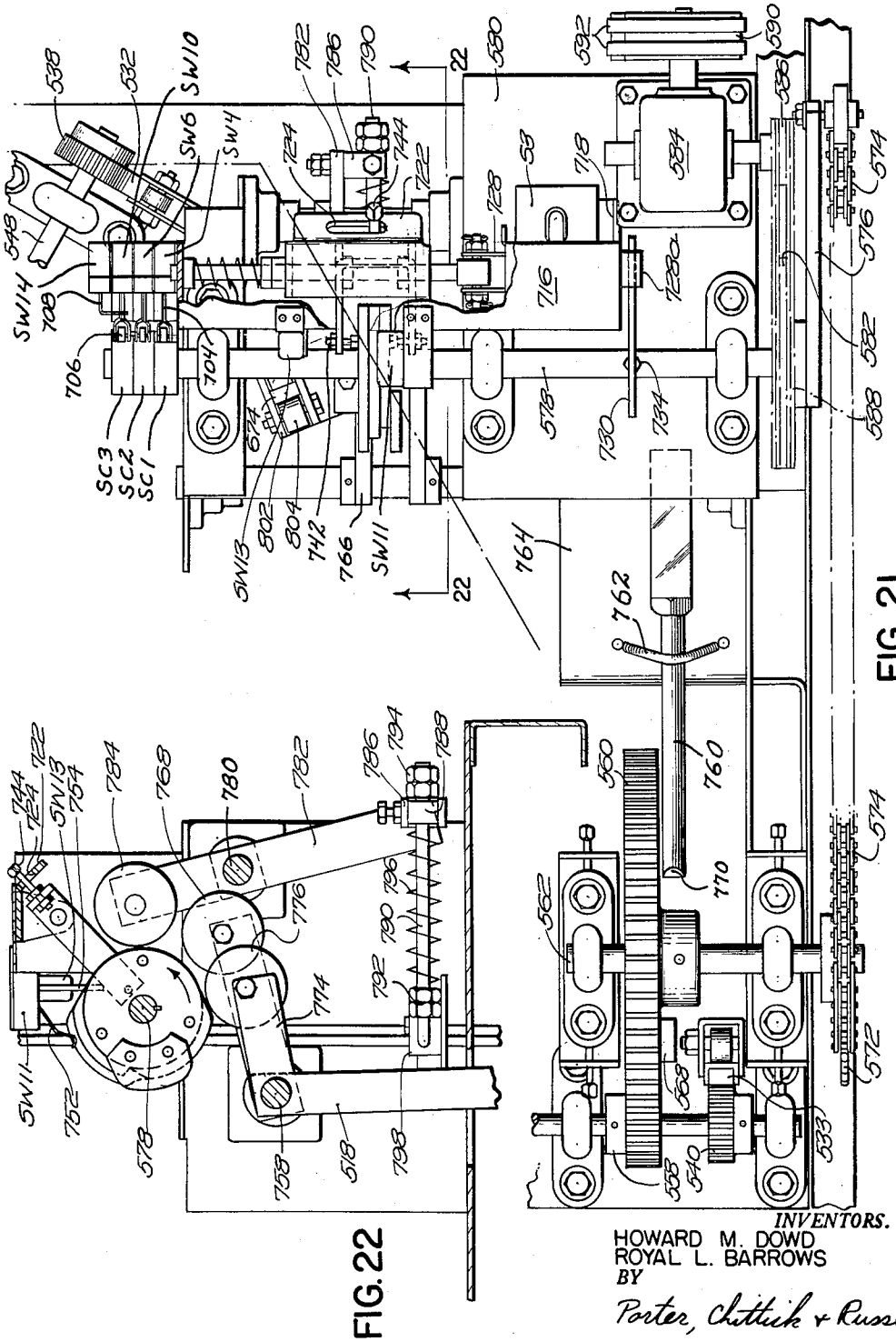
FIG. 20

INVENTORS.
HOWARD M. DOWD
ROYAL L. BARROWS
BY
Porter, Chittick & Russell
ATTORNEYS

Nov. 13, 1962 H. M. DOWD ET AL 3,063,716

AUTOMATIC BOWLING PIN SETTING MACHINE

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INVENTORS.
HOWARD M. DOWD
ROYAL L. BARROWS
BY
Porter, Chittick & Russell
ATTORNEYS

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AUTOMATIC BOWLING PIN SETTING MACHINE

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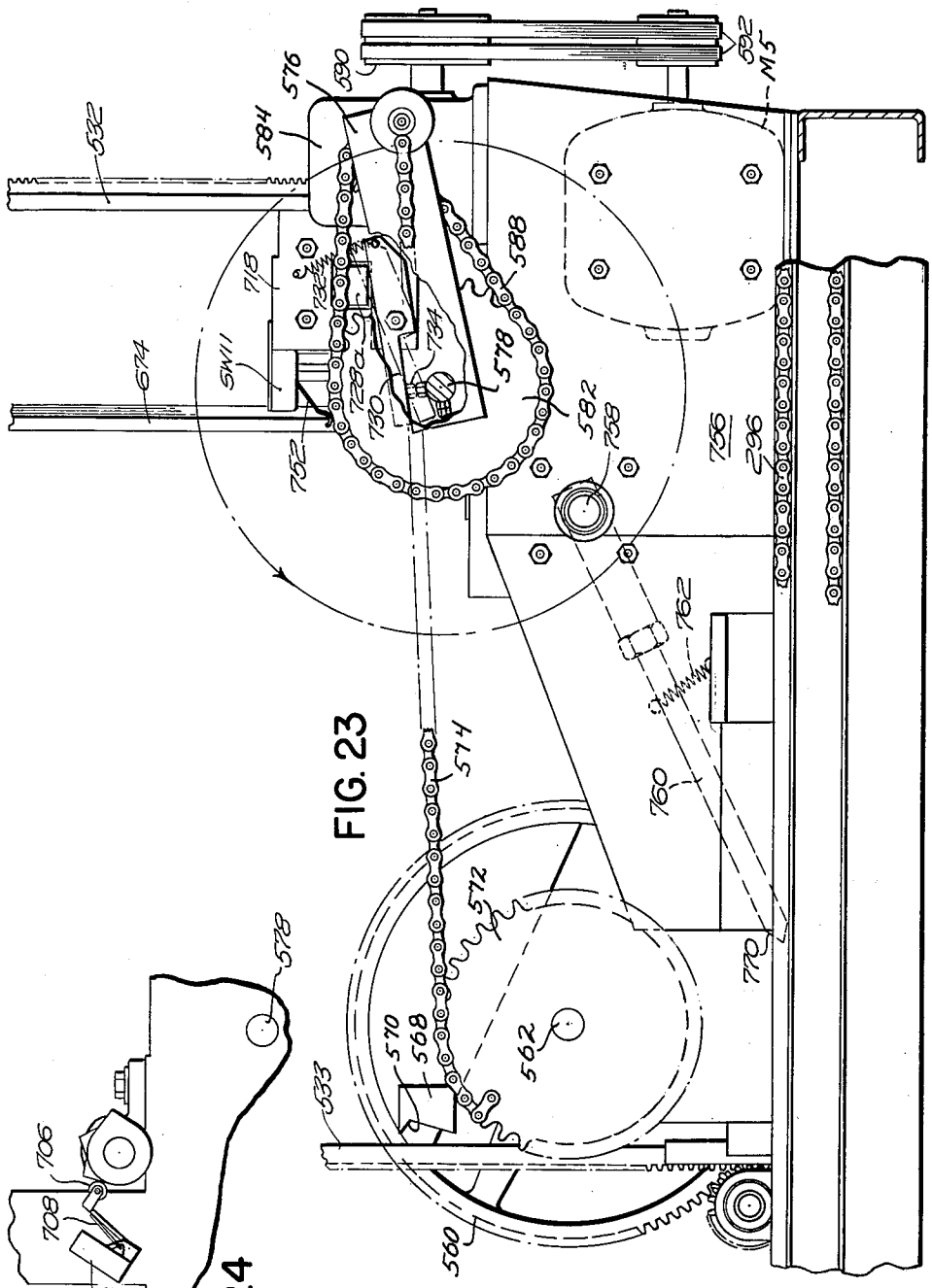


FIG. 23

FIG. 24

INVENTORS
HOWARD M. DOWD
ROYAL L. BARROWS
BY
Porter, Chittick & Russell
ATTORNEYS

Nov. 13, 1962 H. M. DOWD ET AL 3,063,716

AUTOMATIC BOWLING PIN SETTING MACHINE

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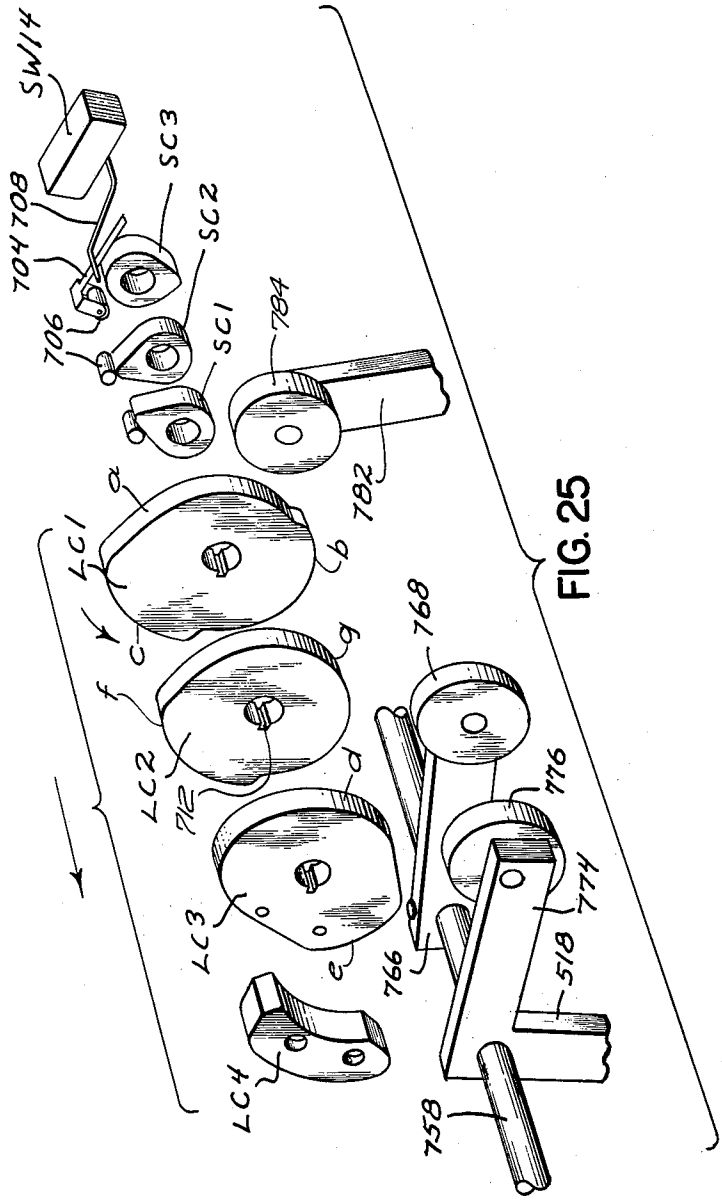


FIG. 25

INVENTORS.
HOWARD M. DOWD
ROYAL L. BARROWS
BY
Porter, Chittick & Russell
ATTORNEYS

Nov. 13, 1962 H. M. DOWD ET AL 3,063,716

AUTOMATIC BOWLING PIN SETTING MACHINE

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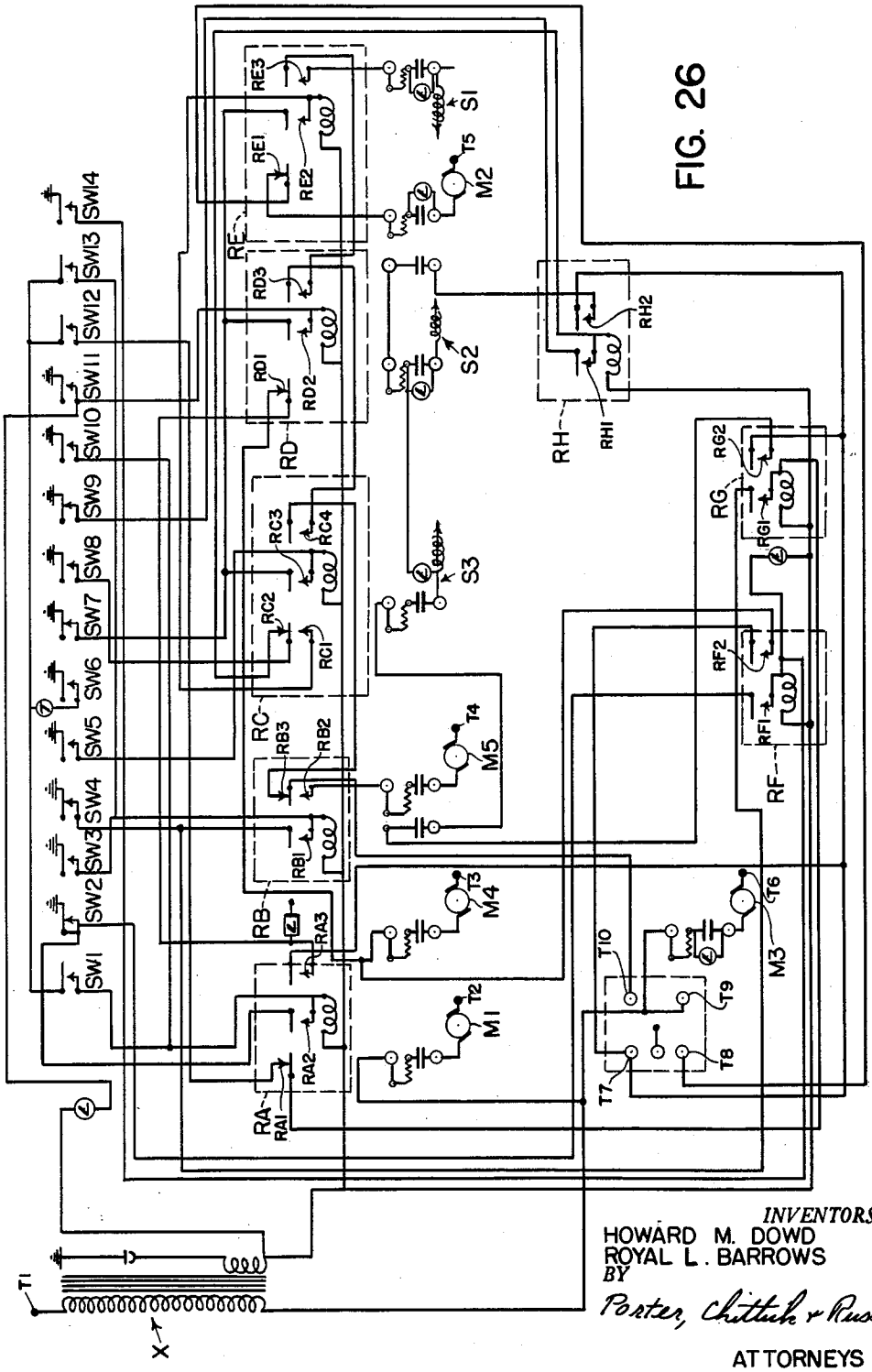


FIG. 26

INVENTORS
HOWARD M. DOWD
ROYAL L. BARROWS
BY
Porter, Chittick & Russell
ATTORNEYS

United States Patent Office 3,063,716 Patented Nov. 13, 1962

3,063,716

AUTOMATIC BOWLING PIN SETTING MACHINE

Howard M. Dowd, Littleton, Mass. (31 Milk St., Boston 9, Mass.), and Royal L. Barrows, Middleton, Mass. (10 Woodland St., Everett 49, Mass.)

