March 25, 1952 J. MILLMAN ET AL 2,590,444

BOWLING MACHINE TOTALIZER

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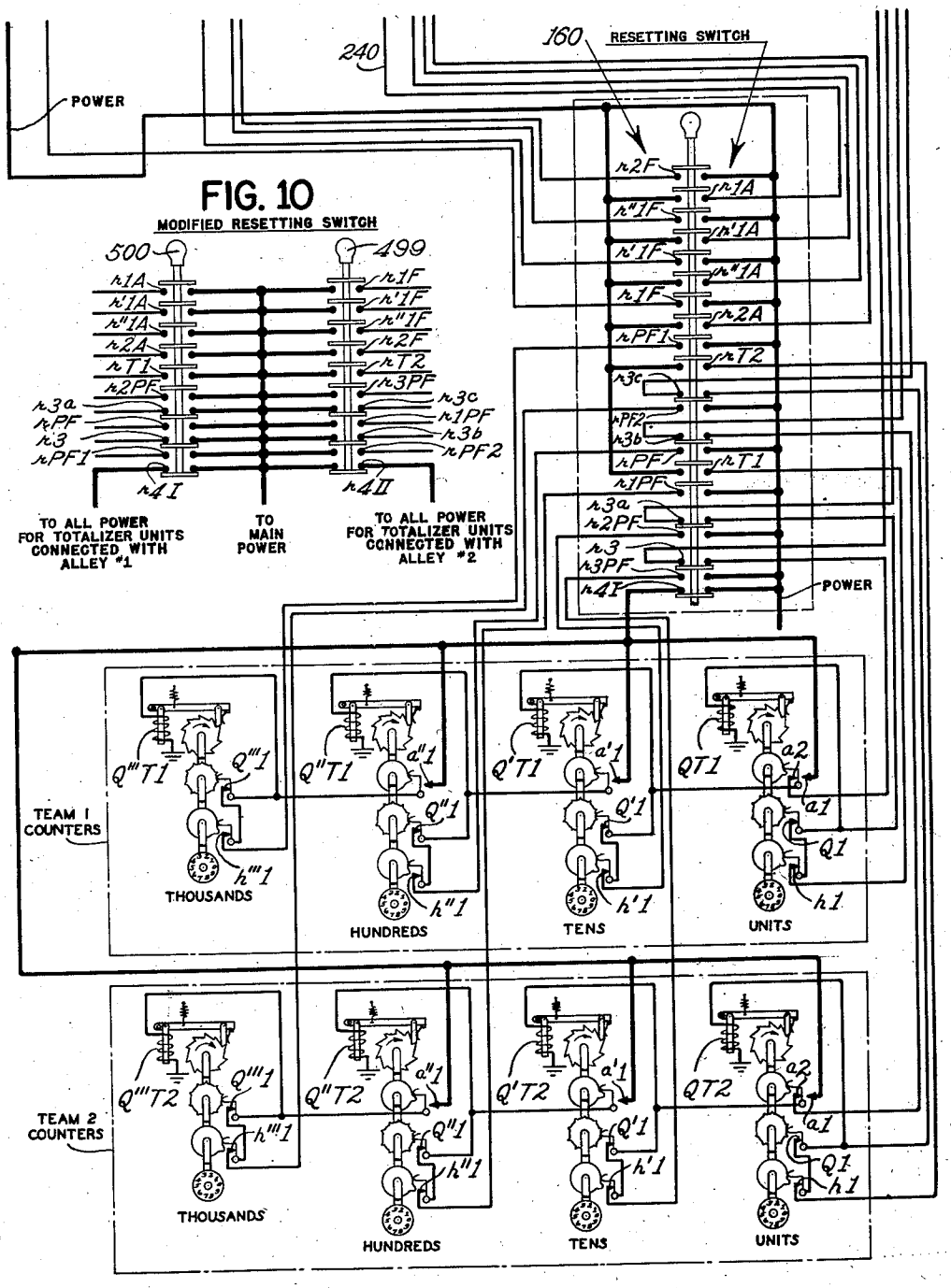


FIG. 10

MODIFIED RESETTING SWITCH




FIG. 1

INVENTORS
JACOB MILLMAN
HOWARD P. STABLER
BY Wentworth B. Clapham
ATTORNEY

March 25, 1952 J. MILLMAN ET AL 2,590,444

BOWLING MACHINE TOTALIZER

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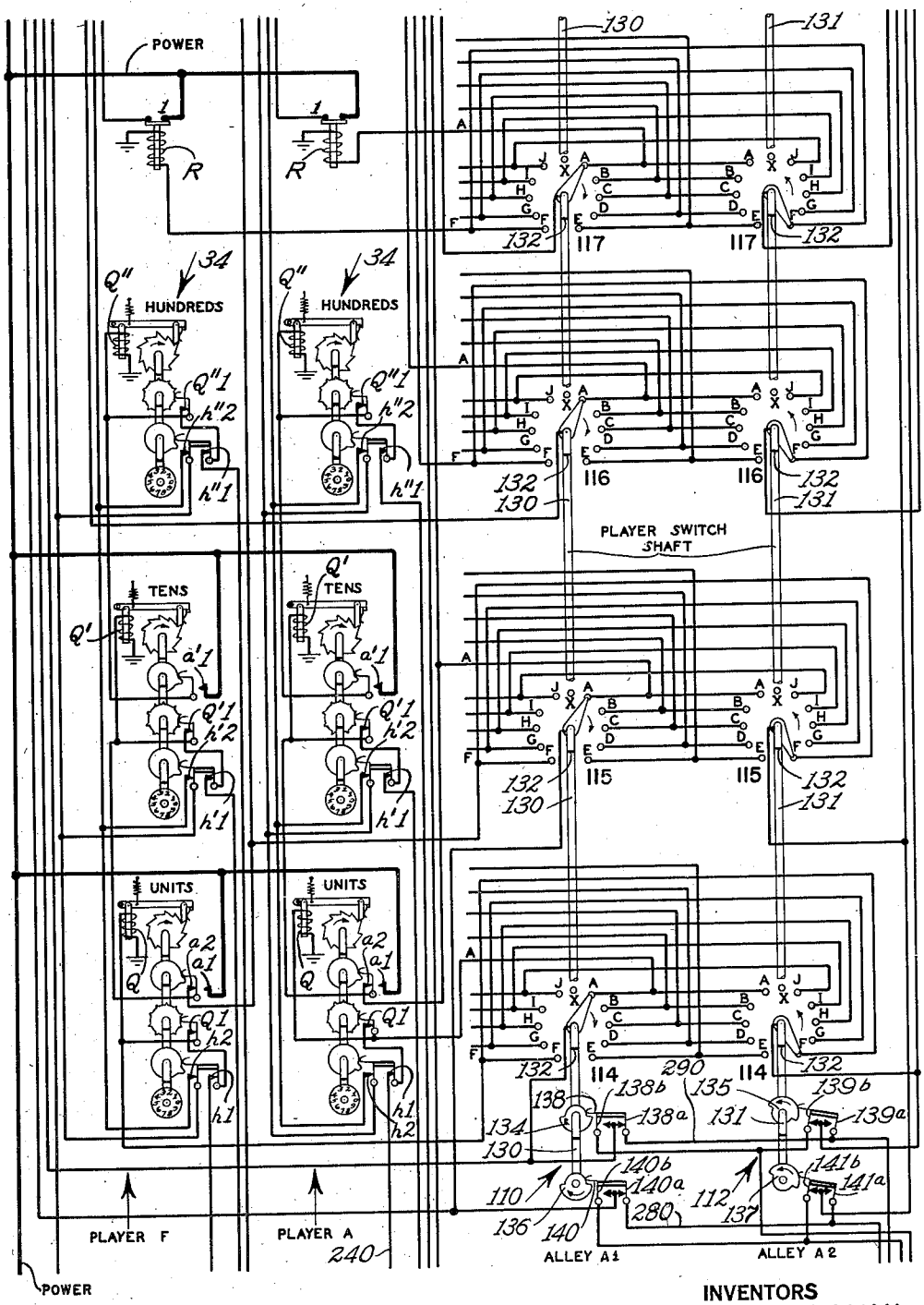