Filed Dec. 3, 1956, Ser. No. 625,739
3 Claims. (Cl. 273—43)

This invention relates to bowling pin setting machines and more particularly to novel mechanism for automatically setting duck pins and king pins.

Many mechanisms have been designed for the purpose of setting bowling pins of the duck pin and ten pin types, but for various reasons they have failed to fully satisfy bowling alley proprietors and the bowling public. The primary purpose of a pin setting machine is to eliminate the need for pin boys; but for pin setting machines to fully supplant pin boys and to be commercially successful as well as acceptable to the bowling public, it is necessary not only that such machines be capable of fully performing the various functions of a pin boy, but also that they (1) be of compact design to fit in existing alleys without need for extensive revamping of the alley structure; (2) operate accurately and rapidly; (3) be under complete control of the bowler; (4) be substantially free of jamming; and (5) have a cost of installation, use and maintenance that fully justifies the fact of automation. Machines hitherto designed have failed to satisfy all of the aforesaid requirements. Some have not been capable of fully performing all of the normal functions of a pin boy, such as removing dead wood. Others have been so large or heavy as to require enlargement or strengthening of bowling alley establishments. Still others have operated too slowly or inconsistently, or have required constant attention to remove pins that become jammed in the varioun mechanisms or have piled up in the pit due to failure of the pin conveyor to pick them up. In many cases the designs have been such as to make prohibitive the cost of installation and maintenance. Other specific faults and criticisms may be noted against specific mechanisms.

Accordingly the object of this invention is to provide an automatic bowling pin setting machine that is adapted to set duck pins, but which can be modified by dimensional changes to accommodate the larger ten pins (also called king pins), and which is so designed as to be free of the faults noted above attendant to other pin setting machines hitherto invented.

Another object of this invention is to provide a bowling pin setting machine having means for sweeping pins and balls from the alley and gutters, means for removing pins and balls from the alley pit, means for directing balls back to the bowler, means for conveying pins from the level of the pit to a distributing mechanism located above the alley, storage means for receiving a complete set of pins from the distributing means, a pin setting rack, means for releasing pins from the storage means to the pin setting rack, means under the bowler's control for lowering the rack to deposit a complete set of pins on the alley floor, means under the bowler's control for causing the rack to pick up standing pins on the alley so as to allow dead wood to be swept from the alley and to redeposit said standing pins on the alley floor after removal of the dead wood, and control means for causing said various means to operate in a predetermined manner so as to maintain a complete set of pins available for deposit on the alley upon request while at the same time permitting selective operation of the sweeper and pin setting rack to remove dead wood and, if necessary, to pick up standing pins preparatory to removal of dead wood.

Another object is to provide improvements in (1) means for sweeping pins from the alley floor; (2) means

for separating balls and pins in the alley pit; (3) means for picking up, conveying and discharging bowling pins; (4) means for picking up, conveying and discharging bowling balls; (5) means for storing and distributing pins; (6) means for setting pins on the alley floor and for picking up pins from the alley floor; and (7) means for starting and limiting operation of the aforementioned means so as to (*a*) control the traffic of pins throughout the machine, (*b*) maintain a complete set of pins in ready reserve for setting, (*c*) prevent operation of certain mechanisms except under the correct conditions, (*d*) selectively cause certain mechanisms to perform one of several operations, (*e*) remove control of the machine from the bowler after the machine has been set in operation, and (*f*) restore control to the bowler only after the machine has completed its particular operation.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

FIGS. 1*a*, 1*b*, and 1*c* together comprise a plan view of the bowling pin setting machine of this invention, with certain portions broken away and omitted for ease of illustration;

FIGS. 2*a*, 2*b*, and 2*c* together comprise a side elevation of the same machine, with certain portions broken away or shown in section for ease of illustration;

FIG. 3 is a sectional view taken along line 3—3 of FIG. 2*a*;

FIG. 4 is an enlarged fragmentary side elevation showing details of the pin sweeper carriage mechanism;

FIG. 5 is a sectional view in elevation taken along line 5—5 of FIG. 4;

FIG. 6 is a sectional view taken along line 6—6 of FIG. 2*c*;

FIG. 7 is a sectional view of the bowling pin elevator, the section being taken along line 7—7—7—7 of FIG. 1*a*; however, for convenience the several portions of the pin elevator are illustrated as residing in a common plane;

FIG. 8 is a sectional view taken along line 8—8 of FIG. 7;

FIG. 9 is a sectional view taken along line 9—9 of FIG. 7;

FIG. 10 is an enlarged sectional view in elevation of the pin distributor mechanism, the section being taken along line 10—10 of FIG. 1*b*;

FIG. 11 is an enlarged fragmentary plan view of the pin distributor mechanism;

FIG. 12 is an enlarged fragmentary plan view of the pin distributor showing details of the clutch mechanism for indexing the distributor;

FIG. 13 is a sectional view in elevation taken along line 13—13 of FIG. 12;

FIG. 14 is a sectional view in elevation of the pin reservoir section and the pin setting board, the view being taken along a line corresponding to line 14—14 of FIG. 16;

FIG. 15 is a plan view of the pin storage finger assembly;

FIG. 16 is a plan view of the pin-positioning board;

FIG. 17 is a sectional view taken along line 17—17 of FIG. 16;

FIG. 18 is a sectional view taken along line 18—18 of FIG. 16;

FIG. 19 is a fragmentary front view in elevation of the mechanism for operating and controlling the storage finger assembly and the pin-positioning board;

FIG. 20 is an enlarged plan view of certain of the elements for opening and closing the cups of the pin-positioning board;

FIG. 21 is an enlarged plan view of the control mecha-

nism of the machine, including some of the mechanism shown in FIG. 19;

FIG. 22 is a sectional view in elevation taken along line 22—22 of FIG. 21;

FIG. 23 is an enlarged side elevation of the mechanism shown in FIG. 21 for raising and lowering the pin-positioning board;

FIG. 24 is an enlarged side elevation of a portion of the mechanism of FIGS. 19 and 21;

FIG. 25 is a perspective view showing certain of the elements of the mechanism illustrated in FIGS. 19 and 21; and,

FIG. 26 is a schematic representation of the electrical circuits of the machine.

Referring more particularly to the drawings there is shown a conventional bowling alley A, having a stationary pit B at the rear end thereof. Disposed at this same end of the alley is a bowling pin setting machine constructed according to this invention. The machine as illustrated is adapted to handle duck pins. However, by appropriately changing the dimensions of the various pin-transporting mechanisms, machines can be constructed to handle the larger ten pins instead.

The machine can be divided into seven component mechanisms, namely, an alley pit turntable C, a pin elevator D, a ball elevator E, a pin sweeper F, a pin distributor G, a pin reservoir H, and a pin spotting and respotting rack I. Continuously operating gutter belts J for sweeping balls and pins from the gutters of the alley form part of the alley pit turntable mechanism. In addition the machine includes mechanism for operating the aforesaid component mechanisms and electrical controls for controlling said operating mechanism. In the following specification, the operating mechanisms and the various electrical controls are described concurrently with the description of the mechanisms with which they are associated only to the extent necessary to facilitate proper description of the latter and to establish the location and relationship of the former relative to the latter; otherwise the operating mechanisms and electrical controls are described separately.

Pit Turntable C

Positioned in pit B of the alley is a turntable C. The turntable is secured to and supported by a cylindrical member 2 which is rotatably secured to a bearing plate 4 fixed to the floor of the pit B. A large pulley 6 is secured to cylindrical member 2. Also located in the pit at a fixed position is a rotatable vertical shaft 8 provided with an idler pulley 10. A turntable drive motor M1 is located behind the rear wall 14 of the pit. Motor M1 has a drive pulley 16 which acts to drive a belt 18 which passes through a hole 20 in rear wall 14 and rides about idler pulley 10 and pulley 6 to drive the turntable clockwise (FIG. 1*a*). A plurality of rollers 22 which are rotatably secured to standards 24 engage the underside of the turntable adjacent its edge and act to prevent the turntable from wobbling or breaking under the impact of pins and balls delivered thereto from the alley.

Engaging the top surface of pulley 10 is a wheel 19 fixedly mounted on a shaft 21 extending transversely of the pit beneath the turntable. Shaft 21 is journaled in bearings 23 and is provided at its ends with pulleys 25 which drive endless gutter belts J. Two additional pulleys (not shown) are positioned in the gutters further back in the alley and are so positioned as to direct the upper run of the belts over the top surface of the gutter. Pulley 10 drives wheel 19 and shaft 21 in a direction such that the upper run of the belts moves toward the pit, as shown by the arrow in FIG. 1*a*. The gutter belts operate continuously so long as motor M1 is operating.

Pin Elevator D

Located at the rear end of the pit is a pin elevator D. This component mechanism comprises three integrated frame sections 26, 28 and 30, and a pin conveyor comprising a pair of endless chains 32 and 34 which cooperate to transport a plurality of pin-conveying elements generally identified by numeral 36. Frame section 26 is disposed behind rear wall 14 of the pit and extends horizontally and laterally of the machine. Frame section 26 has a pair of wall members 38 and 40 secured together in parallel spaced relation by a vertical end wall 42 and a horizontal floor member 44 located between the upper and lower edges of wall members 38 and 40. Floor member 44 terminates short of end wall 42 and is offset along its center line to provide a longitudinally extending channel section 46. At the end opposite wall 42, floor 44 curves upwardly as at 47. The curved floor section 47 has a longitudinal channel 46*a* which is deeper than channel 46 and connects with the latter at 152. Channel 46*a* is wide enough to receive the V-shaped portion 138 on pin carrier elements 36 and the head but not the body of a bowling pin. Also secured to wall members 38 and 40 above floor member 44 are two inclined wall members 48 and 50 which act to deflect and guide pins into the channel 46 of floor member 44. Wall members 48 and 50 also shield chains 32 and 34 from pins falling into the trough defined by wall members 38 and 40 and floor member 44.

At the end opposite end wall 42 the two side walls 38 and 40 are joined to the two vertically extending side walls 52 and 54 of frame section 28. As shown in FIG. 2*a* the bottom ends of side walls 52 and 54 are in the same vertical planes as walls 38 and 40, which planes are parallel to the plane of rear pit wall 14. However, side walls 52 and 54 are both permanently twisted so that their upper ends lie in vertical planes extending obliquely of the machine. Extending between and secured to side walls 52 and 54 is an elongated plate or partition 58 having a U-shaped channel 59 which functions as a continuation of channel 46*a*. Plate 58 is permanently twisted in conformance with the twist of side walls 52 and 54. The front edges of side walls 52 and 54 are also provided with flanges 60 and 62 which are disposed parallel to plate 58 and cooperate with the latter to provide a guideway for chains 32 and 34.

Frame section 30 comprises two side wall members 66 and 68 secured to the top ends of side wall members 52 and 54. Both members 66 and 68 have inturned flanges 70 and 72 at their bottom edges, the flanges acting as supporting guideways for chains 32 and 34. At their forward end side wall members 66 and 68 have like pin carrier deflecting members 74 and 76 on their inside surfaces. These pin carrier deflecting members are spaced from each other by an amount large enough to accommodate therebetween the neck portion of a bowling pin P but small enough to intercept and support the curved yoke portion of the pin carriers. Deflecting members 74 and 76 extend between the depending extensions 78 and 80 of the side wall members 66 and 68, terminating at 82. Also secured to the side wall members 66 and 68 is a flat horizontal floor member 86. The rear end of floor member 86 curves downwardly as shown at 88. Attached to depending extensions 78 and 80 by two brackets 90 is a delivery chute 92. The chute is provided with a large arch-like slot 94 on the side beneath extension 78. Slot 94 is wide enough to allow passage therethrough of a bowling pin in upstanding position. Attached to the chute is a normally open switch SW8 having a resiliently mounted switch finger 96 which extends into the bottom end of the chute through a slot 98. Switch finger 96 extends into the chute far enough to be engaged by pins P falling down through the chute. Each time a pin drops through the chute it contacts the switch finger to momentarily close the switch.

The path of travel of chains 32 and 34 is determined by a plurality of sprocket gears. Two sprocket gears 100 are mounted on a shaft 102 journaled in side walls 38 and 40 adjacent end wall 42. Two pairs of sprockets 104

and 106 are rotatably mounted on stub shafts mounted in side walls 38 and 40 adjacent their bottom and rear edges respectively. Each sprocket is mounted on a separate stub shaft. Two large sprockets 108 are mounted on stub shafts mounted adjacent the top edge of side walls 38 and 40. Two small sprockets 110 are mounted on a shaft 112 journaled in side wall members 66 and 68 adjacent the top edge and at the rear end thereof in line with sprockets 106. Two large sprockets 114 are rotatably mounted on stub shafts fixed in side members 66 and 68, directly in line with sprockets 108. Two small sprockets 115 are rotatably mounted on stub shafts mounted in side members 66 and 68 slightly below the end 82 of deflecting members 74 and 76. Two small sprockets 116 are rotatably mounted on stub shafts supported by depending extensions 78 and 80 and two additional sprockets 118 are similarly mounted at the front end of side wall members 66 and 68 above sprockets 116 and in front of horizontal floor member 86. Also journaled in extensions 78 and 80 is a shaft having a centrally disposed roll 120 positioned to deflect pins discharged from the pin conveyor onto switch finger 96.