FIG. 2

INVENTORS
JACOB MILLMAN
HOWARD P. STABLER
BY Wentworth B. Clapham
ATTORNEY

March 25, 1952 J. MILLMAN ET AL 2,590,444

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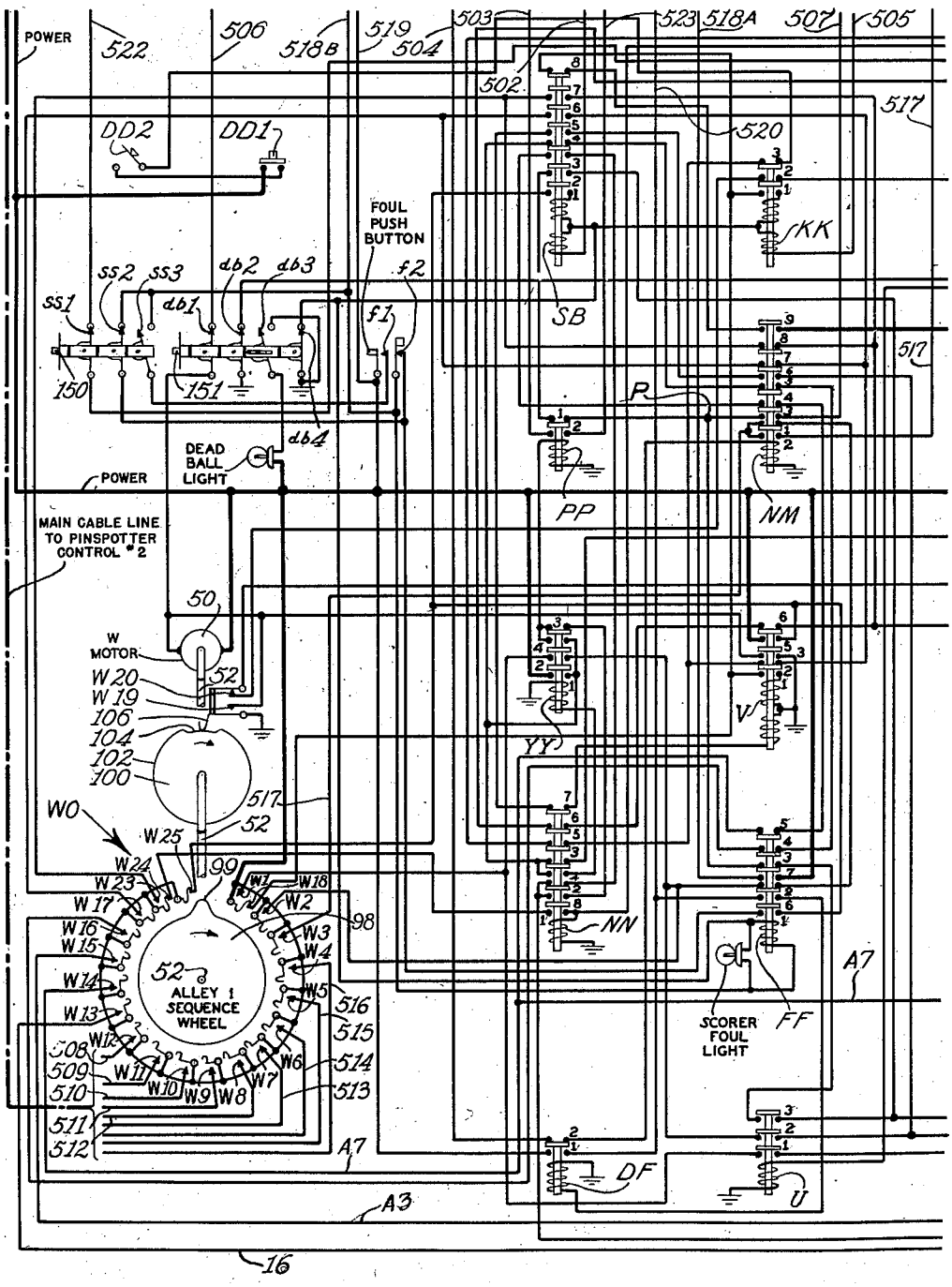


FIG. 3

INVENTORS
JACOB MILLMAN
HOWARD P. STABLER
BY Wentworth B. Clapham
ATTORNEY

March 25, 1952 J. MILLMAN ET AL 2,590,444

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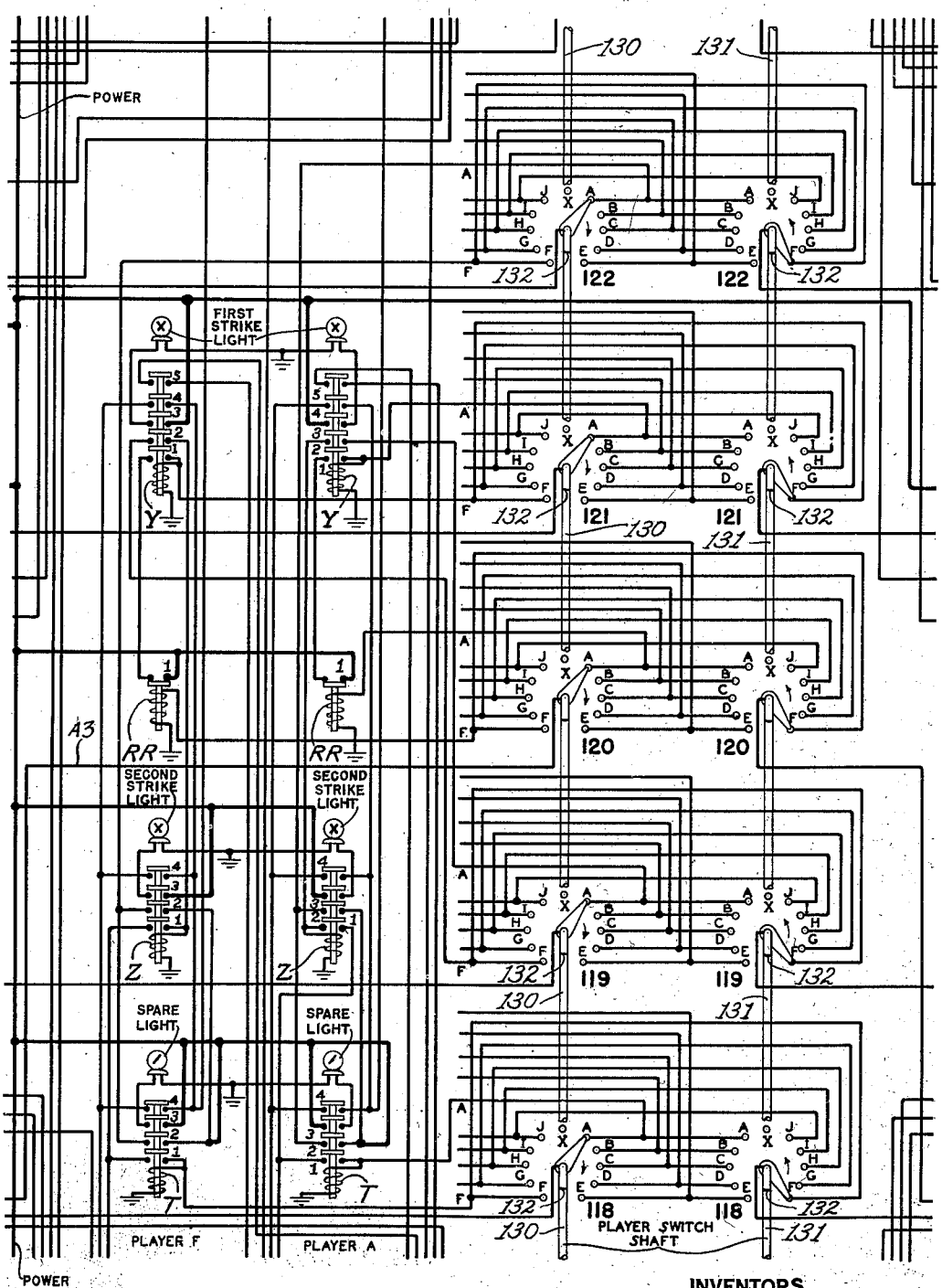


FIG. 4

INVENTORS
JACOB MILLMAN
HOWARD P. STABLER
BY Wentworth B. Clapham
ATTORNEY

March 25, 1952 J. MILLMAN ET AL 2,590,444

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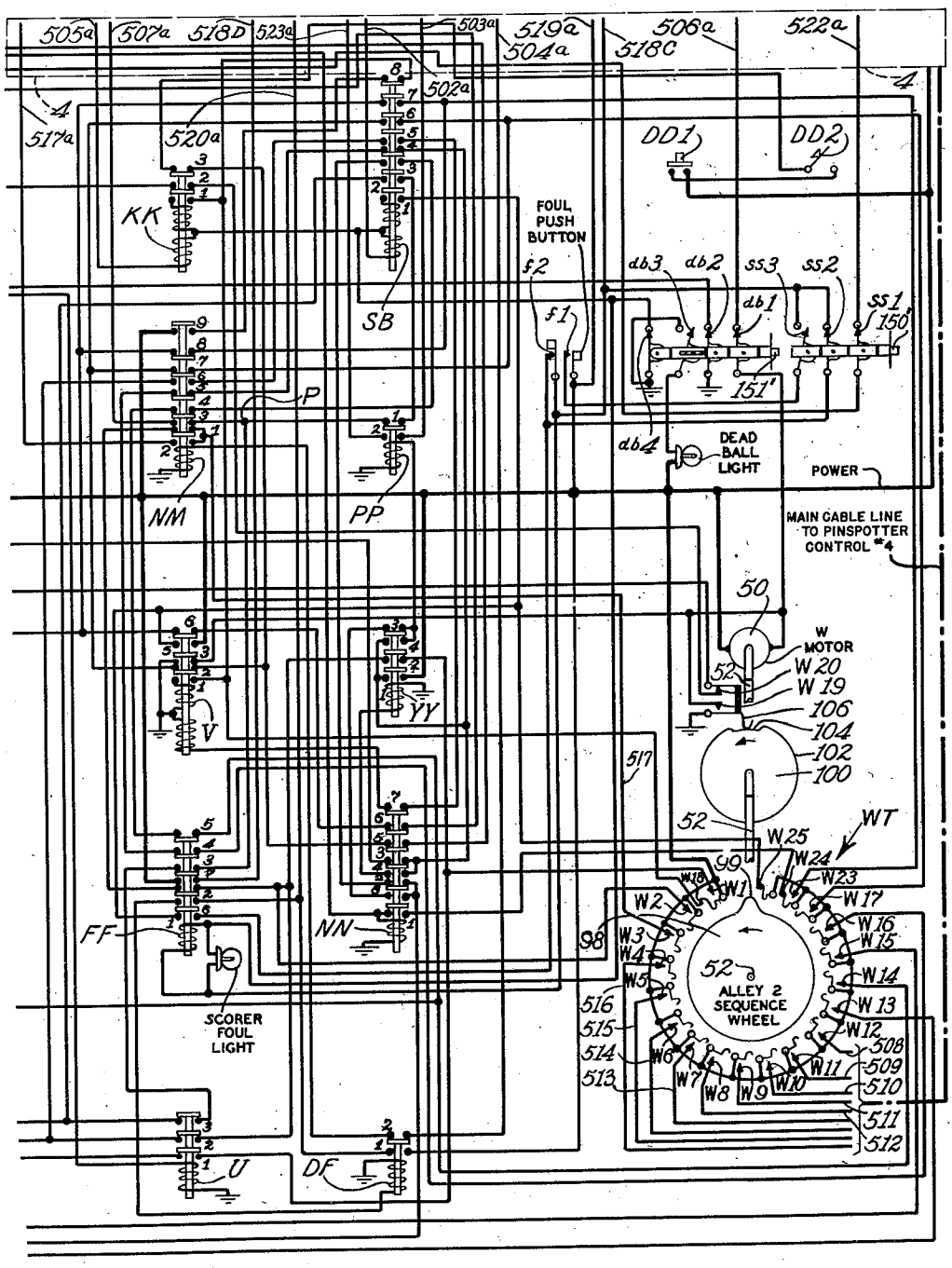


FIG. 5

INVENTORS
JACOB MILLMAN
HOWARD P STABLER
BY Wentworth B. Clapham
ATTORNEY

March 25, 1952 J. MILLMAN ET AL 2,590,444

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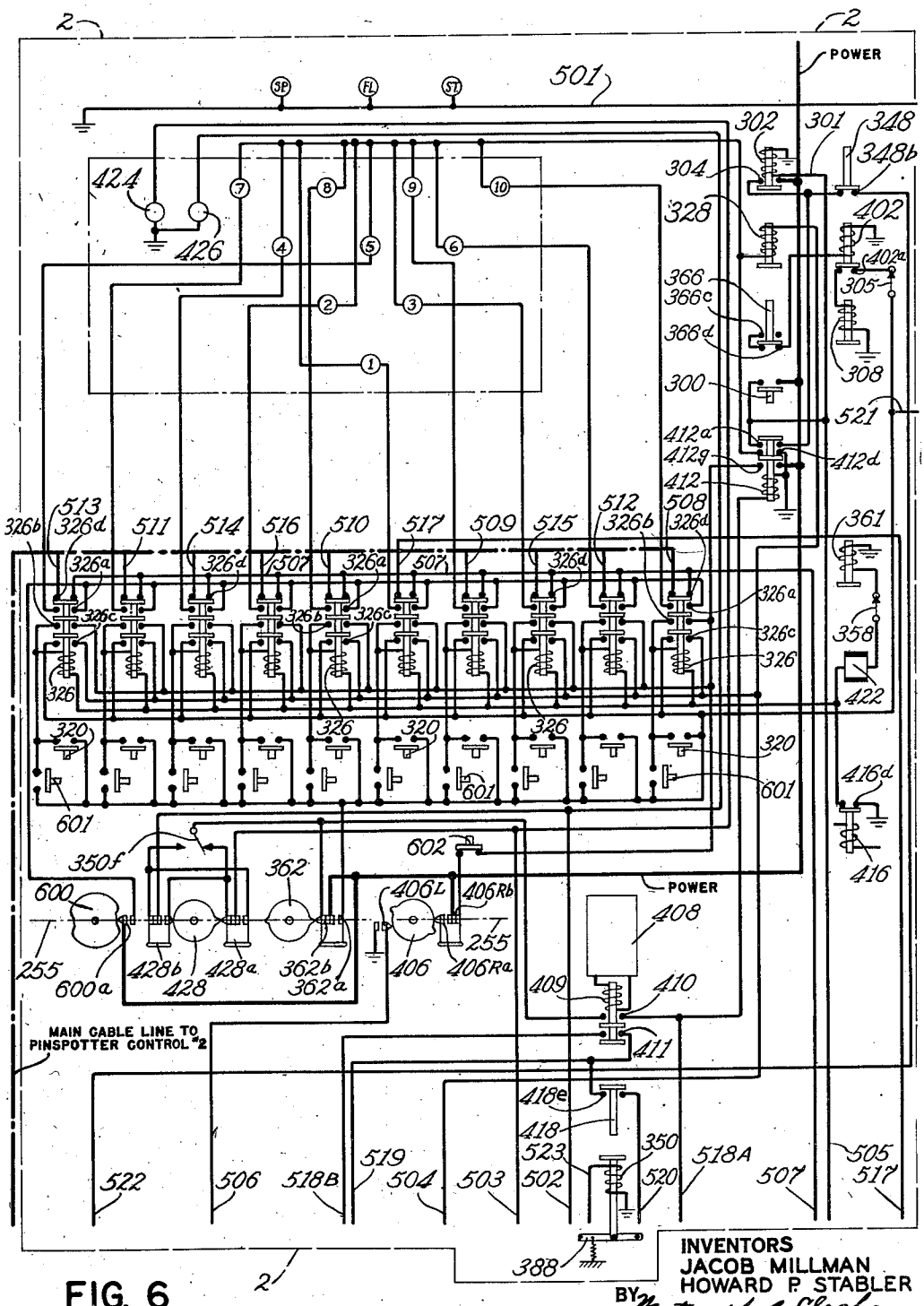


FIG. 6

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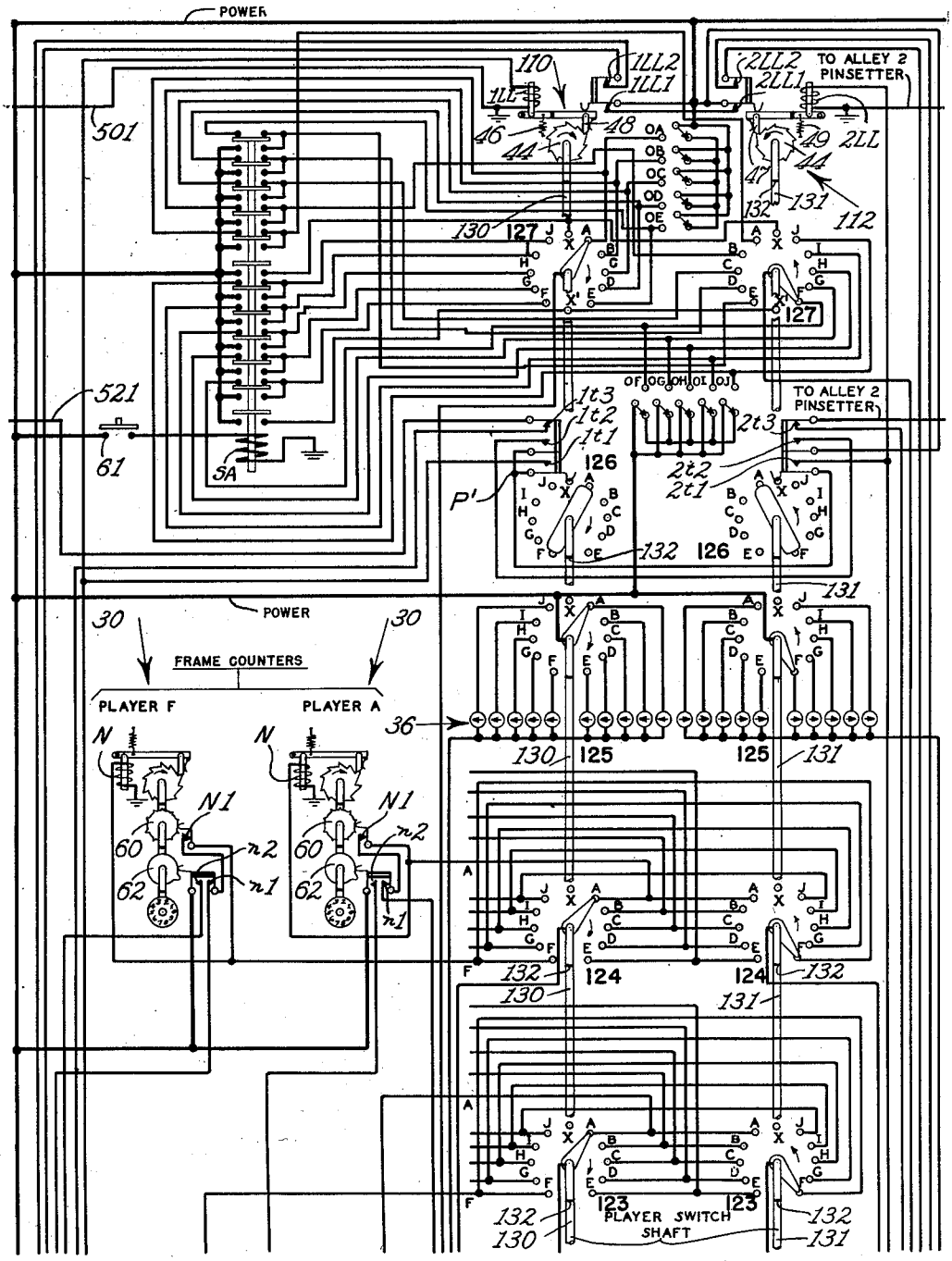