The end of shaft 112 is provided with a sprocket gear 122. Mounted on a plate 124 attached to wall member 68 of frame section 30 is a motor M2 for operating the pin conveyor. Also mounted on plate 124 is a gear reduction unit 126 provided with a pulley 128 on its input shaft and a sprocket gear 130 on its output shaft. Pulley 128 is driven by a belt 132 that is driven by a pulley 134 mounted on the output shaft of motor M2. Gear 130 drives a chain 136 that drives gear 122 which in turn drives the conveyor chains 32 and 34.

Starting for convenience at gears 110, the endless path followed by the chains is down behind wall section 58, around sprockets 106 and 104, beneath floor 44, about sprockets 100, over floor 44, under and around gears 108, up in front of wall 58 and behind flanges 60 and 62, around gears 114, over flanges 70 and 72 and deflecting members 74 and 76, over and around sprockets 115, under and around sprockets 116, in front of and over sprockets 118, over floor 86, and back around sprockets 110.

The pin carrier elements 36 comprise a central U-shaped portion 138 and oppositely extending arm portions 140 and 142 whose ends are rotatably secured in chains 32 and 34. Successive pin carrier elements are spaced from each other a distance equal to or greater than the overall length of one of the bowling pins P intended to be used in the machine.

Bowling pins P enter the trough defined by wall members 38 and 40 and floor member 44 through a slot in the rear wall 14 of the pit. The slot is L-shaped, comprising a large section 146 and a small section 148. The height of the large slot section 146 is larger than the greatest diameter of the bowling pin but small than the diameter of the bowling ball intended to be used in the machine. The height of the smaller slot section 148 is sufficiently great to accommodate the head but not the body of the bowling pin. The width of slot section 146 is less than twice the greatest diameter of a bowling pin P. The total width of the slot is greater than the length of a pin but preferably smaller than the sum of the diameter of the head portion of one pin and the length of another pin. Tests have shown that with a slot of such shape and size, only one pin at a time can pass through the slot, two pins cannot become wedged in the slot so as to cause a jam-up, and most of the pins will pass through the slot with their longitudinal axes disposed parallel to wall 14 of the pit. Although some of the pins will pass through the slot with either the head or bottom end first, they become alined with the trough upon striking inclined wall members 48 and 50.

In practice it has been found that most of the pins pass through the slot and land in the trough with their head ends pointing in the direction of movement of the upper run of chains 32 and 34 in the trough, as illustrated by the pin P1 positioned in the slot in FIG. 7. Those that land in the trough with their bottom ends pointing in the direction of travel are righted at the end of the trough where the conveyor chains begin their upward run.

Operation of the pin conveyor from the standpoint of conveying pins is as follows: Pins P falling onto turntable C in the alley pit are carried around with the turntable and, due to the centrifugal force generated, the pins migrate toward the edge of the turntable. The pins on the turntable constantly seek to escape but are prevented from doing so by the side and back walls of the pit. However, the pin slot in rear wall 14 does allow the pins to escape and thus the pins are directed into the trough. The pins in the trough rest on floor member 44 with the heads and the fat body portions of the pins tending to lie in the channel 46. As the pin carriers pass over floor 44 away from end wall 42, their U-shaped sections 138 trial their end portions 140 and 142.

Assuming now that a pin passes through the slot in wall 14 with its head end leading its bottom end, (see pin P1 in FIG. 7), a pin carrier (see pin carrier 36*a*) will pass up and around sprocket 100 and will engage the fat part of the pin, causing the pin to move toward sprockets 108. When the pin moves beyond the offset portion 152 of floor 44, its head drops into the deep channel 46*a* (see pin P2). When the pin carrier conveying the pin passes beyond 152, it automatically rotates under gravity so that its U-shaped portion 138 hangs in channel 46*a* below chains 32 and 34 (see pin carrier 36*b*). This same pin carrier moves up along the body of the pin and begins to move upwardly along the curved path followed by chains 32 and 34 around sprockets 108. As it does so it catches the pin at its neck and carries it upwardly toward sprockets 114 (see pin P3 and pin carrier 36*c*). The head of the pin passes from channel 46*a* to channel 59 with the body of the pin engaging and sliding relative to wall member 58. The latter limits swinging of the pin and causes it to quickly assume the inclined position shown in FIG. 7. This inclined position is maintained even after the pin clears the top of wall member 58 and moves forward of sprockets 114. This is due to the center of gravity of the pin being located in the fat body part of the pin and because the pin and its carrier naturally assume the position in which the center of gravity is in vertical alinement with the pivot point of the pin carrier. The pin remains in this position until it reaches deflecting members 74 and 76, whereupon the carrier element slides up on and over the deflecting members (see carrier 36*d*). As it does so it is shifted to a horizontal position so as to place the pin which it carries in a vertical position as it passes between the two deflecting members. The arms 140 and 142 of the pin carrier lead and as they leave the forward end of the deflecting members they are pulled down by the chains toward sprockets 116. The trailing yoke portion 138 of the pin carrier is still supported by the deflecting members when the arms 140 and 142 start moving down toward sprockets 116 and, as a result of the yoke portion being in elevated relation with respect to arms 140 and 142, the pin slides downwardly and forwardly out of the pin carrier element, engages roller 120, and is deflected downwardly and rearwardly to strike switch finger 96 as it passes out of the bottom of chute 92.

It sometimes happens that a pin falls into the trough with its bottom end in leading position. When this occurs the next pin carrier to appear will slide under the head of the pin and engage its body. The pin carrier then acts to move the pin along floor 44. As the pin passes beyond the offset portion 152 of floor 44, its body will be supported by floor section 47, but its head will drop into channel 46*a*. The pin carrier which transported it along floor 44 moves past the pin and moves upward empty. However, the next appearing pin carrier will catch the pin at its neck and move it upwardly with the bottom end of the pin still in leading position. As the pin moves upwardly from the curved floor section 47 it engages wall

58. The body of the pin is too large to fit in channel 59 and as it engages wall 58 it is cammed clockwise by the wall about the pivot of its pin carrier past true vertical position and flips over into the normal hanging position illustrated by pin P4 (see FIG. 7). In the event the said next appearing pin carrier is dragging along another pin, the said another pin will be stopped by the preceding pin supported on floor section 47 and the said next pin carrier will move under the past said another pin to pick up the waiting preceding pin in the manner just described. The said another pin is then picked up by a later appearing pin carrier in the same usual manner.

Ball Elevator E

At the rear right corner of the alley pit directly in front of the vertically extending section 28 of the pin elevator is a ball elevator E. The latter comprises a vertically extending housing of U-shaped cross section comprising side walls 160 and 162, a rear wall 164 and a pair of ball guide members 165 spaced from each other a distance less than the diameter of a bowling ball. The rear wall is bent forwardly at its top end to provide a ball-deflecting member 166. The side walls have inturned flanges 168 at their forward edges. The side walls and the rear wall of the ball elevator housing extend below the level of the turntable C. Positioned between the side walls are two conveyor chains 170 and 172 carried by a pair of sprocket gears 174 located at the lower end of the housing and two pairs of sprocket gears 176 and 178 located at the top end of the housing. The shaft on which gears 176 are mounted extends outside of side wall 162 and is provided with a gear 180 which is driven by a worm 182 attached to the output shaft of a motor M3. The motor drives the chains downwardly behind wall 164 and upwardly behind flanges 168. A plurality of cylindrical bar elements 184 are attached to chains 170 and 172. Attached to rear wall 14 of the pit and extending forwardly over turntable C is a horizontal elongated deflecting member 186. The false inwardly or concavely sloping floor 189 of the pit surrounding turntable C is slotted as at 188 in front of the ball elevator housing so as to provide a well or cavity 190 into which balls on the turntable may fall. The deflecting member 186 acts as a barrier to prevent balls and pins from falling directly into the cavity as they move with the rotating turntable.

Extending transversely of the machine and secured to the upstanding side walls of the pit is a horizontal beam 192 which supports the rear end of a horizontal platform 194 and from which is pivotally suspended a cushioned bumper wall 196. The bumper 196 deflects flying balls and pins into the pit. Rearward movement of the bumper when struck with a ball or pin is limited by bumper stops 198 attached to the side walls of the alley. The bumper wall hangs directly over or behind the central axis of turntable C. The bottom edge of bumper wall 196 is spaced from the turntable a distance slightly greater than the diameter of a bowling ball. Attached to the bottom edge of bumper wall 196 is a roller bar 200 which is rotatable on its own axis. The vertical distance between bar 200 and turntable C is less than the diameter of a bowling ball but greater than the largest diameter of a bowling pin. The roller bar 200 is disposed to the right of the axis of rotation of turntable C, as viewed from the front end of the pit.

Supported by platform 194 is a ball return chute 202 which runs from the top end of the ball elevator housing diagonally of the machine and leads to the conventional ball return track (not shown) that runs along the side of the alley back to the foul line.

Operation of the ball elevator E is as follows: Pins and balls on the turntable continually seek an avenue of escape. As the turntable rotates both pins and balls are directed toward the pin exit slot in rear wall 14 of the pit. None of the balls can escape through this slot and so they pass by it toward deflecting member 186. Some of the pins manage to escape through the slot in wall 14 the first time they approach it. The rest of the pins are carried around with the turntable toward deflecting member 186. The deflecting member prevents the pins and balls from dropping directly into well 190 and deflects them inwardly of the turntable. The deflected pins readily pass beneath the bumper wall and continue to turn with the turntable until finally they pass through the slot in wall 14 into the pin conveyor trough. The balls that are deflected by member 186 are too large to pass beneath roller bar 200 and when they engage the roller bar a reverse spin is imparted to them by the constantly turning turntable, causing the balls to migrate rearwardly into the well 190. The balls that fall into cavity 190 roll in between the side walls 160 and 162 of the ball conveyor housing against tapered guides 165. These balls are picked up by bars 184 and travel upwards with them. The balls roll along guides 165 as they move up and when they strike the inclined ball-deflecting member 166 they gradually move forward of the front edges of the side walls and fall clear of bars 184 into ball return chute 202 along which they roll back to the bowler.

It happens sometimes that a pin on the turntable will be struck by a ball or another pin falling onto the turntable from the alley and be knocked thereby into well 190 to be picked up by the ball elevator. To prevent these pins from being delivered to the ball return chute or jamming up against deflecting member 166, provision is made for removing them from the ball elevator before they reach the deflecting member 166. A rectangular slot 206 having a width less than the diameter of a bowling ball is provided in rear wall 164 of the ball conveyor housing. Below this slot a bracket 208 is secured on an incline to the outside of wall member 160. A second bracket 209 is similarly secured to wall member 162. These brackets are pivotally secured to a rod 210 to which is attached a flat paddle member 212 having a tongue portion 214 that extends into the ball elevator housing. Attached to the top side of paddle member 212 at an angle to the pivot axis of the paddle member is a pin deflector member 216. This member extends over bracket 208 and thereby prevents the paddle member from swinging down below the bracket.

Slot 206 and paddle member 212 cooperate to return pins caught in the ball elevator to the pit as follows: Both balls and pins moving upwardly in the conveyor housing will pass paddle member 212, the latter pivoting upwardly each time its tongue 214 is engaged by a ball or pin and returning by gravity to its normal inclined position after the ball or pin has passed. The balls will move upward past slot 206 without difficulty, due to guides 165 which prevent the balls from entering the slot. However, when a pin reaches slot 206, it tends to tip over into the slot and as it does so, the bar element 184 which carries it is free to slide by the pin. When the bar slides by the pin, the latter immediately falls down onto tongue 214 which allows the pin to roll down into contact with deflector 216 which immediately diverts it laterally off of paddle 212 back onto the turntable.

Sweep Mechanism F

The sweep mechanism is illustrated in FIGS. 1*b*, 1*c*, 2*c*, 2*d*, 4 and 5. Platform 194 referred to previously extends forward of the pit and is additionally supported at its front end by a transversely extending beam 234 attached at its opposite ends to the side walls 236 and 238 of the alley. Secured to beam 234 is a channel iron 240. Channel iron 240 and a second channel iron 242 form part of a framework 244 which functions as a support for various mechanisms hereinafter described. The framework 244 is secured in elevated horizontal position by suitable strut members (not shown) which are so positioned as not to interfere with the operation of the various mechanisms. The framework also comprises a pair of longitudinally extending beams 248 and 250 attached to beams 240 and 242, a front transverse beam 254 and various strut beams 256 disposed at various angles. Supported by framework 244 is a wooden platform 258.

Platform 258 covers the framework except for one corner where a metal plate 259 is secured to act as a supporting platform for certain mechanical drive elements. Also attached to beams 240 and 242 are two L-beams 260 and 262 which lie outside of beams 248 and 250 respectively and extend forward of framework 244. The horizontal flanges of beams 260 and 262 are identified by numerals 261 and 263 respectively. FIGS. 1*c* and 2*c* are plan and side views respectively of the forward ends of beams 260 and 262. At their front ends beams 260 and 262 are curved to provide inclined legs 264 and 266 respectively which are held together by transversely extending brace members 268 and 269. Mounted on the outer face of beam 260 is a U-shaped channel iron 270 having upper and lower flanges or sides 272 and 274. Beam 262 has a like channel iron 276 having flanges 278 and 280. Rotatably secured to the extreme forward ends of the upturned legs 264 and 266 of beams 260 and 262 are sprockets 282 and 284. Several additional pairs of idler sprockets 286 and 288 are rotatably secured to beams 260 and 262 at the lower ends of upturned legs 264 and 266. Sprockets 286 are disposed in pairs, one of each pair being above and the other below flange 272. Sprockets 288 are similarly disposed relative to flange 278.

Located at the rear end of the framework 244 is a shaft 290 (FIGS. 1*b* and 2*b*) whose opposite ends are journaled in and extend through beams 260 and 262 between the upper and lower flanges of channel irons 270 and 276. Sprockets 292 and 294 are affixed to the ends of shaft 290. An endless chain 296 is mounted on sprockets 292, 286, and 282, running endlessly around flange 272. Another endless chain 298 is mounted on sprocket 294, 288 and 284, running endlessly about flange 278.