FIG. 7

INVENTORS
JACOB MILLMAN
HOWARD P. STABLER
BY Wentworth B. Clapham
ATTORNEY

March 25, 1952 J. MILLMAN ET AL 2,590,444

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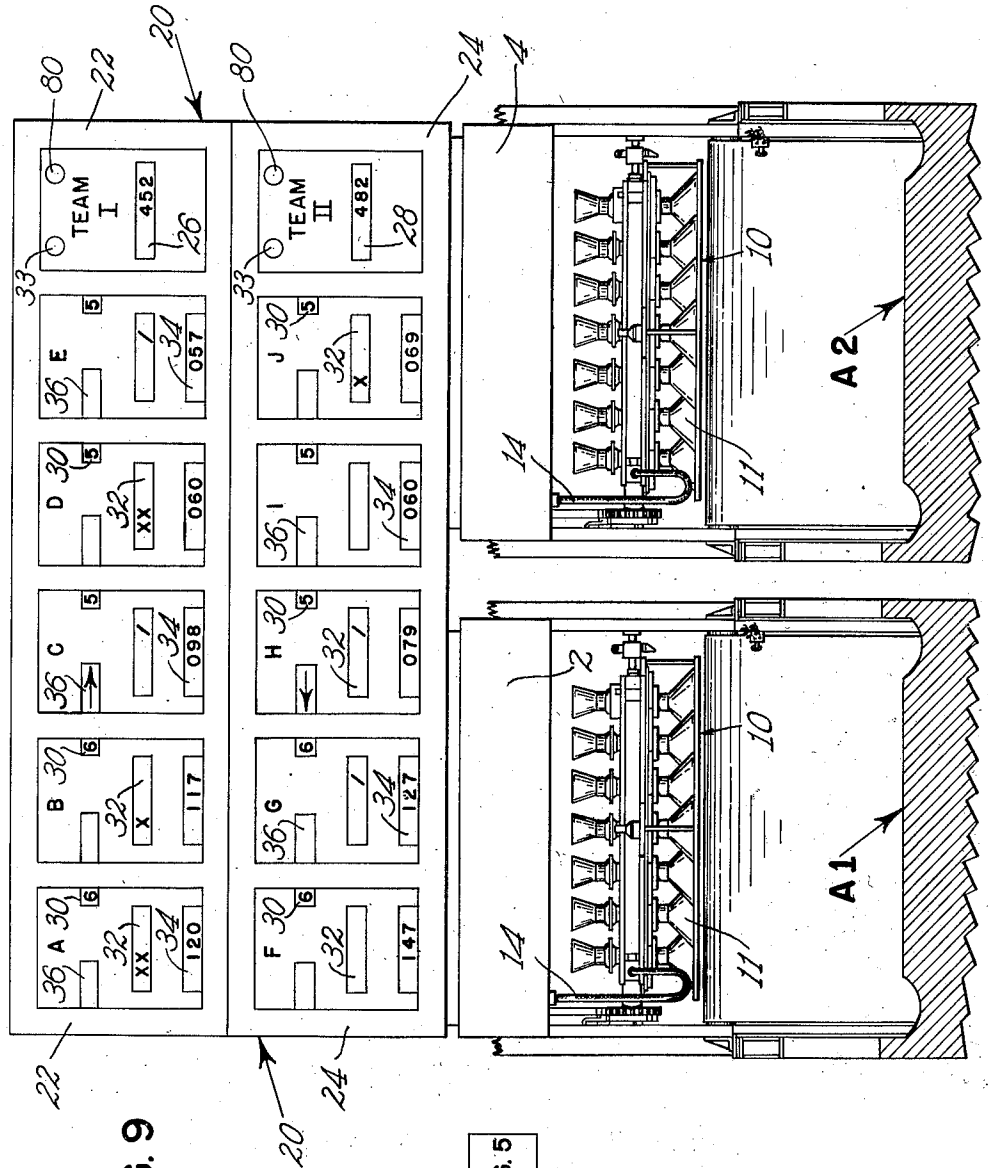


FIG. 9

FIG. 8

| | | | |
|---|---|---|---|
| FIG. 6 | FIG. 7 | FIG. 3 FIG. 4 | FIG. 5 |
| | | FIG. 2 | FIG. 1 |

INVENTOR
JACOB MILLMAN
HOWARD P. STABLER
BY Wentworth B. Clapham
ATTORNEY

Patented Mar. 25, 1952

2,590,444

# UNITED STATES PATENT OFFICE

2,590,444

## BOWLING MACHINE TOTALIZER

Jacob Millman, Flushing, N. Y., and Howard P. Stabler, Williamstown, Mass., assignors to American Machine and Foundry Company, a corporation of New Jersey

Application January 2, 1947, Serial No. 719,869

30 Claims. (Cl. 273—43)

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This invention relates to a bowling totalizing and scoring device which totalizes and scores the results of one or more players from the beginning to the end of each game, whether each player is bowling individually or as a member of opposing teams, and whether each player is bowling on one or two alleys during the playing of a game.

The mechanism is so arranged that any number of players up to, say two teams of five players each, can bowl as is customary in league play, on two alleys, and each individual player's score, and also the team scores, are progressively totalized and scored or made visible on a suitable scoreboard or annunciator panel forming a part of the machine or used in conjunction therewith. In this manner each player sees on the scoreboard exactly what he would see on a score chart if his score was being kept by a scorekeeper.

Heretofore in the game of bowling it has been customary to use scoring charts or blank forms provided by proprietors or operators of bowling alleys for scorekeeping. It is generally customary for either the bowler himself or a person designated for the purpose to keep score. After each frame is played, the frame score is written in the appropriate place in the box or part of the score chart corresponding to the particular frame adjacent the name of each player. If, for instance, a strike or a spare is made on the first or second ball, respectively, of a frame, a symbol well-known in scoring the game is placed in the upper right-hand corner of the box representing that frame to indicate the results of the pin fall by a particular ball in the case of a strike, or two balls in the case of a spare. In the case of a strike, two balls must be rolled before appropriate scores in preceding boxes can be entered. In case of a spare, scoring is delayed until the next or first ball of the next frame is rolled; whereas in the case of two normal balls knocking down less than ten pins, the frame score can immediately be entered and the play to that point totalized.

As far as is known, we are unaware of any device which can be used in connection with full size normal bowling alleys employing full size conventional, free bowling pins such as ten pins, duck pins or candle pins, etc., which automatically registers pin fall from frame to frame as the game progresses and records and totalizes each score of one or more players, individually or in team play. Accordingly, the solution of this problem, which is evidenced by the present invention represents an important advance in the art. It makes it possible for each player to direct his

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full attention to his bowling and improving his score, because he is not required after the completion of each frame to stop and enter his score, or record the results of a ball thrown in the case of a strike or spare, yet each player substantially, immediately after each frame is completed, can see the results of his and his competitors' play to and including the frame last completed. Furthermore, it is not necessary to require the services of another player or an intermediary to tabulate the results of the play as the game progresses.

Our invention also solves the problem of providing an automatic bowling totalizing and scoring device which can be used in scoring and totalizing the play on a single bowling alley using a bowling pin setting machine, or scoring and totalizing the play of several bowlers on two bowling alleys using two independently operated bowling pin setting machines having means for sending selective impulses to the scoring and totalizing device which automatically totalizes and scores the in-turn frame by frame play of the several bowlers bowling either on one alley or on first one and then the other in turn during the frame to frame play of complete games.

Our invention also makes possible a minimum of discussions and argument arising in connection with entries on the score charts since the proper result is automatically set up in our machine with positive accuracy at all times regardless of the number of players within the limits of the machine. For purposes of illustration we have shown mechanism capable of caring for up to five players per side or fewer as the case may be. If desired, however, in the totalizer illustrated up to five bowlers could use a single alley and all scores could be properly tabulated and totalized.

The totalizing mechanism, which forms our invention, is so constituted that it will indicate a spare, a strike, or two spares or strikes, or any combination thereof in succession or be operated by normal, less than ten pin, pin fall frames. The totalizer records each mark made by each player, and memorizes the occurrence thereof so that although the scoreboard does not indicate the exact numerical score until the appropriate ball of the next frame or next two frames is or are rolled depending upon whether a spare or a strike is made, they are properly taken into account in the scoring so that each player looking at the scoreboard, and in particular at his own score panel, can see his numerical score, and also the mark or marks credited to him, though not yet totalized. For example: if a player starts a game with two successive strikes, his score is zero until

he bowls the next ball. Hence, at the end of the second frame the totalizer scoreboard will read zero for this particular player, but two strikes will be indicated in that player's individual annunciator or scoring panel. After the next ball is thrown, this being the first ball of the third frame in the case assumed, the proper score for this player's first frame will be immediately indicated because of the fact that he has then rolled the two balls required by the rules for completing the scoring of the first strike.

A similar situation exists in the case of a spare. For example: if a spare is made on the second ball of the first frame, the score indicated for the first frame will be zero until after the first ball of the second frame has been rolled after which the totalizing mechanism sets up the proper score for the first frame. In the examples given above, reference to the first, second, or third frame is merely exemplary since the principle of scoring obtains throughout the entire play except in the case of a spare or a strike in the tenth frame, which will be described hereinafter. The same totalizing and scoring relationship obtains for all players as each player bowls in turn in playing his game.

The totalizer and scoring mechanism which constitutes our invention is designed primarily for use with bowling pin setting machines, and especially with machines which have means for indicating pin fall and progress of play from frame to frame to the end of each game. The invention, however, is not to be considered limited only to use with bowling pin setting machines since it can also be used in conjunction with manually operated or pin controlled mechanisms for operating the totalizing and scoring mechanism to obtain the desired results. When used with an automatic bowling pin setting machine, our invention is especially suitable and well adapted for conjoint operation with a machine of the general type shown in Rundell patent, No. 2,388,707, issued November 13, 1945, and copending Broekhuysen application, Serial No. 627,605, filed November 9, 1945, for Bowling Pin Setting Machine, now Patent 2,559,274, granted July 3, 1951. When our invention is employed with a machine of the type shown in the Broekhuysen patent, the electric control mechanism of the bowling pin setting machine is interconnected with the electric circuit and control of our totalizing and scoring mechanism in order to effect the desired registering, scoring and totalizing of the entire play for one or more players, or opposed teams consisting of from one to five players on a side.

The conjoint operation of the pin setter and totalizing mechanism is so constituted that after each ball of a frame is thrown by a player, whether it be open individual competition or team play, during the subsequent operation of the bowling pin setting machine impulses are sent from the bowling pin setting machine to our novel bowling pin totalizer indicating the result of each ball thrown or pin fall caused thereby, whereupon the totalizer takes into consideration the pin fall, or whether or not the first or last ball of a frame has been thrown and there is automatically set into operation the coacting mechanism for registering both normal pin fall, strikes and spares, and special cases such as fouls, dead balls, etc. In the latter, which can be termed "special cases," manual circuit operating elements are actuated in order to control the operation of the totalizer mechanism



and thereby obtain the proper results. In this way it can be seen that accurate results are obtained at all times as the play of the game progresses from the beginning to the end inasmuch as the operation of the automatic totalizing mechanism is coordinated with that of the automatic bowling pin setting machine from which it receives its impulses.

While reference is made particularly to the use of our invention in connection with bowling pin setting machines, especially automatic bowling pin setting machines, it is apparent that it can also be used on bowling alleys in which semi-automatic pin spotters are employed, or where only manual spotting is used. In these latter cases, it is necessary to have an actuating means which will send the proper impulses to the totalizer representing the pin fall for each ball of a frame so that the result of the plays of the game can be progressively recorded and tabulated by the totalizer and set up on the score board.

It is an object of our invention, therefore, to provide a totalizer for use with bowling alleys which solves the problem of accurately totalizing and registering bowling scores.

It is also an object of our invention to provide a bowling totalizing and scoring device capable of conjoint use with a plurality of bowling pin spotting machines, for instance, two bowling pin spotting machines mounted on two alleys with which the novel totalizing and scoring device is operable to totalize and score the frame to frame and final scores and also the team scores of a plurality of players bowling, first on one and then on the other alley.

It is also an object of our invention to provide a totalizer and score indicating device which automatically and progressively computes and records the bowling score of one or more bowlers bowling on a single alley or adjacent bowling alleys.

It is a further object of our invention to provide a totalizer and score indicating device which automatically and progressively computes and registers the bowling score of one or more bowlers, including accurately scoring strikes and spares and automatically adjusting each score in order to properly score each mark. The invention also provides means for conforming scoring to American Bowling Congress specifications by making it possible to adjust the score for fouls, dead balls, and other plays decreed illegal by the American Bowling Congress.

It is a further object of our invention to provide an automatic bowling totalizer and score indicating device in which pin fall resulting from each ball of a frame causes the actuation of our novel bowling totalizer to indicate the score of one or more players on one or two bowling alleys during the progressive play on one or two alleys with which the bowling totalizer is associated.

It is a further object of our invention to provide a bowling totalizer which can be used in connection with a single alley or two alleys, and which will record pin fall as each frame of a game is played whether it be the result of a single player bowling on a single alley or a plurality of players bowling against each other in open play or in team play. In the case of team play, individual team scores are also automatically totalized during the play until at the end of each game the complete team score as well as individual scores are automatically and accurately computed and made visible.

The invention is further characterized by the

provision of an automatic bowling totalizer which automatically and accurately sets up and progressively computes bowling scores in a foolproof manner thereby eliminating inaccuracies which arise in human score keeping.

It is a further object of our invention to provide a bowling totalizer preferably for use with automatic bowling pin setting machines which computes individual and/or team scores on one or two alleys and which takes into consideration all of the rules prescribed by the American Bowling Congress, especially in connection with fouls, deadballs, and other special cases which can readily be compensated for in order that an accurate score can be set up and computed.

The invention also consists in the provision of novel score indicating mechanism which indicates the progressive play of the game of one or more players, and totalizes each individual player's game; and in the case of team play totalizes and indicates the final score of each team.

The invention is also characterized by the provision of a novel scoreboard associated with and forming a part of our totalizer and scoring mechanism which is provided with a plurality of panels adapted to indicate the score, frame of play, occurrences of marks (strikes and spares) and also the final score of each player.

The invention also consists in the provision of a scoreboard which contains separate team panels including separate panels for individual players on each team. Each player's panel is provided with mechanisms associated with and forming part of our novel bowling totalizing and scoring mechanism for indicating the individual score, frame of play, occurrence of marks (strikes and spares), and the final score. In addition there is also included in each team panel scoring mechanism for tabulating and indicating each team's score.

Other objects of our invention will be set forth in the following description and drawings which illustrate preferred embodiments thereof, it being understood that the above statement of the objects of our invention is intended generally to explain the same without limiting it in any manner.

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

Figures 1 to 7, inclusive, show a partial view of a preferred wiring diagram and mechanism employed for totalizing and scoring progressively as the game proceeds and also indicating the final score of each bowling game whether it be for one or more players in direct competition or in team play;

Figure 8 shows the arrangement of Figures 1 to 7, inclusive, in proper associated relationship to form a complete diagram;

Figure 9 is a view showing a preferred form of a preferred scoreboard which forms a part of the invention, and the manner in which it may be used with one or two bowling pin spotting machines; and

Figure 10 shows a modified resetting switch suitable for use in resetting in single alley operation.

The preferred embodiment illustrated in the drawings shows our novel bowling and totalizing device used in connection with an automatic bowling pin spotting machine of the type shown in the above referred to Broekhuysen patent. Information obtained by the bowling pin setting machine as the result of pin fall after each ball of a frame is thrown and after each frame is completed is impulsed by selective mechanism shown in Figures 1–7 inclusive to the totalizer and converted into a totalized score for each player, and if the players are bowling as teams, team score mechanisms are operated to totalize and score the results of each team.

Our device is so constituted that each individual score indicator will at all times after each frame is rolled show exactly what would be visible to a bowler on a standard score sheet as the frame by frame play progresses. In addition, each player s panel of the totalizer will show a mark, such as a spare, a strike or two strikes if such marks have been made by a player, but have not yet been taken into account for scoring. For example, if a player starts the game with two successive strikes, his score is zero until he bowls the first ball of the next or third frame. Hence, at the end of the second frame, the totalizer will read zero but two strikes will be indicated in the proper indicating space of that particular bowler's panel or scoring and totalizing unit.

The game is normally divided into ten frames, each having a predetermined number of balls. In the case of tenpins, two balls are allowed per frame. In the case of a strike, all pins are knocked down by the first ball; the frame ends with the throwing of the strike ball.

If a spare or a strike is made in the tenth or last frame of a game, one or two bonus balls are allowed respectively. Mechanism is provided for automatically taking each bonus ball into consideration and computing the proper score. Our mechanism conforms to customary rules of play in that as soon as each bowler completes normal bowling in the tenth frame he immediately rolls off the bonus balls alotted him as the results of the type of mark he has made in the tenth frame.

*Scoreboard*

The scoreboard may take any desired form provided it contains sufficient mechanism and indicating devices to satisfy the purposes of our invention.

A preferred embodiment of the scoreboard or annunciator designated **20** is shown in Figure 9. Scoreboard **20** is constituted of two team panels **22, 24** which may be formed either integrally or in two separate juxtaposed units. As shown in Figure 9, panels **22** and **24** are formed in one integral unit. Panel **22** is provided with five player panels or units numbered A, B, C, D and E, although more or less can be furnished if desired. Panel **24** is likewise provided with five player panels or units designated F, G, H, I and J. Panel **22** is provided with a team scoring unit **26** for one team; panel **24** is provided with a team scoring unit or panel **28** for the opposing team.

Since each of the player panels or units is identical, it is considered sufficient to describe but one in detail. In player panel A, for example, there is provided an indicator **30** which indicates the frame of the game at any instant. As shown in Figure 9, the sixth frame has ben completed by player A. **32** designates the mark indicator on player panel A, and as shown in Figure 9, makes it apparent that two strikes have been rolled in succession so that the scoring indicator **34** has not yet set up the final score resulting from the rolling of the last ball of frame No. 6.

For illustrative purposes assumed individual scores, and team scores are indicated in Figure 9. Assumed marks (strikes and spares) are also shown at 32.

Generally team play in league or open play competition takes place on two side-by-side alleys. Our bowling totalizing and scoring mechanism, as illustrated herein, preferably is employed in conjunction with two automatic bowling pin setting machines mounted on two adjoining alleys A1 and A2, although its use is not so limited and it can be used on one alley with equally satisfactory results. In team play, one team bowls on one alley, say alley A1, while the other team bowls on alley A2. In order to indicate which alley the members of a team are bowling on at a particular time, an alley indicator 36 is provided in each of the player panels. As shown in indicator 36 for player C, the right-hand alley A2 is being bowled by members of the first team; at the same time, as shown in player panel H, the left-hand alley A1 is being bowled by members of the second team. The several indicating means of each of the player panels described hereinabove are preferably electrically operated. The construction and operation of the operating mechanisms is described hereinafter.

A bowling pin setting machine of the type shown in the above mentioned Broekhuysen patent is provided with a pin spotting and respotting device, designated generally 10 having one respotter unit 11 for each pin, or ten triangularly arranged units 11 in the case of ten pins usually used. Each unit is provided with a switch 320 (Figure 6). As described in the above mentioned patent, after each ball of a frame is rolled, the spotter-respotter device 10 is moved by suitable mechanism (not shown) to a position adjacent the alley with which the machine is associated to test for the presence or absence of standing pins whereupon if any pins are standing, certain of the switches 320 are closed. As shown in Figure 9 two machines 2 and 4 are mounted in the kickbacks of two side by side alleys A1 and A2. Switches 320 in units 11 are connected by cables 14 to the electric control mechanism of the pin spotting machines 2 and 4.

The result of the movement of a spotter-respotter device 10 to pin testing position after each ball of a frame is rolled, causes impulses to be sent to the totalizing mechanism in order to selectively operate selected mechanisms and thereby effect the totalizing of each individual bowler's game, and also each team score. For example, with either machine 2 or 4, if after the first ball of a frame is rolled on either alley A1 or A2, one or more pins remain standing, the particular switch or switches 320 corresponding to the position or positions of the pin or pins standing on the alley is or are moved to circuit closing positions, and lights (see Figure 6) corresponding to these pins are energized and glow. In the interest of brevity it is assumed that alley A1 is in use, hence the signal lights in the annunciator used with machine 2 are energized. At the same time, each relay 326 in machine 2 (Figure 6) corresponding to a particular standing pin is pulled in and the circuit through corresponding contacts 326*d* is broken. The effect of this operation is to indicate that certain pins remain standing, say for example, Nos. 7 and 9. As is customary in scoring a game, no score is placed on the score chart until the last ball of the frame is rolled, except in the case where spares or strikes are completed, and the aggregate score is entered to complete the score in the frames in which such marks were made. In a two ball per frame game, the impulses received from the respotter devices 11 cause the operation of a particular player totalizing unit to score the pin fall for that frame only after the second ball is rolled, when less than ten pins are knocked down.

It will be remembered, however, that in normal bowling scoring, no score is indicated for pin fall on the first ball of a frame, except in the case where a spare has been made in the immediately preceding frame, and pin fall for the first ball is added to ten, and the ten plus the number of pins on the first ball is added to the prior score to complete the score through the frame in which the spare was made. In a simple two ball frame where less than ten pins are knocked down, it is only after the second ball is rolled that impulses resulting from the contact 326*d* remaining closed cause the totalizer unit 34 for the particular bowler who has just completed his frame to operate and totalize the score to and including that frame. The score showing in each player's panel will be exactly the same as it would be in a conventional chart now used.

In a similar manner, if all pins are knocked down by the first ball of a frame and a strike is made, none of the ten switches 320 is closed. However, light ST of machine 2 is energized. A strike impulse is sent to the selected totalizer and scorer so that the proper strike "memory" circuit is operated, and the strike scored properly after all balls allowed for that strike have been rolled as the play of the game progresses from frame to frame.