Attached to beam 240 of the framework is a small platform on which is mounted a unidirectional motor M4. The output shaft of motor M4 has a sprocket 300 which drives a chain 302 that drives a sprocket 304 affixed to shaft 290. As viewed in FIG. 2*b*, shaft 290 is driven by motor M4 in a clockwise direction, thus causing the chains 296 and 298 to travel forwardly over flanges 272 and 278 and rearwardly over flanges 274 and 280.

Pivotally secured to chain 296 is a lever arm 306 provided with a longitudinal slot 308. A sweeper carriage 310 comprising a body member 312 provided at its opposite ends with a pair of rollers 314 and 316 is positioned to move along flange 261 of beam 260. Pivotally secured to body member 312 by means of a wrist pin 318 is an arm 320. Wrist pin 318 also extends through slot 308 of lever arm 306 and acts to pivotally and slidably connect the latter to body member 312. A chain 322 is connected at one end to the rear end of the carriage and at the other end to arm 320. Chain 322 prevents arm 320 from swinging forwardly beyond the vertical position of FIG. 4 while allowing it to swing rearwardly to an inclined position, also as shown in FIG. 4 in phantom.

Endless chain 298 is connected to a second slotted lever arm 306′ which is identically connected to a second identical carriage 310′ which rolls along the flange 263 of beam 262. A second arm 320′ is identically connected to carriage 312′ and its swinging movement is restrained in one direction by a chain-like chain 322.

Attached to the bottom ends of arms 320 and 320′ by bolts 324, 324′, and spacers 326, 326′, are elongated bars 328, 328′. The ends of a sweeper board F are positioned between bars 328, 328′, and arms 320, 320′, and are supported by bolts 332, 332′. Bolts 332, 332′ extend through vertical slots in the sweeper board. The slots allow the sweeper board to be moved up and down relative to arms 320 and 320′. The slots are so positioned and have a length such as to allow the board to contact or almost contact the alley floor during the sweeping operation, but to yield vertically should it come down upon a pin or ball in the alley at the start of the sweeping operation. The ends of the sweeper board are so shaped as to clean the gutters as well as the floor of the alley.

Associated with the sweeper mechanism are two switches SW2 and SW3. Switch SW2 is mounted on the front end of the pin sweeper frame and in the illustrated embodiment of the invention is carried by a small bracket 340 attached to the inside surface of the upper end of the inclined leg 264 of frame member 260. Switch SW2 is normally closed and is actuated by a leaf finger 342 that is positioned to be engaged and deflected by lever arm 306 as it moves beyond the forward end of flange 272 toward sprocket 282. As soon as lever arm 306 moves beyond leaf finger 342 switch SW2 reopens. By means of associated circuitry described hereinafter switch SW2 functions when actuated to open position to terminate operation of the sweep motor M4.

Switch SW3 is attached to the rear end of sweeper frame member 262 (see FIGS. 1*b* and 3), and is so positioned that its actuating finger 344 is actuated by lever arm 306′ as the latter begins its forward movement along flange 280, that is, when the sweeper board F has finished its sweeping operation and is at the beginning of its return run toward the front end of the sweeper frame. Switch SW3 is a normally open switch and, as explained hereinafter, it functions when momentarily closed to start operation of the pin-positioning board.

Operation of the sweeper is as follows: Assuming that the sweeper board F is in its normal at rest position above the alley floor (see FIG. 2*c*), motor M4 is energized by means hereinafter described. Operation of motor M4 causes shaft 290 to be rotated in a clockwise direction (FIG. 2*b*). Chains 296 and 298 then follow the paths previously described. As the chains move along their endless paths carriages 310 and 310′ travel down along the inclined portions of flanges 261 and 263 toward the bend immediately above brace member 269. During this downward movement of the sweeper carriages the levers 306 and 306′ lag wrist pins 318 and 318′. This is due to the fact that the carriages tend to travel under gravity at a velocity in excess of the speed of the chains, but are prevented from exceeding the speed of the chains by levers 306 and 306′. However, as the carriages pass from the inclined to the horizontal portions of flanges 261 and 263, the propelling effect of gravity is converted to a simple loading effect, causing the carriages to slow down. At the same time chains 296 and 298 continue to travel at a constant velocity and cause levers 306 and 306′ to slide and rotate relative to the carriages as allowed by the loose connection provided by the slot 308 and wrist pin 318. Thus a short distance beyond the bends in frame members 260 and 262 the levers 306 and 306′ assume a leading position relative to the carriages. This leading position is illustrated in dashed lines in FIGS. 1*c* and 2*c*. When levers 306 and 306′ are in this leading position they act to pull the sweeper carriage rearwardly along flanges 261 and 263 at the same velocity as chains 296 and 298.

At this point it is to be noted that once in a while during play a pin may come to rest in the alley in front of the pin plate. In such an event there is the possibility that when the sweeper board drops down to the alley floor at the beginning of a subsequent sweeping cycle, the board may land on the pin and either damage it or cause it to become wedged between the board and the alley so as to disturb, if not obstruct, operation of the sweeper. This problem is avoided by the present construction wherein, as previously described, the sweeper board F is capable of shifting upward relative to sweeper arms 320 and 320′. Thus if the sweeper board should come down on top of a pin lying on the alley floor, the board will yield and pass over the dead pin.

Returning again to the sweeper operation, before the sweeper carriages 310 and 310′ reach the rear ends of frame members 260 and 262, lever arms 306 and 306′ are carried by chains 296 and 298 around sprockets 292 and

294 and start moving forwardly back toward the upstanding legs 264 and 266 of the sweeper frame. As the levers reverse their direction of movement they pivot about wrist pins 318 and 318'. The carriages continue to move rearwardly while the levers are reversing positions and then, when the levers have changed positions, the carriages come to a full stop and begin to move forwardly in the same direction as the levers. As the carriages start to move forward switch SW3 is actuated to start operation of the pin-positioning board. Just before the carriages again reach the top forward end of frame members 260 and 262, lever 306 strikes switch finger 342 to stop motor M4. The momentum of the armature of the motor and carriages 310 and 310', is sufficient to cause the levers 306 and 306' to pass around sprockets 282 and 284 before coming to rest in the position shown in FIG. 2c.

Pin Distributor G

The function of the indexing pin distributor G is to collect pins from the pin elevator and deliver them upon signal in groups of 10 to the pin reservoir H. The pin reservoir is described separately in the next section of this specification.

The pin distributor G comprises a circular base 350 fixedly supported above framework 244 by a plurality of upstanding legs 352. Attached to base 350 at its center is an upstanding hollow shaft 354, FIG. 10. Rotatably journaled on shaft 354 is a cylindrical hub 356. Attached to hub 356 is a plurality of radially extending arms 358. Hub 356 and arms 358 together constitute a rotatable spider which supports an annular ring. The ring comprises an inner cylidnrical wall 360, an outer cylindrical wall 362, ten cylindrical cups arbitrarily identified for convenience as G1, G2, G3, . . . G10, and a plurality of intermediate strength-giving web portions 364 extending between walls 360 and 362 and connecting adjacent ones of the cups G1 to G10. Arms 358 are connected to selected ones of the intermediate web portions 364. Positioned on the top edge of cylindrical wall 360 is an annular dump ring 366 provided with 10 radially extending projections 368 which are equally spaced from each other. Normally projections 368 extend into cups G1 . . . G10 through suitable slots 370 provided in the wall of the cups. The projections are beveled so that their outside surfaces 372 are at such an angle to support pins in the cups in vertical positions. It is to be noted that the cups are just large enough to loosely accommodate a bowling pin and that the projections 368 are to prevent pins deposited in the cups from above from falling out of the bottoms of the cups. Slots 370 are large enough to allow the projections 368 to move out of the cups to free pins therein upon rotation of ring 366 relative to the cups.

Rotation of ring 366 relative to the cups is controlled by a dump solenoid S1 mounted on a bracket 376 attached to one of the spider arms 358. Electrical power is applied to the dump solenoid through a cable 378 which extends into a housing 380. Affixed to the interior of housing 380 is a phone jack 382 which is connected to cable 378. Attached to the shaft 354 is a cylindrical connector 384 to which is affixed a phone plug 386. Phone plug 386 is connected by a cable 388 to a source of power for the dump solenoid. Phone jack 382 is fitted on phone plug 386 and rotates with the spider and housing 380 while the phone plug remains stationary with shaft 354. Pivotally attached at 390 to armature 392 of solenoid S1 is a lever arm 394. The opposite end of lever arm 394 is pivotally attached to a lever 396 forming one arm of a toggle. One end of lever 396 is pivotally attached to an angle iron bracket 398 secured to one of the web portions 364, and the opposite end is pivotally secured to the end of a lever arm 400 forming the other arm of the toggle. The opposite end of lever arm 400 is pivotally attached to a bracket 402 fixedly secured to dump ring 366. A tension spring 404 is connected at one end to bracket 402 and at the other end to one of the spider arms 358.

Normally solenoid S1 is de-energized and the dump ring 366 is so positioned that each one of its projections 368 protrudes into one of the cups G1 . . . G10. At the same time arms 396 and 400 are at an angle to each other beyond dead center position, resting against the wall of the adjacent cup, whereby the dump ring is locked. Thus shifting of the dump ring relative to the cups will take place only after the arms 396 and 400 are pivoted beyond dead center position toward solenoid S1. When the solenoid is energized its armature 392 is retracted, pulling lever 394 in the same direction. When this occurs, lever 396 pivots relative to bracket 398 and pulls lever 400 toward lever 394, thereby causing the dump ring 366 to rotate in a clockwise direction relative to the cups and cylindrical walls 360 and 362. Rotation of dump ring 366 is just sufficient to move projections 368 out of the cups, thereby to free the pins that where being held in the cups. It is to be noted that rotation of dump ring 366 relative to the cups is accomplished in opposition to spring 404. Thus when the solenoid S1 is again deenergized, spring 404 will cause the dump ring to return automatically to its normal pin-blocking position, relocking the toggle.

Intermittent rotation or indexing of the distributor ring assembly is accomplished by drive and clutch means now to be described.

Attached to and rotating with shaft 119 of the pin elevator when the pin elevator is in operation is a sprocket 408 which drives a chain 410 that runs about a takeup idler sprocket 412 and a drive sprocket 414 (FIGS. 2a and 2b). Sprocket 414 is attached to a shaft 416 journaled in a bearing 418 attached to an angle iron 420 that is attached to platform 194 and acts together with a second angle iron 422 to support side members 66 and 68 of the horizontal section 30 of the pin elevator assembly. Also attached to shaft 416 is a second sprocket 424 which drives a chain 426. Chain 426 passes beneath guide sprockets 427 and 428 (FIGS. 2b and 12) attached to the circular base 350 of the distributor and drives a sprocket 429 attached to a shaft 430 rotatably secured to circular base 350 by bearings 432 and 434. Fixedly secured to the opposite end of shaft 430 is a sprocket 438 (FIG. 13). Pivotally attached to shaft 430 between bearing 434 and sprocket 438 is an elongated plate 440. Adjustably carried by plate 440 is an idler sprocket 442, FIG. 13. A chain 444 is mounted on sprockets 438 and 442. Chain 444 is driven by sprocket 438 in the clockwise direction shown in FIG. 13. Attached to chain 444 is a plurality of laterally extending equally-spaced drive fingers 450. At the end opposite to shaft 430 plate 440 is pivotally attached to an elongated rod 458 (FIG. 13) which extends down through a slot 460 in circular base 350 and is attached to the spring biased armature 462 of a clutch solenoid S2 (FIG. 12) attached to a platform 258 (FIG. 2b) supported on framework 244. To assist in holding the plate 440 in its elevated position (shown in broken lines in FIG. 13) a compression spring 445 is secured between plate 440 and base 350. When clutch solenoid S2 is deenergized its armature 462 is extended and plate 440 is in the raised position shown in dashed lines in FIG. 13. When the solenoid S2 is energized its armature is retracted, drawing plate 440 to the horizontal position shown in full lines in FIG. 13, against the bias of spring 445.

Attached to the inside surface of cylindrical wall 360 of the index ring distributor are 10 drive lugs 468 which are spaced equally from each other. Drive lugs 468 extend inwardly of cylindrical wall 360 far enough to become engaged by drive fingers 450 as explained hereinafter. It is to be noted that plate 440 has a lateral extension or flange 470 on its bottom edge, the flange extending beyond drive fingers 450 for about half its length measured from the pivoted end of plate 440 and having

a portion 472 of reduced width that terminates short of the curved line of travel of drive lugs 468. A second flange 475 prevents the lower run of chain 444 from yielding upwardly.

Operation of the above described drive clutch mechanism is as follows: Assuming (1) that the pin elevator is in operation so that chain 444 is driven by shaft 430 and sprocket 438 in the direction shown by the arrow, (2) that solenoid S2 (FIG. 12) is deenergized, and (3) that the distributor assembly is positioned so that one of its drive lugs, e.g. 468*a*, is positioned short of the edge 471 of flange 470, the whole distributor assembly will remain at rest and be unaffected by the moving drive fingers 450 of clutch chain 444. However, if now solenoid S2 is energized, plate 440 will be drawn from its normal position shown in dashed lines (FIG. 13) to its drive position shown in full lines. When this occurs, the lower run of chain 444 is in the same horizontal plane as lugs 468 and one of the fingers 450 at the beginning of the lower run of chain 444 will engage lug 468*a* and move it and the whole distributor assembly in a clockwise direction (FIG. 1*b*), the distributor assembly rotating about hollow shaft 354. Lug 468*a* will move over flange 470 and as it reaches the edge 473 of the flange (at approximately the position of lug 468*b* in FIG. 12) it will become free of the finger 450 propelling it since the finger will have begun to move upward around sprocket 438. Assuming that solenoid S2 is still energized, when lug 468*a* reaches the edge 473 of flange 470, lug 468*c* will be in the position previously occupied by lug 468*a*, and will be engaged by the finger 450 immediately following the finger that engaged lug 468*a* and itself advanced to the position of lug 468*b*. However, if clutch solenoid S2 is deenergized slightly before or just as lug 468*a* clears the finger 450 propelling it, the plate 440 will pivot upward due to armature 462 returning to its normal extended position and none of the fingers 450 will be able to engage lug 468*c*. As a result the ring assembly will stop and will remain stationary until the solenoid S2 is reenergized.