If all pins are knocked down by the second ball of a frame, none of the switches 320 of machine 2 is closed. However, spare light SP is energized and an impulse is transmitted to the spare "memory" circuit of the totalizing and scoring mechanism, so that after the first ball of the next frame is rolled the proper score is registered and made visible in a particular player's panel and also his team's score if team play is occurring.

Figures 1 to 7, inclusive, arranged as indicated in Figure 8, disclose the preferred complete electric circuit and operating mechanism of the entire totalizing and scoring device, and its connections for use with two automatic bowling pin setting machines 2 and 4. In the interest of simplifying the drawings, details of necessary electrical connections with only bowling pin spotting machine 2 have been shown. For the same reason only two complete player operating and totalizing units have been shown. The remaining player actuating and totalizing units and connections with machine 4 are identical in construction and operation, and are connected in the circuit disclosed in Figures 1 to 7 in the same manner. The two player units disclosed are for players on opposing teams; player A is on one team; player F is on the opposing team.

Bowling pin spotting machine 2 is connected in operative relationship with the totalizing and scoring mechanism (as shown in Figure 3) by means of connections 522, 506, 518B, 519, 504, 503, 502, 523, 520, 518A, 507, 505 and 517 referred to hereinafter. In a similar manner pin spotting machine 4 (Figure 5) is connected in operating relationship with the totalizing and scoring mechanism through connections 517*a*, 505*a*, 507*a*, 518D, 520*a*, 523*a*, 502*a*, 503*a*, 504*a*, 519*a*, 518C, 506*a* and 522*a*.

*Alley sequence wheels*

Scoreboard 20 preferably is located above and centrally of the two side by side alleys A1 and A2. For alley A1 there is provided an alley sequence wheel unit WO, which controls the operation of the totalizer in response to impulses transmitted from bowling pin spotting machine 2 on alley A1. A second alley sequence wheel unit WT controls the operation of the totalizer in accordance with impulses transmitted from the bowling pin spotting machine 4 on alley A2.

Since both sequence wheel units WO and WT are the same in construction and operation (see Figures 3 and 5), only one is described in detail. Unit WO is provided with a suitable motor 50, such as a gear reduction motor capable of driving shaft 52 on which are mounted two spaced cams 98 and 100. Cam 100 is provided with a high portion 102 and a low portion 104 tracked by a switch operating arm 106 opening and closing switches W19 and W20 during the operation of motor 50, as described hereinafter.

Cam 98 is provided with a high or switch operating portion 99 which during the rotation of cam 98 engages switch operating arms W1–W18, and W23–W25, inclusive, to momentarily make or break control circuits of the totalizing and scoring mechanism. In the description hereinafter, when mention is made of either wheel WO or WT rotating, it is to be understood that this includes cams 98 and 100.

In Figures 1–7, two individual player scoring units 34 are shown connected in proper operative relationship in the operating circuit. In the form of totalizer and scoring device illustrated, ten separate units 30, 32, 34 and 36 are required, each of which is connected in the operating circuit in the same manner as units 30, 32, 34 and 36, designating players A and F on opposing teams. Inclusion of each of the units 30, 32, 34 and 36 in detail showing in the Figures 1–7, inclusive, has, therefore, been omitted in order to simplify the drawings, and prevent unnecessary repetition of showing.

Units 34 can be any conventional type of counter device. We have found Veeder-Root counters or teleregister indicators provided with units, tens and hundreds counters very satisfactory. Since the maximum possible score is 300, the counters 34 can take care of any individual player's score.

Team counters 26 and 28 are shown diagrammatically in Figure 1. These counters can also be of any well known type. Veeder-Root counters capable of counting up to thousands have proved satisfactory in use. It is only necessary that each five players team counter be capable of totalizing the maximum possible score of 1500.

*Player advancing mechanisms*

In order to operate each individual player unit (which includes frame indicator 30, mark indicator 32, scoring unit or counter 34 and alley indicator 36) it is necessary after each player has bowled, whether in individual competition or in team play, that the totalizer mechanism be set automatically for properly computing the score of the next player who bowls and also indicating the alley, spares or strikes, and frame number. If two teams are playing, that part of the totalizer mechanism and operating circuits which is provided for each team score is actuated selectively to effect the necessary and proper results. This mechanism is termed a player advancing mechanism or player switch because it is responsible for the proper selective operation of each individual player unit during individual player bowling, and also team scoring.

Referring to Figures 2, 4 and 7, arranged as indicated in Figure 8, it will be seen that there are two player advancing mechanisms designated generally 110, 112, one mechanism being provided for each alley. Since these mechanisms are the same in construction and operation, only one is described in detail. Player advancing unit 110 (112) consists of a plurality of discs or sections 114—127 each having a center conducting arm mounted on shaft 130, each center conducting arm being separated from the others by suitable insulation 132. Also mounted on shaft 130 are cams 134, 136 on which run switch operating arms 138, 140, respectively. A ratchet 44 also secured to shaft 130 and engaged by pawl 48 of step relay 1LL is operated at the proper time to turn shaft 130 one step to advance the center arms of each of the discs from one position to the next. That is, when player A, say, completes a frame and bowler B of the same team is next to bowl, the information transmitted by impulses from bowling pin setting machine 2 on alley A1 to the totalizer causes the energization of relay 1LL and shaft 130 turns clockwise, as viewed in Figure 2, 4 and 7, one step. In the case of player advancing mechanism 112, shaft 131 is turned counterclockwise after each player completes a frame.

It will be noted that each player advancing mechanism is provided with ten active positions and two inactive positions, twelve in all, thirty degrees apart. The active positions correspond to the ten players representing two teams. The inactive positions occur at the points where each team completes its play on one alley, and shifts to the other. In player advancing mechanism 110, the twelve o'clock position designated is an inactive position. Reading clockwise, in mechanism 110, are positions A, B, C, D and E with the second inactive position at the six o'clock position designated $X^1$. Then follow positions F, G, H, I and J all of which positions correspond to the ten players, five on a side. Player advancing mechanism 112 is also provided with similar player positions and two inactive positions, except that the positions of team one players A–E, are 180° out of phase with the positions of the same team members on mechanism 110. This arrangement allows five players A–E, inclusive, to bowl on alley A1 while bowlers F–J, inclusive, are bowling on alley A2. When each team completes a given frame, the center arms of discs 114–127 move to the inactive positions described above and danger of improper totalizing and scoring is prevented. When, however, each team, that is when players on team I on alley A1 and players on team II on alley A2, begin a new frame, step relays 1LL and 2LL are actuated and the proper operation of the player and team totalizing mechanism is effected. As described hereinafter, properly controlled electric impulses operate step relays 1LL and 2LL to advance the center arms of discs 114–127, from inactive positions to positions representing players A and F, respectively, after each team has shifted from one alley to the other.

The player advancing mechanisms are designed preferably for teams of five players. However, it is quite possible to totalize and score the play of ten bowlers A–J, inclusive, in individual

competition. In this case the team score counter can either be deactivated or the score appearing thereon can be disregarded. If less than ten persons desire to bowl, and use the totalizing and scoring mechanism, adjustment can be made which will enable them to bowl as teams of less than five members, or as individuals. These conditions will be described in detail hereinafter.

In Figures 2, 4 and 7 each disc 114–127, inclusive, is shown diagrammatically as provided with a conducting arm having a contact and arranged to turn progressively through 30° increments and engage contacts labelled A–E in quadrants 1 and 2, and F–J in quadrants 3 and 4 of player advancing mechanism 110, and F–J in quadrants 1 and 2, and A–E in quadrants 3 and 4 in the case of advancing mechanism 112.

In the same manner, when bowler F completes a frame, shaft 131 is turned counterclockwise to advance the contact points on discs 114–127 shown as conducting contact bearing arms, from player position F to player position G. The totalizer mechanism is then set awaiting results obtained by players B and G on their respective alleys. Similar stepwise rotation of shafts 130 and 131 takes place after each bowler concludes a frame. When all bowlers on a side have completed their play and change alleys, the center arms of discs 114–127 of each player advancing mechanism 110 and 112 turn to inactive six ($X^1$) or twelve (X) o'clock positions, as described. An additional pulse is then sent to relays 1LL and 2LL which causes the center arms of discs 114–127 to rotate one more step which advances them so that their single contact points engage contacts at stations F and A, respectively, awaiting the beginning of play of the next frame, each team exchanging alleys from frame to frame as the game proceeds.

In the totalizer control illustrated, the fourteen discs designated 114–127, in each of the player advancing mechanisms provide means for selectively operating all related mechanisms to totalize and score each individual player's game and team score. Discs 114, 115 and 116 control the operation of the units, tens and hundreds indicators of each of the player's score totalizing units of which there are ten. However, as noted above, only two complete totalizing units, representing opposing players A and F, are shown. Disc 117 operates a release relay in each player unit memory circuit for spares and second strikes, i. e., a strike immediately following a first strike. Discs 118 and 119 operate mark indicator signals for spares and second strikes, respectively. Disc 120 operates the first strike memory switch release relay. Disc 121 operates the first strike signal. Disc 122 operates the delayed count relay which makes it possible to accurately totalize a player's score after the first ball after a spare, and the second ball after a strike for the prior frame in which the spare or strike was made. Disc 123 operates what is termed a tenth frame relay because it functions in accordance with results obtained by the last ball rolled in the tenth frame. This action may result in a strike (in which case two bonus balls are delivered) or a spare (in which case one bonus ball is delivered) or less than ten pins knocked down for the two balls of the tenth frame. Disc 124 actuates a selected frame counter to show which frame of a game a particular player has completed. Disc 125 operates selected alley indicator signals to show on which alley a particular player is bowling. Disc 127 operates "omit" switches, and disc 126 operates the "waiting" stations or "inactive" positions relay. The waiting station control makes it impossible for bowlers to cause inaccurate totalizing and scoring in the event that players on one team on one alley finish their frames before the other team on the other alley complete their play in the corresponding frame as the game progresses from frame to frame to the end of the game.