As seen in FIGS. 1*b*, 2*b*, and 10, the distributor assembled is so positioned that as it rotates its cups G1 . . . G10 will pass in turn directly under chute 92 of the pin conveyor. The lugs 468 are so positioned and the fingers 450 so spaced that each time a lug is engaged by a finger the distributor assembly will rotate through a distance equal to the spacing between successive cups. Also when a lug is over the edge 473 of flange 470 just clear of the fingers of chain 444, one of the cups G1 . . . G10 is directly beneath chute 29 of the pin elevator so that if a pin is discharged from the elevator through chute 92 it will fall into the cup directly beneath the chute. By energizing solenoid S2 each time a pin falls into a cup, and by maintaining the solenoid energized long enough to allow the distributor assembly to be advanced the distance between susccessive cups, an empty cup will always be in position to receive a pin falling from the pin conveyor, especially since the pin carriers are spaced from each other by such an amount that at the speed at which the pin carriers move the time interval between the discharge of pins carried by successive carriers is slightly longer than the time interval required to energize solenoid S2 and advance the distributor assembly through a distance equal to the distance between successive cups.

In order to prevent the distributor assembly from overriding when advancing from one pin position to the other, two safeguards are provided. One of these safeguards takes the form of a pair of brake shoes 476 (FIG. 1*b*) which are pivotally attached to circular base 350 and bear against the outside wall 362 of the distributor assembly. Tension springs 378 connected to base 350 and the brake shoes keep the brake shoes in contact with wall 362. The second safeguard is flange 470 previously referred to. When the plate 440 is in down position parallel to base 350, flange 470 is below the level of lugs 468. However, when plate 440 is in raised position, its edge 471 is at the level of lugs 468. Thus should the distributor tend to overtravel, edge 471 of the flange 470 will be engaged by one of the lugs 468 and, since the flange cannot shift, it will act to stop the distributor immediately. The flange cannot be wedged tight by the lug with which it is engaged since the edge 471 of the flange is below the upper edge of the lug. Thus when next the solenoid S2 is energized, the plate 440 will pivot down without obstruction.

Two switches are associated with the distributor mechanism. One switch, identified as index stop switch SW9, is attached to circular base 350 and has a leaf finger 480 (FIG. 1*b*) positioned to be deflected by successive lugs 468 as the distributor assembly is rotated. Switch SW9 is a normally closed switch which is opened when leaf finger 480 is deflected by a passing lug 468. When the distributor assembly is at rest with one of its cups positioned directly beneath chute 92, leaf finger 480 is not engaged by any of the lugs 468. The position of leaf finger 480 is such that it is deflected by one of the lugs each time one of the cups is just short of being directly under chute 92. This is to allow time for the armature of solenoid S2 to return plate 440 and raised position and stop rotation of the distributor assembly just as one of the cups is directly under chute 92.

The second switch attached to circular base 350 is identified as cup switch SW5 (FIG. 10). Counting clockwise starting with the cup instantaneously positioned beneath chute 92, switch SW5 is located adjacent the tenth index position. In FIG. 1*b* cup G7 is in the tenth index position, the distributor having indexed previously five times to accommodate pins in cups G1 to G6. Switch SW5 has a leaf finger 482 extending inwardly over the top edge of cup G7. Switch SW5 is normally open and its finger is so positioned as to be deflected by a pin resting in a cup located at the tenth index position. Thus when cup G1 advances to the tenth index position its pin will strike leaf finger 482 to close switch SW5. Switch SW5 will remain closed by the pin in cup G1 until all of the pins are dumped out of the cups. As explained hereinafter switch SW5 is in the circuit controlling dump solenoid S1 and when it closes it completes one of the phases in that circuit. The dump solenoid is energized to effect release of pins from cups G1 . . . G10 when all of the phases of its control circuit are completed.

Storage Reservoir H

As previously described platform 258 is secured to the upper side of frame 244. This platform is provided with ten circular openings 490 (FIG. 13*b*), each of which is in direct vertical alinement with one of the ten triangularly arranged pin positions on the alley. Securely positioned in each opening 490 is a cylindrical sleeve 492 (FIGS. 1*b*, 2*b*, and 14). Each sleeve 492 extends above and below platform 258. Circular base 350 of the pin distributing mechanism is provided with ten circular openings 494 arranged in a circle, each opening 494 being in direct alinement with one of the cups G1 . . . G10 when one of the cups is located directly below chute 92. Securely positioned in each opening 494 and depending downward from circular base 350 is a sleeve 496. These sleeves are entirely cylindrical at their top ends where they are secured to base 350, but a short distance beneath base 350 the sleeves are semi-cylindrical so as to give the appearance of open chutes. Connecting sleeves 492 and sleeves 496 are semi-cylindrical chutes 498. Chutes 498 function to deliver pins from sleeves 496 to sleeves 492 and in doing so they also function to shift the relative positions of the pins from the circular pattern established by openings 494 of circular base 350 to the triangular pattern of openings 490 in platform 258.

Slidably secured to the underside of framework 244 at the bottom ends of sleeves 492 is a horizontal storage finger assembly 500 (see FIGS. 1*b*, 14 and 15). The

storage finger assembly comprises ten longitudinally extending strut members **502** each provided at its forward end with an arcuate finger **504** having a radius approximately the same as that of sleeves **492**, seven transversely extending strut members **506**, two angularly positioned strut members **508**, and three longitudinally extending strut members **510**. Elongated flat bars **512**, secured to the underside of framework **244** by bolts **514**, slidably support finger assembly **500**. Each bearing bar **512** extends beneath one of the struts **502** with bolts **514** acting to prevent the framework from shifting laterally, but not longitudinally. Each finger **504** extends into one of the sleeves **492** when the finger asesmbly **500** is in its forward position as shown in FIG. 12. For this purpose it is to be noted that half of each sleeve **492** is cut away at its bottom end as at **515** so as to allow the fingers **504** to be moved into the sleeves. Attached to one of the transversely extending struts **506** are two large tensison springs **516**. The opposite ends of the tension springs are attached to the bottom of platform **258**. Springs **516** act to keep the finger assembly in its forward position. In this position, if a set of pins is dumped from cups G1 . . . G10, the pins will fall through sleeves **496** in circular plate **350**, down along chutes **498** to sleeves **492**, where they will be stopped by fingers **504**. The pins will remain in sleeves **492** supported by fingers **504** until the finger assembly is moved rearwardly to place the fingers in the retracted position shown in FIG. 14, whereupon the pins will be released to the pin positioning board, hereinafter described.

Movement of the storage finger assembly **500** from its normal storage position to its pin release position is effected by a lever **518** which extends vertically through a slot **520** in platform **259**. The bottom end of lever **518** is pivotally secured to a wire rod **522** which is secured to an arm **524** that is pivotally anchored to a bracket **526** attached to the foremost transversely extending strut **506** of the finger assembly. The top end of lever **518** is connected to operating and control mechanism described hereinafter for operating lever **518** to move the finger assembly to release position.

At this point it is to be noted that a switch SW7 is attached to platform **258** (see FIG. 1*b*). This switch has a finger **528** which extends through a slot in the top end of one of the sleeves **492**. As illustrated switch finger **528** extends into the #10 sleeve, that is, the sleeve that is in direct alinement with the spot on the alley usually reserved for the #10 pin. Switch SW7 is normally closed but opens momentarily when its finger **528** is deflected by a pin dropping into the #10 sleeve. Switch SW7 is closed when a pin is supported in the #10 sleeve by the storage finger assembly **500** since the pin will be below the switch finger **528**. Switch SW7 is in the control circuit for dump solenoid S1. Its specific function is explained hereinafter.

Pin Positioning Rack I

Pin positioning rack I comprises a plywood board **530** which has the general shape of a triangle (FIGS. 1*b*, 14, and 16). Attached to the board **530** at its front end and along its sides are three upstanding gear racks **532**, **533**, and **534**. As seen in FIGS. 16 and 18 the bottom ends of the gear racks are secured by bolts **535** to metal plates **536** which are in turn secured by bolts **537** to board **530**. The gear racks **532**, **533**, and **534** extend above platform **258** and mesh with identical gears **538**, **540** and **542** respectively. The racks are slidably guided by bearings **546** attached to the platforms **258** and **259**. Gear **538** is attached to a drive shaft **548** journaled in bearings mounted on platform **258**. Gears **540** and **542** are affixed to opposite ends of a long drive shaft **552** which extends transversely of the machine and is journaled in two pillow blocks **554** and **556** fixed on frame members **248** and **250**. Shaft **548** is driven from shaft **552** through bevel gears **555** and **557**, both shafts rotating at the same speed so that gears **538**, **540** and **542** will drive racks **532**, **533** and **534** evenly.

Also affixed to shaft **552** is a gear **558** which meshes with a bull gear **560** carried by a stub shaft **562** journaled in suitable fixed bearing blocks. Attached to the outside of bull gear **560** is a plate **568** having a V-shaped notch **570**, cut in one end (see FIGS. 21–23). Also affixed to shaft **562** is a sprocket gear **572**. One end of a chain **574** is attached to the periphery of gear **572**. The other end of chain **574** is pivotally attached to the end of a crank arm **576** which is secured to a shaft **578** rotatably mounted on top of a pedestal **580** supported by platform **258**. A sprocket **582** is carried by shaft **578** and this is driven from a gear reducer uni **584** through a sprocket **586** and a chain **588**. The input shaft of the gear reducer has a pulley **590** which is driven from a motor M5 through belts **592**. Motor M5 is supported by framework **244** and is designated hereinafter as the setting board motor. Motor M5 is a unidirectional motor.

The radius of sprocket gear **572**, the lengths of chain **574** and crank arm **576**, and the distance between shaft **562** and shaft **578** are such that when crank arm **576** is in substantially a horizontal position with its free end pointing rearwardly toward sprocket **572**, the setting rack will be in its bottommost position just short of engagement with the floor of the alley. When the crank arm is substantially in a horizonal position but pointing forwardly away from sprocket gear **572**, that is, when the crank arm occupies the position shown in FIG. 23, the setting board will be in its uppermost or home position. The direction of rotation of crank arm **576** during operation of motor M5 is counterclockwise as viewed in FIGS. 2*b* and 23. Starting with the crank in home position, the setting rack will descend while the crank arm rotates through the first half of a complete revolution and will ascend while the crank arm completes the second half of a complete revolution. During the first half revolution of the crank arm a slack is produced in chain **574** and this slack is taken up as rapidly as it is produced by sprocket **572** which is caused to rotate counterclockwise under the weight of the positioning rack I. During the second half revolution the rotational force exerted on sprocket **572** by the weight of the positioning board is overcome by the pull exerted on chain **574** by the crank arm, with the result that the positioning board is moved upwardly. When the crank arm is moving through its two dead center positions, nearest and furthest away from sprocket **572**, it has its smallest effect on chain **574** and sprocket **572**. Consequently, the positioning board dwells for a short interval of time in its bottommost position. The dwell period is of sufficient duration to effect smooth deposition of pins on the alley from the rack.

To the extent already described the mechanism for lowering and raising the pin setting rack is capable of moving the rack back and forth from a first raised position immediately below the finger assembly **500** to a second lowered position immediately adjacent the alley floor. However, as hereinafter described, additional mechanism is provided for stopping the rack at a third position which is at the level of the necks of pins standing on the alley floor.

Details of pin positioning rack I are illustrated in FIGS. 1*b*, 2*b*, 14, 16–18, and 19. Plywood board **530** is provided with ten rectangular openings **600** which, like the openings **490** in plaftorm **258**, are disposed in vertical alinement with the pin positions on the pin plate of the alley. Secured to board **530** are eight evenly spaced longitudinally extending bars **602**. The edges of bars **602** slightly overlap the longitudinal edges of openings **600**. Secured to each bar **602** in inverted position is a U-shaped channel member **604** provided on each side with laterally extending flanges **606**. Associated with each opening **600** are two oppositely disposed pin-retaining elements **608** and **610** each having a body portion **612** whose interior surface **614** is curved in general conforma-

tion to the contour of the lower part of the body of a pin. The two body portions 612 together form a cup to support a bowling pin. As seen in FIGS. 1b and 16, the interior surfaces 614 are notched at the bottom to provide recessed straight edges 616. When the pin-retaining elements 608 and 610 are closest to each other, their straight edges 616 are spaced from each other a distance slightly less than the diameter of the head of the pin, but greater than the diameter of the neck of a bowling pin so that a pin may be held suspended by its neck. The body portions 612 are surrounded by integrally formed flanges 620 having side edges which fit between bars 602 and the flanges 606 of channel members 604. The body portions 612 extend into openings 600 which are large enough to allow retaining elements 608 and 610 to be separated far enough to establish a distance between the adjacent straight edges 616 equal to about 1½ times the greatest diameter of a bowling pin. Positioned directly above each cup is a cylindrical sleeve 624 which has an inside diameter that is slightly larger than the largest inside diameter of the cups and also larger than the greatest diameter of a bowling pin. Each sleeve 624 is welded to two small plates 626 which are supported by and are welded to the flanges 606 of channel members 604. Sleeves 624 have a height such that their upper edges terminate at or slightly above the point of greatest diameter of pins sitting in the cups. As seen in FIG. 14, when the positioning board is in its topmost position the upper edges of sleeves 624 are just below the bottom end of sleeves 492 attached to platform 258. Thus when the positioning board is in its uppermost or home position, and pins stored in tubes 492 are released by retraction of the storage finger assembly 500, the pins will be guided by sleeves 624 into the cups on the pin-positioning board. Sleeves 624 function to keep the pins in an upright position as they drop into the cups and also while the positioning board is dropping to the alley floor, thereby reducing the tendency of the pins to wobble when they are deposited on the pin plate of the alley.

The cups are opened and closed, that is, elements 608 and 610 are separated and brought together, by means of an operating framework comprising four transversely extending connecting bars 630, 632, 634, and 636 connected to cup elements 608 and four transversely extending bars 640, 642, 644, and 646, connected to the cup elements 610. Two longitudinally extending bars 648 and 650 link together bars 630, 632, 634, and 636. A longitudinally extending bar 652 connects bars 640, 644, and 646. Another bar 654 connects the corresponding ends of bars 640 and 642. The opposite end of bar 642 is attached to a bar 656 which is connected to bar 646. A short bar 658 connects one end of bar 634 to bar 636. Another short bar 660 is connected at one end to bar 644 and at the other end to bar 646. Two additional bars 660 and 662 connect bars 642 and 646. Two other bars 664 and 666 connect bars 632 and 636. The longitudinally extending bars 648, 650, 652, 654, 656, 658, and 660 all rest lightly on plates 626.

Turning to FIGS. 16 and 19, the foregoing bar framework that opens and closes the cups on the pin positioning board also comprises a vertically extending rod 674 of rectangular cross section having at its bottom end cylindrical extension 676 that is rotatably received by a bearing 678 attached to the plywood board 530. Bearing 678 not only allows bar 674 to rotate, but it also retains the bar so that it will move up and down with the pin positioning board. Attached to the underside of platform 259 is a bearing 680 to which is rotatably secured a bushing 682 having an interior opening of rectangular cross section just large enough to slidably receive bar 674 which extends through a suitable opening 684 in platform 259.

A rectangular plate 686 is fixedly mounted on rod 674 adjacent its lower end. Pivotally secured to the ends of plate 686 are two operating rods 690 and 692. The opposite end of rod 690 is pivotally secured to bar 642. The corresponding end of rod 692 is pivotally secured to bar 634. When rod 674 is turned clockwise (by mechanism hereinafter described) from the position shown in FIG. 16, plate 686 acts through rods 690 and 692 to draw bars 642 and 634 toward each other. This in turn causes the other elements of the framework to move, some forwardly, some rearwardly, to shift the pin-retaining elements 608 and 610 to full open position, that is, to simultaneously open the ten cups on the board 530. Springs 694 and 696, connected at one end to bars 636 and 646 respectively and at the other end to the plywood board 530, act to close the cups when the force urging rod 674 clockwise is released.

Mechanism (1) for Restricting Operating Stroke of Pin Positioning Board During Pin Retrieving and Respotting Operation, (2) for Operating Storage Finger Assembly, (3) for Actuating Operating Framework of Cups on Pin Positioning Board, and (4) for Sequentially Opening and Closing the Circuits Controlling the Component Mechanisms of the Machine

The mechanism contemplated by this subtitle is illustrated in FIGS. 19 to 25, and is mounted in front of the pin distributor G. This mechanism includes an upstanding frame plate 700 secured to platform 259. Looking from the front to the rear of the machine, the right hand end of shaft 578 previously mentioned extends through an opening in frame plate 700 and is rotatably supported by a pillow block 702 secured to plate 700. Attached to the right hand end of shaft 578 are three tear-drop shaped switch-operating cams SC1, SC2, and SC3. The cams are fixed on shaft 578 with their lobes staggered as shown in FIGS. 24 and 25. Affixed to the outside of frame plate 700 are four switches SW4, SW6, SW10, and SW14. Switches SW4, SW6 and SW10 have spring-mounted switch fingers 704 which project forward and are provided with small rollers 706 which ride on cams SC1, SC2 and SC3. Switch SW14 has a switch finger 708 which is secured to the switch finger of switch SW10, so that both switches SW10 and SW14 are operated by cam SC3. Switch SW4 is normally closed and is opened when its switch finger is deflected by cam SC1. Switch SW6 is a normally open switch which is held closed by cam SC2 when shaft 578 is at rest in home position, that is, when the pin positioning board is in its home position. Switches SW10 and SW14 are normally open and are closed when the switch finger of SW10 is deflected by the lobe of cam SC3.

Four additional cams LC1, LC2, LC3 and LC4 are associated with shaft 578. Cams LC1–3 are mounted directly on the shaft and have keyways 712 which slidably receive a long axial key 714 on the shaft. By virtue of this keyway connection, cams LC1–3 are slidable to and fro along shaft 578 in addition to rotating with it. Cam LC4 is an arcuate segment attached to and rotatable with cam LC3.

Frame plate 700 is joined at its top end to a horizontal transversely extending plate 716 which is supported at its opposite end by a second upstanding frame plate 718 attached to pedestal 580. Secured to the underside of horizontal plate 716 is a bracket 720 having a downwardly sloping flange 722 at its forward edge. Flange 722 has an elongated slot 724. Positioned beneath bracket 720 is an elongated rod 726 whose right hand end extends through a suitable opening in the upper end of frame plate 700. The opposite end of rod 726 is connected to one end of the armature 728 of a cam switching solenoid S3 which is secured to horizontal plate 716 adjacent left hand frame plate 718. The opposite end 728a of armature 728 extends through an opening in frame plate 718 when the solenoid S3 is deenergized. Pivotally secured to the outside of frame plate 718 is a lever 730. The rear end of lever 730 extends over and is kept in engaging relation with shaft 578 by the action of a tension spring 732 which is connected at one end to lever 730 and at

the other end to frame plate 718. As viewed in FIG. 23, spring 732 urges lever 730 counterclockwise so that its forward portion is in position to block the return of armature 728 to its normal home position when the solenoid S3, assuming it to have been in an energized state, is deenergized. Lever 730 is pivoted clockwise out of blocking relation to armature 728 by means of a cam or key 734 on the surface of shaft 578.

A U-shaped yoke 736 is secured to rod 726, the rod extending through the legs 738 and 740 of the yoke. At their lower ends legs 738 and 740 of the yoke are provided with pins 742 that bear against the sides of cams LC1 and LC3. A bolt 744 is attached to the yoke. This bolt extends through slot 724 of bracket 722 and acts to limit the travel of the armature 728. When solenoid S3 is deenergized and lever 730 is not in position to block armature 728, bolt 744 is in the position shown in FIG. 19. When solenoid S3 is energized, bolt 744 is at the opposite end of slot 724. When solenoid S3 is deenergized but lever 730 is held by spring 732 in blocking relation to armature 728, bolt 744 is located at the middle of slot 724. Return of armature 728 toward its home position is effected by a compression spring 746 which bears at one end against a collar 748 set against frame plate 700 and bears at the other end against a collar 750 affixed to rod 726.

Two switches SW11 and SW13 are supported by brackets attached to horizontal plate 716. Switch SW11 is a normally open switch and has a spring biased actuating finger 752 that extends downwardly and rearwardly in position to be engaged by cam LC4 when the cams LC1 to LC4 are in the extreme left position, that is, when solenoid S3 is deenergized and lever 730 is not blocking armature 728. Cam LC4 strikes switch finger 752 to momentarily close switch SW11 just before the positioning board reaches home postion after a setting operation. As explained in greater detail hereafter, when switch SW11 closes it completes one of the phases of the control circuit for dump solenoid S1. Switch SW13 has a depending spring biased switch finger 754 that is located to the right of cam LC1. Switch SW13 is normally open and is closed by cam LC1 when cams LC1—LC4 are shifted to the extreme right position upon energization of cam shifting solenoid S3. The function of switch SW13 upon closing is to complete a circuit that causes the pin positioning board to descend.

The purpose of cams LC1—LC4 is to operate the mechanism now to be described. Journaled at one end to frame plate 700 and at the other end to the outer wall 756 of pedestal 580 is a shaft 758. Affixed to shaft 758 is an arm 760 which extends rearwardly alongside of bull gear 560. A coil spring 762 attached to a fixed horizontal plate 764 holds arm 760 down out of the path of plate 568 on bull gear 560. Also affixed to shaft 758 is an arm 766 provided at its free end with a cam follower roller 768. Cam follower 768 is positioned to be engaged by cam LC4 when bolt 744 is at the extreme right hand end of slot 724 or is intermediate the ends of the slot. When the cams LC1—LC4 are in their normal position, that is, when bolt 744 is at the extreme left hand end of slot 724, cam LC4 is out of line with cam follower 768 and so cannot engage the cam follower when shaft 578 rotates. Cams LC2 and LC3 do not project far enough to engage cam follower 768. However, if the cams are in their extreme right hand position or in their intermediate or middle position, when shaft 578 rotates cam LC4 will engage cam follower 768, causing it and its arm 766 to rotate clockwise (FIG. 22). This in turn causes shaft 758 and arm 760 to rotate clockwise, placing the tapered end 770 of arm 760 in position to be engaged by plate 568 on bull gear 560. When plate 568 engages arm 760 (this occurs as the positioning board moves downward and gear 560 is rotating counter-clockwise as seen in FIG. 23), bull gear 560 is brought to a halt while crank arm 576 continues to rotate through dead center position nearest sprocket 572. At some point beyond this dead center position, the crank arm commences to exert an increased pull on chain 574, causing the bull gear to rotate clockwise so as to raise the positioning rack. When the bull gear begins to rotate clockwise it frees the tapered end 770 from the notch 570 in plate 568, and thus allows spring 762 to pull arm 760 downward so as not to interfere with operation of the bull gear. It is to be noted that cam LC4 rides free of cam follower 768 shortly after the bull gear is brought to a halt by arm 760 but before the bull gear begins to rotate clockwise. The length of arm 760 and the location of stop plate 568 on bull gear 560 is such as to stop the bull gear when the positioning board has dropped to the level of the necks of pins standing in the alley. In the case of duck pins this is preferably about 6" from the floor but may be slightly more or less depending upon the structure of the pin positioning rack.

Lever 518, previously described as the operating lever for storage finger assembly 500, is rotatably secured to shaft 758 by a set screw 772 which rides in a peripheral groove in the shaft. Lever 518 has a forwardly extending arm 774 provided with roller-type cam follower 776 which is positioned to be engaged by cam LC4 when the cams are in their left-most or home position on shaft 578, that is, the position shown in FIG. 19. When cam LC4 engages cam follower 776, it causes lever 518 to rotate clockwise (FIG. 22) just enough to withdraw the storage fingers 504 out of supporting relation with bowling pins positioned in tubes 492. When cam LC4 moves free of cam follower 776, springs 516 return the finger assembly 500 to its normal position and thereby cause lever 518 and arm 774 to rotate counterclockwise so as to bring cam follower 776 back into the path of rotation of cam LC4.

Journaled in frame plate 700 and the right hand side wall 778 of pedestal 580 is a shaft 780. Affixed to this shaft is a lever 782 having at its top end a cam follower 784. The bottom end of lever 782 is pivotally connected to a bracket 786 secured to a block 788 slidably carried by a rod 790. Threaded on rod 790 adjacent its rear end are two nuts 792. A second pair of nuts 794 is screwed onto the front end of rod 790. A strong compression spring 796 surrounds rod 790, bearing against nuts 792 on one hand and block 788 on the other hand with the result that block 788 is kept against nuts 794. The rear end of rod 790 is pivotally secured to a block 798 which is itself pivotally secured by a vertically extending pin to the flange 799 of a rectangular sleeve 800 through which extends rod 674 of the mechanism for opening and closing the cups carried by the pin positioning board. Sleeve 800 rests on the flange of bearing member 680 affixed to platform 259. Flange 799 has two upstanding plates 802 which support two spaced rollers 804 which act as guide bearings for rod 674. A tension spring 805 is connected between flange 799 and platform 259 so as to oppose clockwise rotation of rod 674 as seen in FIG. 20. When cam follower 784 is acted on by one of the cams LC1, LC2, or LC3, it moves forwardly, causing lever 782 to pivot clockwise about shaft 780 (FIG. 22). When this occurs block 788 tends to slide forward relative to rod 790 but is prevented from doing so by strong spring 796. Instead block 788 causes rod 790 to move block 798 forward, thereby causing sleeve 800 to turn clockwise (FIGS. 20 and 21). This in turn causes rod 674 and through it, block 686 and levers 690 and 692, to turn in the same direction, thereby opening the cups of the pin positioning rack. When cam follower 784 is no longer being forced back by one of the cams LC1, LC2 or LC3, the cups reclose and rod 674 rotates counterclockwise to move rod 790 forwardly and pivot lever 782 counterclockwise (FIG. 22). This action restores cam follower 784 to its original position where it can again be acted upon by one of the cams. This return movement is accomplished by spring 805 assisted by springs 694 and 696. The purpose of spring 796 is to allow lever 782 to

pivot under the action of one of the cams LC1, LC2 or LC3 without causing rod 674 to rotate in the direction to open the cups on the rack when for one reason or another the operating framework for opening the cups or the cups themselves on the pin positioning rack are jammed. Thus damage to rod 790 or its associated mechanism is avoided.

It is to be noted that when the pin positioning board I is in its uppermost position, the low or dwell portions of cams LC1, LC2 and LC3 are facing, but do not engage cam follower 784. Consequently the cams may be shifted laterally by yoke 740 under the influence of solenoid S3 or spring 746. However, as soon as the lobe (the raised camming surface) of one of the cams LC1, LC2 and LC3 moves into engagement with cam follower 784, no shifting of the cams can take place.

The specific functions of cams LC1 to LC4 are best explained by reference to FIGS. 19 and 22 which show the cams in their home and rest positions and to FIG. 25 which shows the shape of the cams. The cams are in "home" position when bolt 744 is at the left hand end of slot 724. The cams are in "rest" position when shaft 578 is stopped with the pin positioning board in its uppermost position immediately beneath storage finger assembly 500.

Cam LC1 is a two-step cam which functions to open and close the cups of the pin positioning board when a new set of pins is to be deposited on the alley. The trailing end of the shallow cam surface A of the cam faces but does not touch cam follower 784 when the machine is at rest. Upon starting of the motor M5 shaft 578 brings the leading end of raised portion *b* in engagement with cam follower 784, causing the lever 782 to pivot a small amount to open slightly the cups on the rack. This slight opening of the cups is completed before the board has dropped about an inch or so from its uppermost position and takes place just before or about the same time as the release of pins from the storage tubes 492. This slight opening of the cups assures that the pins received from tubes 492 will settle snugly into the cups and will protrude below the cups so as to be in light contact with the alley floor when the pin positioning rack is stopped in its bottommost position. Rubber bumpers 807 (FIGS. 2*b* and 14) prevent the rack I from hitting the alley floor and allow the pins to protrude slightly below the cups. The cups remain in this slightly opened condition until the positioning board is about one inch from the floor, at which time the leading end of the foremost raised portion *c* engages cam follower 784 and causes lever 782 to open the cups to their fullest extent to deposit the new set of pins on the alley floor. The cups remain open as the pin positioning board begins to move upward again. During this upward movement the raised portion *c* rides off of the cam follower and the leading edge of shallow portion *a* engages it. When this occurs the cups begin to close and the closing is completed before the trailing end of dwell portion *a* again faces cam follower 784.