*Pin spotting machine control for totalizing and scoring mechanism interconnections*

As mentioned hereinabove our novel totalizing and scoring mechanism is especially adapted for use with one or two automatic pin spotting machines. In the embodiment selected for purposes of illustration, the totalizer is shown in use with two automatic pin spotting machines 2 and 4. In Figure 6 there is disclosed a portion of the control mechanism employed in the bowling pin spotting machine illustrated in the above referred to Broekhuysen patent. Only that part of this mechanism is illustrated which will make possible the transmittal of impulses needed to selectively operate the totalizing and scoring mechanism constituting the present invention. This is because the pin spotter controls form no specific part of our invention and hence further description and showing thereof are omitted in the interest of brevity.

For the same reasons, in Figures 1 to 7 there are only shown in detail one circuit and its associated mechanism employed in one bowling pin spotting machine (see machine 2). Machine 4, designated generally in Figure 5, is provided with exactly the same control mechanism and, therefore, it is deemed unnecessary to duplicate the mechanism and wiring diagram shown in Figure 6.

In the control mechanism of the machine shown and described in the above referred to Broekhuysen patent there is provided a control cam shaft 255 on which are mounted a plurality of circuit making and breaking cams. The cams, which are used in connection with our invention for transmitting the desired information to our totalizing and scoring mechanism and for operating mechanisms are cams 428, 362 and 406. An additional cam 600, not forming a part of the bowling pin spotting machine control mechanism, is also employed.

As described in the Broekhuysen patent, the timing of cam shaft 255 is such that it makes one half revolution for each ball of a frame rolled or one complete revolution for each normal two ball frame. By means of the above mentioned cams and the circuit making and breaking mechanism operated thereby, and the operation of the bowling pin spotting tables 10 which move to and from either alley $A_1$ or alley $A_2$, as the case may be, and effect a closing of the switches 320 (Figure 6) when engaged by the head ends of standing pins, which thereby selectively operate relays 326, sufficient information is transmitted from each machine to the alley sequence wheels WO, WT to operate the totalizer and effect the desired results.

*Pinsetter information*

The pin spotter recognizes the following events:

(1) A ball is delivered;
(2) This ball is a strike;
(3) This ball completes a spare;
(4) This ball completes a frame; and
(5) Any pins that are knocked down.

The operation of the pin spotter which causes the movement of table 10 to and from alleys $A_1$ and $A_2$ after the rolling of each ball, therefore, closes the switches corresponding to the above noted items as follows:

(1) When a ball is delivered;
(2) When a strike is made;
(3) When a spare is made;
(4) When a frame is completed; and
(5) When relays **326** are operated to cause the operation of alley sequence wheels WO or WT (or both when two bowling pin spotting machines are in simultaneous use) to effect the necessary rotation of cams **98** and **100** to operate switches W1 to W20 and W23—W25, inclusive, and operate switches, relays, ratchets, indicators, lights, etc. to give the desired operation as described above or as will be described hereinafter.

*Example of totalizer scoring*

The chart shown hereinbelow illustrates what the totalizer will indicate in an assumed game. For purposes of simplifying the description and drawings, the scoring of one single player rolling a single game involving all possible strike, spare and non-mark combinations incident to the rolling of this game will be described. It is to be understood that when more than one player is bowling, say two five-player teams on two alleys, the scoring of each individual player will follow exactly the same sequence and involve the same mechanical and electrical operations as set forth in the play of a single bowler. The scoring example in the chart is chosen arbitrarily except that it is to be noted every scoring possibility, of which there are twelve, which can occur in an actual game, has been included. The totalizer will indicate at the end of each frame exactly the same information as appears in each frame portion of the score sheet shown in the chart.

In the game under consideration it is, therefore, assumed that there is only one bowler, say player A and that he remains on one alley, say alley $A_1$. Under such circumstances, the player switch ratchet **44** does not move. Hence, no reference is made to the action caused by contacts W20 and W23 of alley sequence wheel WO since it is these contacts which advance the player switch. In the following description of the scoring of an assumed game where no mention is made to specific contacts being opened or closed by cam **98** of an alley sequence wheel, the opening or closing of such contacts has no effect. A separate description appearing hereinafter will be given of the operation of the player switch.

*Conditions before the first ball is delivered*

The "first-ball light" **424** of the bowling pin spotting machine control mechanism (Figure 6) is energized through the circuit from the power line through contact **362***b* through contact **350***f* through contact **428***a* through light **424** to ground. The "second-ball light" **426** (Figure 6) is not energized because there is no completed circuit through it since it is connected to the open terminal **428***b* (also the open contact of **350***f*), the latter being opened and closed at the proper time in the operation of bowling pin spotting mechanism **2** by means of a step relay **350** shown in part in Figure 6. Thus, there is no power on line **502** and hence relay SB is not energized. (This is seen by starting at **426** (Figure 6) and tracing to the junction of contact **428***b* and line **502** which goes to coil SB of Figure 3.)



*Play and totalizing and scoring of assumed game (one bowler)*

In the chart shown there is indicated as assembly of the scoring of the assumed game. In the play shown in the chart all possible bowling combinations are indicated. In the "pins-down" column are shown the results obtained by first and second balls, except on strikes where only one entry appears.

| Frame | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Pins-Down | 8,1 | 9,1 | 9,0 | 10 | 8,1 | 10 | 10 | 9,1 | 10 | 10,10,10 |
| Symbol | – – | / | – – | X | – – | X | X | / | X | X X X |
| Score | 9 | 28 | 37 | 56 | 65 | 94 | 114 | 134 | 164 | 194 |

*Ball 1, Frame 1*

Eight pins fall; say 7 and 9 remain standing. The ball drops into the pit of the alley (not shown.) This closes switch **300** which is connected by wire **301** to a delayed closing relay **302** (Figure 6). This allows a few seconds, say three for example, before the ball and pin handling mechanism of the pin spotting machine, say machine **2**, begins operating. Switch **300** is also connected by wire **505** to relay KK (Figure 3) which in turn is connected by closed switch *db***4** to ground. Thus, as soon as the ball arrives in the pit relay KK is energized. This closes contact KK1, and opens contacts KK2 and KK3 (Figure 3). Contact KK1 is connected to normally closed contact W18 on sequence wheel WO. This explains how the frame-duration relay KK is energized and remains energized until the end of each frame.

When the predetermined time has elapsed after the ball arrives in the pit, delayed action relay **302** is activated and closes contact **304** (Figure 6). This completes a circuit from power through **304** through normally closed contact **348***b* of the pin spotting machine control through wire **522** through normally closed contacts SS1 (Figure 3) through contact *lt***3** (Figure 7) through wire **521**, through switch **305**, through contact **402***a*, through relay **308** to ground (Figure 6). As explained in the above mentioned Broekhuysen patent, the energizing of relay **308** starts the pin setter sequence. The pin spotting machine control causes normally open contact **362***a* to be closed by cam **362** mounted on shaft **255** (Figure 6), which supplies power directly through switch **305** and contact **402***a* to relay **308** and holds relay **308** energized until the end of the cycle (even after the ball is delivered from the pit which opens switch **300**). As soon as cam **362** starts to rotate power is removed from contact **362***b* and the first ball light **424** goes out. Cam **406** also on shaft **255** now operates, opening contact **406R***b* and closing **406R***a* momentarily. The reason for this will be described hereinafter. Then **406R***a* opens and **406R***b* remains closed.

Table **10** is constructed and operated as shown in the above referred to Broekhuysen patent. Its operation is such that it moves to and from alley $A_1$ (or alley $A_2$) after each ball of a frame is rolled. The presence or absence of standing pins is thus ascertained, and as the result of the actuation or non-actuation of switches **320**, the necessary signals are given to the totalizing and scoring mechanism. The first ball having been rolled, table **10** is moved down by suitable mechanism (not shown), and the two standing pins Nos. 7 and 9 close two of the contacts **320** (Figure 6). This completes the circuit from the

power line through switch 362*a* through switch 320 through relay coil 326 through normally closed contact 416*d* to ground (Figure 6). Since this energizes two relays 326 corresponding to pin positions 7 and 9, contacts 326*b* of these two relays 326 close. This completes the circuit from the power line through 406R*b* through the normally closed push-button 602 through contact 326*b* through relay 326 through contact 416*d* to ground. This holds relay 326 energized even after the standing pins are released from the respotting units 11 and reset in on- or off-spot position on the alley.

When the pin spotter sequence started, say three seconds after the ball arrived in the pit, and shaft 255 began to rotate, cam 600 thereon was turned. This closes contact 600*a* and completes the circuit from the power line through contact 600*a* through the now closed contacts 326*a* through the proper signal lamps through normally closed contact 412*d* to ground. This, in the assumed case, energizes lights Nos. 7 and 9 showing that pins 7 and 9 are standing. These lights remain energized until a short time, about two seconds, before the pin spotter cycle is completed at which time cam 600 has rotated (approximately 180°) so that contact 600*a* has opened and the lights are extinguished.

Since two of the contacts 326*c* are closed, there is a completed circuit from the power line through 362*a* through 326*c* through wire 504 through the normally closed contact DF2 through coil of relay NM to ground. Thus relay NM is energized, indicating a non-mark (a mark has not been made).

Since two relays 326 are energized, as explained above, this opens the two contacts 326*d* corresponding to standing pins Nos. 7 and 9 but leaves closed contacts 326*d* corresponding to pins 1, 2, 3, 4, 5, 6, 8 and 10 which (as will be seen below) allows us to score these fallen pins as a result of rolling the first ball of the first frame.

Shortly aften the standing pins 7 and 9 have energized relays 326, cam 406 turns into position to close contact 406L, which completes a circuit from ground (Figure 6) through wire 506 to normally closed switch *db*1 (Figure 3) through the motor 50 to the power side of the line. Motor 50 starts and rotates cams 98 and 100 of sequence wheel WO mounted on shaft 52. Cam 406 is so shaped that contact 406L remains closed until cam 100 of WO has rotated far enough so that cam portion 102 closes contact W19 and opens contact W20. Then 406L opens. However, WO continues to rotate because the circuit through motor 50 is completed from ground through W19 through motor 50 to the power side of the line (Figure 3). Wheel WO continues to rotate until it has made one (or sometimes two) revolutions, as will be explained below.