Cam LC3 is a one-step cam which functions to open and close the cups when the pin positioning board operates to retrieve pins standing on the alley preparatory to removal of deadwood by the sweeper. This cam is in operating alinement with cam follower 784 only when solenoid S3 is fully energized. Assuming that this is the case, the trailing end of shallow surface *d* faces but does not touch the cam follower when shaft 578 is at rest. However, as the positioning board moves downward, shaft 578 rotates and the projecting lobe *e* of the cam comes into engagement with cam follower 784, causing the cups to open. The cups are fully open by the time the pin positioning board reaches the level of the heads of pins standing on the alley so that as the board drops still further the cups come down about the standing pins. Experience has shown that any pins still standing on the alley will be within approximately one inch of their original position. This fact coupled with the fact that when the cups are fully opened they define an opening several times that of the head of a pin assures that the cups will drop over and about rather than strike the standing pins. Due to the action of cam LC4 on cam follower 768, the bull gear stop arm 760 acts on the bull gear to stop the rack I about 6" from the floor, or just at the level of the necks of the pins. While the board is stopped momentarily in this position the lobe *e* of cam LC3 rides off of cam follower 784, allowing the cups to close upon the necks of the standing pins before the rack I commences its upward stroke back to its original position.

Cam LC2 also is a one-step cam which functions to open and close the cups when the pin positioning board is operating to respot pins on the alley. This cam is in operating alinement with cam follower 784 only when the armature of solenoid S3 is prevented from returning to its normal retracted position by the action of lever 730, that is, when bolt 744 is positioned intermediate the ends of slot 724. Solenoid S3 is rendered deenergized only after the crank arm 576 reaches the home position shown in FIG. 15, in which position the cam 734 on shaft 578 no longer engages lever 730 which has been pulled by spring 732 into blocking relation with armature 728.

When shaft 578 is at rest and cam LC2 is in operating alinement with cam follower 784, the cam and cam follower are not touching. When shaft 578 begins to rotate cam LC2, the cam lobe *f* commences to approach cam follower 784. The cam lobe *f* engages cam follower 784 to operate lever 782 only after the pin positioning board has been stopped about 6" from the floor. Then the cam causes lever 782 to reopen the cups fully to redeposit the pins previously picked up by the cups. The cam keeps the cups open fully until they have been raised clear of the respotted pins. The cups close when the cam lobe *f* rides past cam follower 784. Shortly before the pin positioning board reaches it home position, lever 730 is pivoted by the cam on shaft 578 so as to release armature 728 which is immediately returned by spring 746 to its home position. This places cam LC1 back into alinement with cam follower 784, ready for the next pin setting operation. It is to be noted that the radius of the shallow portion *g* of cam LC2 is just small enough to permit it to clear cam follower 784, so that when the lobe *f* has passed out of contact with the cam follower, the cam no longer engages the cam follower and, therefore, armature 728 can return to its home position so as to place cam LC1 back into alinement with cam follower 784.

Cam LC4 has three functions. When cam LC1 is in alinement with cam follower 784, cam LC4 is in alinement with cam follower 776. In this position it acts to engage cam follower 776 to retract the storage finger assembly 500 just immediately after the pin positioning board has started to move downward so that the pins which are released from tubes 192 will drop into the cups on the pin positioning board just as they have been opened slightly by action of cam surface *b* of cam LC1. When either cam LC2 or cam LC3 is in alinement with cam follower 784, cam LC4 is alined with cam follower 768. Cam LC4 engages cam follower 768, thereby to raise arm 760, just early enough to cause arm 760 to stop the bull gear 560 as the pin positioning board is about 6" from the alley floor. Cam LC4 rides off of follower 768 after arm 760 has been engaged by plate 568. Arm 760 remains in blocking position until the bull gear commences to move clockwise again, whereupon plate 568 moves clear of arm 760 and allows the latter to be pulled back down to its normal position by spring 762.

Miscellaneous Electrical Elements

Two additional switches not previously described form part of the machine. Switch SW1 is a normally open switch and is mounted on a post at the head end of the bowling alley (see FIG. 2*c*). Post switch SW1 is a

momentary button type switch which is operated manually by the bowler when a new set of pins is desired. Switch SW12 also is a normally open momentary button-type switch and is mounted on the floor at the head end of the alley where it can be conveniently actuated by the bowler's foot. The function of foot switch SW12 is to start operation of the machine when it is desired to remove deadwood from the alley before attempting further to knock over pins standing on the alley.

As seen in FIG. 1*b*, a control box 810 is mounted on platform 258 or any other convenient member and houses the various electrical relays identified hereinafter in the description of the electrical circuits of the machine. Electrical wires connecting the elements in control box 810 with the various switches and motors have been omitted from FIG. 1*b* in order not to complicate it further. However, the manner in which the various electrical elements are connected is readily apparent from FIG. 26.

Electrical Circuits and Mode of Operation of the Machine

FIG. 26 diagrammatically illustrates the electrical circuits of the machine. Switches SW1–14 inclusive are shown at the top of the drawing. With the exception of switch SW6, the switch contacts are in their normal positions when the machine is at rest. Although switch SW6 is a normally open switch, it is held closed by cam SC2 when the machine is at rest with the positioning board in home position. Eight relays RA–RH are included in the circuit. When the contacts of switches SW1–14 are in their normal positions, the relays are all "Off" with the various contacts set as follows:

Contacts:	Normal setting
A1	closed
A2	open
A3	open
B1	open
B2	open
B3	closed
C1	open
C2	closed
C3	open
C4	open
D1	closed
D2	open
D3	open
E1	closed
E2	open
E3	open
F1	open
F2	open
G1	open
G2	open
H1	open
H2	open

Electrical energy at commercial line voltage is supplied to motors M1–M5 inclusive and solenoids S1–S3 from a common source of power, terminals T1, T2, T3, T4, T5 and T6 being connected to one side of the source of electrical power and terminals T7, T8, T9 and T10 being connected to the other side of the power source. The several relays require a lower voltage and for this purpose a 24-volt transformer X is utilized.

A conventional line switch (not shown) is utilized to connect and disconnect the circuits from the source of power. Upon closing of the line switch, motors M1 and M3 immediately begin to operate the turntable and the ball elevator and will continue to do so until the source of power is again isolated from the machine.

(1) OPERATION TO SPOT A NEW SET OF PINS

Assuming now that with the pin positioning board at rest in home position so that switch SW6 is closed, and with ten pins supported in tubes 492 by the storage finger assembly 500, a bowler (having previously knocked down all of the pins on the alley or having exhausted his quota of throws) presses the button of post switch SW1. This closes switch SW1 and energizes relay RA. When relay RA is energized contact RA1 opens and contacts RA2 and RA3 close. The closing of contact RA2 establishes a holding circuit for relay RA through switch SW2. Thus when the bowler releases the button of post switch SW1, relay RA remains energized.

The sweep motor M4 begins to operate when contact RA3 closes, the power circuit for the motor being completed through terminal T3, the normally closed contact RD1 of relay RD, contact RA3, and terminal T7. The sweep moves downwardly and then rearwardly along the path defined by the tracks 261 and 263, sweeping all pins which are still on the alley or in the gutters rearwardly into the alley pit. On the return flight the sweep actuates setting start switch SW3.

When switch SW3 closes it energizes relay RB, causing contacts RB1 and RB2 to close and contact RB3 to open. Closing of contact RB1 immediately establishes a holding circuit for relay RB through setting limit switch SW4 which is a normally closed switch. When contact RB2 closes, setting board motor M5 begins to operate. The circuit for motor M5 is as follows, terminal T4, contact RB2 and terminal T10. As the setting board motor begins to operate relay RG is off due to the fact that foot switch SW12 is open. Should the bowler inadvertently actuate foot switch SW12 while the sweep is operating, it will have no effect on relay RG due to the fact that contact RA1 is open. Should the bowler depress foot switch SW12 while setting board is in operation, it still will have no effect on relay RG due to the fact that switch SW6 is open to switch SW12. The setting board motor starts operating before sweep limit switch SW2 is tripped to stop sweep motor M4.

When relay RG is off no current is supplied to cam switching solenoid S3. Thus the cams LC1, LC2 and LC3 are in their left most positions and cam LC1 is in operating alinement with the cam follower 784 of the operating lever 782 which opens and closes the cups on the pinsetting board. Cam LC4 is in alinement with cam follower 776 of storage finger assembly 500. As the setting board motor causes the setting board to drop toward the floor cam LC1 acts through lever 784 to open the cups slightly. Just as the cups are opened slightly cam LC4 operates the storage arm 518, causing the latter to withdraw the storage fingers and release ten pins from the storage tubes 492 into the slightly opened cups on the descending positioning board. The pin positioning board drops down to the alley floor and as it is stopped adjacent the alley floor cam LC1 moves the lever 784 controlling the cups still further so as to open the cups fully and release the pins to the alley floor. The pin positioning board begins to move upward toward its normal home position. Just before the setting board reaches home cam LC4 strikes storage dump switch SW11. Teardrop cam SC1 makes one revolution with the shaft 578 that drives cams LC1 to LC4 and toward the end of its revolution it actuates setting board stop switch SW4. The cam assembly coasts after setting board motor M5 is shut off so that the lobe of teardrop cam LC1 drops off of the operating finger of the switch SW4 and allows the switch to close again automatically. When the cam shaft 578 begins to rotate the lobe of the center teardrop cam SC2 rotates away from switch SW6, allowing it to break the ground circuit to both the post switch SW1 and the foot switch SW12. The ground circuit remains interrupted while cam shaft 578 makes a complete revolution, whereupon switch SW6 will again be closed by the high point of the center teardrop cam. Should the setting board fail to reach home position, switch SW6 will remain open to keep the post switch SW1 and the foot switch SW12 (also SW13) inoperative so that the bowler cannot start another cycle until the trouble preventing the pin positioning board from reaching home position

has been eliminated. Similarly, should the bowler close switch SW1 or SW12 while the pin positioning board motor is in operation, it will have no effect on sweep motor M4 or on cam switching relay RG.

When setting limit switch SW4 is opened by cam SC1, the holding circuit for relay RB is interrupted. When this occurs the relay drops out and contact RB2 reopens, interrupting the power circuit of setting board motor M5.

The setting board start switch SW3 is so located as to allow the sweeper board to be moved forwardly out from below the pin setting platform early enough so as to avoid interference with the setting board as it descends. The sweep stops automatically when the conveyor chain strikes sweep limit switch SW2. When switch SW2 is opened by lever arm 306 attached to sweeper carriage 310, the holding circuit for relay RA is broken and relay RA drops out. This opens contact RA3 and prevents the sweep motor M4 from operating further.

(2) OPERATION TO PICK UP STANDING PINS, SWEEP ALLEY, AND RESPOT PINS

Foot switch SW12 is used when one or more pins are lying on their sides on the alley plate and the bowler desires to eliminate this deadwood before attempting further to knock down any pins that remain standing on the alley floor.

Closing of footswitch SW12 energizes relay RG. It is to be noted that when the sweep mechanism has been stopped by opening of sweep limit switch SW2, relay RA is deenergized and contact RA1 closes. Thus when footswitch SW12 is depressed by the bowler's foot, a circuit is established through contact RA1 and switch SW6 to energize relay RG. A holding circuit for relay RG is established through contact RG1 and setting limit switch SW4. When relay RG is energized contact RG2 closes. This establishes a closed circuit to cam switching solenoid S3 from terminal T7. The solenoid S3 shifts cams LC1, 2, 3 and 4 to the right and places cam LC3 in operating alinement with cam follower 784 of the lever arm 782 that controls the opening and closing of the cups on the pin positioning platform. At the same time cam LC4 is placed in operating alinement with cam follower 768 of lever 766 that operates the bull gear stop arm 760.

When the cams are moved to the right, cam LC1 closes solenoid setting start switch SW13. This energizes relay RB, which is then held in energized state by virtue of the holding circuit established through contact RB1 and setting limit switch SW4. Closing of relay RB automatically causes setting board motor M5 to begin operation again. The circuit for setting board motor M5 is the same as previously described. The setting board moves downward and when it is approximately 6" from the alley floor cam LC4 operates the lever arm 766 so as to pivot the bull gear stop arm 760 and stop movement of the pin positioning platform. Cam LC3 operates to open the cups on the pin positioning platform to their full extent while the pin positioning platform is moving downward and to close the cups about the pins standing on the alley while the platform is stopped 6" above the floor. The pin positioning board commences to move up again as soon as the cups are closed and returns to home position. The pin positioning board stops in home position when switch SW4 is opened by cam SC1. Opening of switch SW4 causes relay RB to drop out to stop setting board motor M5.

Opening of switch SW4 also interrupts the holding circuit for relay RG, causing the relay to drop out. When relay RG drops out cam switching solenoid S3 is immediately deenergized, allowing the cams to be moved toward their home position by spring 746 acting against armature 728. However, the armature of cam switching solenoid S3 is prevented from reaching home position by the pivoted lever 730 which at this time is not supported by key 734 on rotating shaft 578 but instead is held in blocking position by tension spring 732. Thus the cams are held in their intermediate position so that cam LC2 is now in operating alinement with cam follower 784. Just before or shortly after the pin positioning board commences to return upward to its home position, switches SW10 and SW14 are both closed by teardrop cam SC3. When switch SW10 closes, relay RA is energized. Relay RA is kept on by the holding circuit established through contact RA2 and switch SW2. Closing of relay RA causes the sweep motor M4 to start a new sweeping cycle. Normally the circuit to sweep motor M4 is completed through contact RD1 of relay RD. However, if at this time relay RD happens to be energized so that contact RD1 is open, an alternate sweep circuit is completed through contact RF2 and terminal T7. Relay RF is energized when switch SW 14 is closed. A holding circuit for relay RF is established through contact RF1 and sweep limit switch SW2.

The sweep passes beneath the ascending pin positioning board to sweep the alley free of pins and on its return run it trips switch SW3 to momentarily close it. This closes relay RB which remains on after switch SW3 is reopened by virtue of the holding circuit established through contact RB1 and setting limit switch SW4. Setting board motor M5 starts when relay RB is energized. The setting board moves downward and is stopped within six inches of the alley floor due to cam LC4 which causes lever 766 to lift the bull gear stop arm 760 to stop the bull gear. While the pin positioning board is stopped above the alley, cam LC2 causes the cups to open fully to respot the pins which were retrieved previously. Cam LC2 keeps the cups open until the ascending pin positioning board has moved above the respotted pins, after which it allows the cups to close again. Pin positioning board I stops again in home position when switch SW4 is momentarily opened by teardrop cam SC1.

Just before the pin positioning board reaches home position the cam 734 on shaft 578 operates to pivot the mechanical stop lever 730, thereby allowing armature 728 of solenoid S3 to return to its normal retracted position so as to restore cams LC1, 2, 3 and 4 to their home positions. In this position, as previously stated, cam LC1 is in operating alinement with cam follower 784, so that the machine is again ready to set another ten pins. However, should the bowler again depress foot switch SW12 instead of calling for a new set of pins, the cams will again shift so as to place cam LC3 in operating alinement. Cam follower 784 and the pin positioning board and the sweep mechanism will repeat the cycle of operation just described, thereby to effect retrieving of the pins, sweeping the alley, and respotting of the pins in their original position.

It is to be noted that relay RF drops out when sweep limit switch SW2 is opened. When relay RF drops out, contact RF2 opens to terminate the alternate sweep motor circuit from terminal T3 to terminal T7. This circuit cannot be ecompleted again until switch SW14 is again closed so as to reenergize relay RF. The primary sweep motor circuit can be completed only when the positioning board is stopped in home position and relay RD is "off." Relay RD can close only when switch SW11 closes. Although switch SW11 is closed only momentarily by cam LC4, relay RD will stay on because switch SW7 is closed so as to establish a holding circuit through contact RD2.

(3) OPERATION TO CONVEY PINS TO DISTRIBUTOR, INDEX DISTRIBUTOR AND DUMP PINS FROM DISTRIBUTOR

Pin conveyor motor M2, clutch solenoid S2 and dump solenoid S1 are controlled by switches SW5, SW7, SW8, SW9, and SW11, and relays RB, RC, RD, RE and RH.

The power circuit of pin conveyor motor M2 comprises terminal T5, contact RE1, and terminal T8. Thus the motor M2 will operate so long as contact RE1 is closed and will stop when relay RE is energized to open contact RE1.

Clutch solenoid S2 is connected to terminal T7 through relay RH. When relay RH closes solenoid S2 is energized through contact RH2.

The circuit for dump solenoid S1 comprises terminal T2 and relays RB, RC, RD, and RE. Solenoid S1 is energized only when relay RB is off and relays RC, RD and RE are on simultaneously, the connection to terminal T10 then being completed through contacts RE3, RD3, RC3 and RB3. Dump solenoid S1 can be energized only when setting board motor M5 is stopped. This is due to the fact that when contact RB2 is open to motor M5, contact RB3 is closed to relay RC, and vice versa. Following is a detailed explanation of the circuit showing (1) how the pin elevator is started when the pin distributor is empty and stopped when the distributor is full, (2) how the distributor is indexed until full, and (3) how the pins are dumped from the distributor only when the distributor is full and the storage tubes are empty.

Assuming that the cups of the distributor G and the storage tubes 492 are all empty, and that contact RE1 is closed, pins are removed from the pit by the pin elevator E and dropped through the pinlift chute 92 into one of the distributor cups. As the pins drop through the chute, switch SW8 is momentarily closed by each falling pin. Switch SW8 is the pickup switch for clutch solenoid relay RH. When switch SW8 closes it completes a circuit through the normally closed contact RC2 of relay RC to energize relay RH. When relay RH is energized, a holding circuit is established through contact RH1 and switch SW9. This keeps the relay on for a period of time sufficient to cause the clutch solenoid S2 to be energized through contact RH2 of relay RH and terminal T7. When the clutch solenoid S2 is energized, the distributor is caused to index through a distance equal to the distance between successive cups, placing another empty cup below the discharge chute of the pin elevator. The holding circuit for relay RH is interrupted by opening of switch SW9 which is momentarily opened by one of the inwardly extending projections or lugs 468 on the distributor ring. Relay RH drops out when switch SW9 is opened and reenergized again only when switch SW8 is again closed by a pin dropping through the chute of the pin elevator. The pin lift and the rotating distributor continue to operate until the first cup having a pin reaches the number 10 index position, closing switch SW5. The index ring now has 9 pins and is waiting for the tenth pin to be discharged from the pin elevator. When switch SW5 closes relay RC is energized. Contacts RC1, RC3 and RC4 close and contact RC2 opens. A holding circuit for relay RC is established through contact RC3 and switch SW7. Energization of relay RC disconnects switch SW8 from contact RC2 and connects it to contact RC1 which leads to relay RE. Thus when another pin falls through the discharge chute of the pin elevator to momentarily close switch SW8, relay RE is energized, causing contact RE1 to open and contacts RE2 and RE3 to close. Opening of contact RE1 interrupts the circuit of pin lift motor M2. A holding circuit for relay RE is established through contact RE2 and switch SW7.

Energization of relay RC and relay RE completes two of the four phases required to be completed in order to execute the dumping operation. The third phase is completed when switch SW11 closes under cam LC4. Cam LC4 closes switch SW11 just before the setting board reaches home position after setting a new set of pins. When switch SW11 closes it energizes relay RD. A holding circuit for relay RD is established through contact RD2 and switch SW7. Thereafter the fourth phase is completed when switch SW4 is opened by cam SC1, dropping relay RB so as to close contact RB3. Upon completion of all four phases of its circuit, dump solenoid S1 is energized to rotate dump ring 366 to effect release of pins from distributor G to storage chutes 492. Relays RC, RD, and RE remain energized until a pin falls into the chute with which switch SW7 is associated. As soon as a pin falls in that chute it momentarily opens switch SW7. When switch SW7 opens, relays RC, RD, and RE immediately become deenergized to interrupt the circuit of dump solenoid S1. This allows the dump ring 366 to be returned to its original pin holding position.

As soon as relay RE is deenergized the pin lift motor M2 begins to operate again to deliver another set of pins to distributor G. Clutch solenoid S2 will be reenergized when switch SW8 is again actuated by a pin falling through the discharge chute of the pin conveyor, thereby causing the distributor to index one position. When the first pin in the distributor reaches the ninth position it again actuates switch SW5. When switch SW5 closes it picks up relay RC to change the circuit path of switch SW8 from relay RH to relay RE. This isolates relay RH so that it will not be picked up when switch SW8 is again actuated, thereby preventing energization of clutch solenoid S2 and further indexing of the distributor. When the tenth pin is delivered from the pin lift, switch SW8 closes momentarily to energize relay RE, cutting out the pin lift motor M2 and closing one of the phases of the circuit to dump solenoid S1. Solenoid S1 operates to release pins from the distributor when the other three phases of its circuit are completed.

The circuit in which switch SW8 is connected is automatically changed from the one which includes relay RE to the one which includes relay RH so that switch SW8 serves two functions. The primary function of switch SW8 is to control operation of the clutch mechanism. The alternate function, which occurs only at every tenth index, is to control and complete one of the phases of the dumping circuit. It is also to be noted that the sweep circuit through contact RD1 cannot be completed until after the dumping operation has been completed, for during the dumping operation relay RD is energized and contact RD1 is opened. It is to be noted that a second set of pins cannot be dumped into storage tubes on top of the first set of pins previously delivered thereto due to the fact that the circuit of the dump solenoid cannot be completed until relay RD is picked up by closing of switch SW11. Since switch SW11 closes only when the pin positioning board is returning to home position after spotting a new set of pins, it follows that the storage tubes are always empty when dump solenoid S1 is energized. It is also to be noted that pins cannot be discharged from the indexing distributor if the distributor is not full since switch SW5 will remain open and relay RC will remain deenergized so long as switch SW5 is not closed by a pin in the distributor.

Still another control feature is to be noted. Once the distributor is full, no further pins can be supplied to it by the pin lift due to the fact that pin lift motor M2 stops operating when contact RE1 opens. As stated previously the holding circuit for relay RE is through switch SW7. Thus until relay E is deenergized, and this happens only when pins are released from the distributor so as to open switch SW7, the pin lift will remain inoperative and no more pins will be delivered to the distributor.

It is to be noted that when switch SW5 is closed by a pin in the distributor, it remains closed until the pin is released to the storage tube 492. Thus relay RC is kept in "On" condition by two circuits, one of which is the normal energizing circuit through switch SW5 and the other of which is the normal holding circuit through switch SW7. The reason for this is best explained by describing the difficulty which it is designed to avoid. Assume that just after the ninth pin has been delivered to the distributor, the machine is shut down. Immediately relays RC, RD, and RE would drop out. Thereafter if the machine is started up again, the pin elevator would commence to operate. Normally as soon as the pin elevator delivers the tenth pin to the distributor, relay RE would be energized through switch SW8 and contact RC1, and contact RE1 would open to stop the pin elevator motor M2. However, when the machine was shut down,

relay C dropped out to open contact RC1. This would prevent relay RE from being energized upon delivery of the tenth pin unless relay RC was itself reenergized when the machine was started up again. If relay E did not become reenergized upon delivery of the tenth pin, the circuit to dump solenoid S1 could not be completed and the pin elevator would continue to operate, delivering additional pins to the distributor even though it was full. These additional pins would fall onto the distributor, causing it to jam, or would fall off of the distributor onto the alley or into some of the other mechanisms of the machine. If switch SW5 was so positioned as to close only momentarily when engaged by a pin in the distributor, relay RC would be energized through switch SW5 but would be held on only by the circuit through SW7. Thus should the machine be shut down, relay RC would drop out, and should the machine be started up again, relay RC would remain out because (1) the circuit through SW7 is effective only to hold it energized but not to place it in energized condition, and (2) the normal energizing circuit would be open due to switch SW5 being open. However, if (as is the actual case) switch SW5 is so positioned as to remain closed so long as the pin which closed it is still in the distributor, relay RC will be reenergized as soon as the current to the machine is again turned on, and relay RE will be energized as soon as the tenth pin is delivered to the distributor, so that the pin elevator will shut down as soon as the tenth pin has been delivered and will not start up again until after the dump solenoid S1 has operated to release the pins in the distributor to the storage tubes.

As shown in FIG. 26, various signal lamps L may be connected into the electrical circuit for the purpose of indicating the operating state of the various control and motor elements. Use of signal lamps is well within the skill of the art and their use in the present circuit is referred to only to point out how they can be utilized to facilitate trouble-shooting and to make manifest the fact that certain component assemblies of the machine are operating.

It is to be noted that in picking up and respotting pins it is essential that the pins not be shifted laterally of the alley. The cups on the pinsetting board are able to pick up and respot pins without shifting them laterally by reason of their recessed straight edges **616**.

Although the machine is adapted to handle three sets of pins, one set in the distributor, one set in the reservoir and one set on the alley floor, it has been found that best results are obtained using 25–27 pins, with 25 being the preferred number. With three sets of pins disposed in the distributor and reservoir and on the alley floor, the pin conveyor will be stopped. Thus when the bowler strikes down several pins, they will fall onto the turntable and be carried around the pit. One or two may fall into the trough of the pin conveyor and they will prevent the rest from doing the same. Thus the pins in the pit will keep traveling around and will be scuffed and bruised by the walls of the pit. Only after the pins in the distributor have been released to the reservoir will the pin conveyor start to operate again. However, with 25–27 pins in the machine, the distributor will release pins almost immediately after it has been filled so that the pin conveyor will be operating substantially continuously and pins will be carried away from the pit almost as rapidly as they are knocked into the same.

Obviously many modifications of the invention as described are possible. The circuit immediately described may be varied without changing the operation of the machine. The cam LC3 may be changed so as to eliminate the slight opening of the cups when the positioning board begins to move downward, and the cups may be changed so as to eliminate the need for having them open slightly during the first part of the downward movement of the pin positioning board. It is also contemplated that other types of pin conveyors may be associated with the machine. Similarly a different sweep mechanism may be utilized or a different pin distributor may be incorporated in the machine. Other component assemblies of the machine may also be varied without departing from the scope of the invention.

In order for the machine to be used with the game of ten pins, it is only necessary to change the dimensions of the various elements that come into contact with the pins. Thus the swinging yokes on the pin elevator may be enlarged so as to accommodate the larger diameter of ten pins. Similarly the cups on the pin positioning board, the cups on the pin distributor, and the chutes leading from the pin distributor to the pin positioning board may all be enlarged so as to readily accommodate the larger ten pins.

Therefore it is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts specifically described or illustrated, and that within the scope of the appended claims it may be practiced otherwise than as specifically described or illustrated.

We claim:

1. Apparatus for collecting bowling pins and distributing them to ten chutes each aimed to discharge a pin at a different point located vertically above one of the ten pin-setting positions of a bowling alley, said apparatus comprising ten cylindrical cups each open at both ends and each having a slot in its side, a frame intermittently rotatable in a horizontal plane in step-by-step progression supporting the cups in a circular array and in evenly spaced relation to each other, a spider secured to the frame and having a central hub coaxial with the central axis of the array, a vertical shaft rotatably supporting the hum, a ring carried by the frame in concentric and relatively movable relation with the array of cups, the ring having ten evenly spaced stop elements fixed thereon, these stop elements normally projecting respectively into the cups through the slots to engage the pins intermediate their length and below their maximum girth so as to prevent pins deposited into the cups from passing out of the bottom of the cups, a solenoid carried by the spider, toggle linkage pivotally connected by its ends between the frame and the ring and normally standing beyond dead center position to lock the ring against movement relative to the frame, and means connecting the solenoid and the toggle linkage to shorten the latter and thereby shift the ring on the frame to move the stop elements out of the cups to release the pins when the solenoid is actuated.

2. Apparatus as defined by claim 1 further including means connected between said frame and said ring for rotating said ring to restore said stop elements to their normal position, after pins have been released from said cups.

3. In a bowling pin setting machine having a positioning board for depositing a set of pins on the floor of a bowling alley in correct bowling position, apparatus for storing a complete set of pins and for distributing them on command for delivery to the pin positioning board, said apparatus comprising a plurality of uniformly-spaced cylindrical vertically-extending pin holders disposed in a circular array, means supporting said pin holders, said holder-supporting means including a hub disposed centrally of said array, a vertical shaft, said hub rotatably mounted on said shaft above said positioning board, drive means for rotating said holders, said holder-supporting means, and said hub step by step in a horizontal plane relative to said shaft, a plurality of pin retainer elements ganged together and supported by said holder-supporting means for rotation therewith, said pin retainer elements normally positioned to prevent pins from falling out of the bottom of said holders, devices attached to said holder-supporting means and operable while said array is stationary to move said pin retainer elements out of said normal position, whereby to release pins supported in said pin holders by said pin retainer ele-

ments, a solenoid carried by said holder-supporting means, and means connected between said solenoid and said devices for operating the latter when said solenoid is energized, a normally open switch having an actuating member positioned to be engaged and operated by a pin positioned in one of said pin holders as said array is rotated, and a power circuit connected to and controlled by said switch for energizing said solenoid only when said switch is closed by said actuating member.

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