In recapitulating the action thus far, when the ball arrives in the pit, the closing of switch 300 results in the energization of frame duration relay KK and about three seconds later time delay relay 302 which starts the pinspotter sequence. Table 10 then moves down and any standing pins close selected contacts 320 which energize the corresponding relays 326 which are thus capable of giving the totalizer the information as to how many pins have fallen. Then, due to the rotation of shaft 255, cam 406 closes contact 406L which supplies an impulse which starts motor 50 and wheel WO rotating.

It can be seen how the scoring is effected or prevented until the proper time by following the sequence of events during the operation of motor 50 and as cams 98 and 100 of alley sequence wheel WO or WT rotate. It is to be noted that relay NM is energized but that relay SB is not. It is also pointed out that any relays which have not already been specifically said to be energized are in their unexcited state and the contacts are as pictured in Figures 1–7, inclusive.

As cam 98 of wheel WO rotates, high portion 99 closes W1 and opens W18 momentarily (Figure 3). Power is applied to contact W1 which is connected to the open contact U1 and to the open contact YY2 (Figure 3). Hence, this circuit is not completed. Power is removed from W18 but this power went to the open contact V1 and hence this circuit is not disturbed. W18 is also connected to the now closed contact KK1 and it might be thought that the power is hence removed from relay KK. However, the circuit from the power line through the now closed contact NM9 through the normally closed contact SB8 through the now closed contact KK1 through coil KK through contact *db*4 to ground keeps coil KK energized even though W18 is opened.

Continued rotation of cam 98 causes high portion 99 to close W2 momentarily. Power is applied to W2 which is connected through closed contact FF2 to the now open contact NM1. Hence, this circuit is not completed. W2 is connected to open contact YY2 and to open contact U2. Hence, no circuit is completed.

Due to the continued rotation of cam 98, W3 is closed momentarily. Power is applied to W3 which is connected through now closed contact NM2 (Figure 3) through wire 517 through closed contact 326*d* corresponding to pin 1 (Figure 6) through wire 507 through the now closed contact NM3 (Figure 3). At this point designated P, the circuit branches. One branch goes through closed contact PP1 to open contact SB2 and hence is not completed. The other branch goes through closed contact FF3 to open contact U3 and hence is not completed. Thus by either path there is an open circuit from point P on. Thus W3 has no effect.

Next cam 98 of WO closes W4 momentarily. Power is applied to W4 which is connected through line 516 through closed contact 326*d* corresponding to pin 2 (Figure 6) through wire 507 through the now closed contact NM3 (Figure 3) to point P. As noted above, the circuit is open beyond P. Thus W5 has no effect.

Cam 98 of WO closes contact W4 momentarily. Power is applied to W5 which is connected through line 515, through closed contact 326*d* corresponding to pin 3 (Figure 6) through wire 507 through the now closed contact NM3 (Figure 3) to point P. As noted above the circuit is open beyond P. Thus W5 has no effect.

It will be evident, therefore, that as indicated above, rotating cam 98 of alley sequence wheel WO for alley $A_1$, and bowling pin spotting machine 2 also closes contacts W6, W7, W8, W9, W10, W11 and W12 in turn momentarily. In the same manner, as set forth with respect to contacts W4 and W5, since the circuit in which each of these contacts is located is open beyond P, these momentarily closed contacts have no effect in totalizing and scoring pin fall for this ball, which is exactly what would take place in manual scoring. In the case of W9 and W11, the circuits are open also at contacts 326*d* since the relays 326 are energized by the standing pins 7 and 9.

Continued rotation of shaft 52 causes cam 98 to close contact W13 momentarily. Power is ap-

plied to W13 which is connected by wire 16 through disc 117 of the player advancing mechanism 110 (since player A is bowling on alley A1—Figure 3) through coil R to ground. Thus relay R is momentarily energized and contact R1 momentarily opens. This, however, has no effect, since there was no completed circuit through contact R1 even before cam 98 closed contact W13. Thus power is applied through contact R1 to either open contact T1 or open contact Z1 (Figure 4). Thus the closing of contact W13 at this time has no effect.

In the continued clockwise rotation of cam 98, contact W14 is next closed momentarily. Power is applied to W14 which is connected by wire A7 through disc 119 of the player advancing mechanism (Figure 4) to open contact Y2. There is another branch of the circuit from contact W14 through normally closed contact FF5 (Figure 3) to now open contact NM4. Thus the closing of contact W14 at this time has no effect on the scoring and totalizing operations.

Power is applied to contact W15 which is connected by conductor A3 through disc 120 of the player advancing mechanism (Figure 4) through coil RR to ground. Thus relay RR is momentarily energized and contact RR1 momentarily opens. This, however, has no effect on totalizing and scoring operations since there was no completed circuit through contact RR1 even before cam 98 closed contact W15. Thus power is applied through contact RR1 to open contact Y1 (Figure 4). Thus the closing of contact W15 has no effect at this time.

Contact W16 is next closed momentarily by cam 98. Power is applied to contact W16 which is connected through normally closed contact FF4 to the now open contact NM5. Thus the closing of contact W16 at this time has no effect in totalizing and scoring.

Cam 98 next closes contact W17 momentarily. Power is applied to contact W17 which is connected to either the open contact SB6 or the now open contact NM7 (Figure 3). Thus closing of contact W17 has no effect.

Cam 98 next closes contact W23 and opens contact W24 momentarily. Power is applied to contact W23 which is connected to open contact SB7 and now open contact NM8. Thus, closing of contact W23 has no effect. When contact W24 is opened, power is removed from contact W24 but this has no effect since contact W24 was connected to the normally open contact NN1 (Figure 3).

Cam 98 next opens contact W25 momentarily. Power is removed from contact W25 which is connected to open contact SB1. Hence this has no effect. Contact W25 is also connected to open contacts FF1 and V5 and hence opening contact W25 has no effect.

Cams 98 and 100 on WO now have finished one complete revolution so that contact W19 opens and contact W20 closes. The opening of contact W19 removes power from the motor 50 (Figure 3) and hence the wheel WO comes to rest. During the operation of wheel WO, the pin spotter mechanism has also been operating, and hence shaft 255 of the control shown in Figure 6 is turning so that at the proper time before the end of the pin spotter cycle, rotation of shaft 255 causes cam 600 to open contact 600*a* and lights 7 and 9 go out.

When pinspotter 2 completes its cycle shaft 255 has made one-half a revolution. Therefore, cam 362 has made half a revolution and power is applied to 362*b* instead of 362*a*. Also cam 428 has made half a revolution so that now the second ball light 426 goes on. This means that relay SB is energized as can be seen by tracing the power through contact 362*b* through 350*f* through 428*b* through wire 502 through the coil of relay SB through contact *db*4 to ground. As in normal score sheet scoring, no score is indicated on the first ball of the first frame of a game. Hence, no score is recorded (none of the indicators receives pulses) on scoreboard 20 in the player panel corresponding to player A. Also, the frame is not complete, frame counter 30 is not advanced. The memory relays, described more in detail hereinafter are not set. Relays KK, NM and SB are energized, and two relays 326 are also energized.

*Ball 2, frame 1*

One more pin, say No. 7 falls (only No. 9 pin remains standing).

The ball arrives in the pit closing switch 300. On the first ball of a frame this energizes relay KK as described above. However, on the second ball it has no effect since KK is already energized. A short time later, say three seconds, the pin spotter cycle begins and shaft 255 begins to rotate. As soon as cam 362 on shaft 255 starts to move the second ball light goes out. However, relay SB remains energized since there is a completed circuit from the power line through closed contact W25 through now closed contact SB1 through coil SB, through closed contact *db*4 to ground. Cam 406 on shaft 255 now operates and opens contact 406R*b* momentarily, thereby deenergizing all the pin relays 326. This is evident from the fact that relays 326 were maintained energized by the closed circuit from the power line through contact 406R*b* through the closed contact 602 through all contacts 326*b* which were closed and their coils 326 through the closed contact 416*d* to ground. Thus, when 406R*b* is momentarily opened, the power is removed and relays 326 are deenergized and contacts 326*b* open.

A short time later, as described hereinabove, table 10 descends and a standing pin (No. 9) closes its corresponding contact 320. This completes the circuit from the power line through contact 362*a* corresponding to the position of switch 320 through pin No. 9, relay coil 326 through normally closed contact 416*d* to ground (Figure 6). Since this energizes relay 326 then contact 326*b* closes again. This completes the circuit from the power line through 406R*b* (which due to the rotation of shaft 255 is now again closed) through 602 through No. 9 pin relay contact 326*b* and through its coil 326 through contact 416*d* to ground. This holds No. 9 pin relay 326 energized even after No. 9 pin is released from its respotter unit 11 and reset on the alley. This action can be summarized as follows: The pinspotter retains the knowledge of which pins have fallen (by closing the relays 326 corresponding to the standing pins) from the instant the table descends after a ball is delivered until a very short time before the table descends after the next delivery.

By the action described above pin light No. 9 is on and relay NM is energized indicating that this is a non-mark ball. Also, all contacts 326*d* are closed except that corresponding to pin No. 9. Also, by the action described above, alley sequence wheel WO starts to rotate. The operation of the totalizing and scoring mechanism in

totalizing and scoring the pin fall results of the first frame are now completed as cam 98 rotates and passes each contact W1, W2, etc., and momentarily closes or opens each contact is as follows:

*Contacts W1 and W18.*—Power is applied to contact W1 which is connected to the open contact U1 and to the open contact YY2 (Figure 3). Hence the circuit is not completed. Power is removed from contact W18 momentarily which deenergizes relay KK (the frame is completed), since SB8 is now open and hence there is no completed path from the power line through relay KK. *Contact W2.*—No action as explained under ball 1, frame 1. *Contact W3.*—As explained under ball 1, frame 1, power is brought to point P (Figure 3). At this point there is one branch which goes through closed contact PP1 through the now closed contact SB2 through section disc 114 of player advancing mechanism 110 (Figure 2) through units ratchet coil Q to ground. This momentary flow of current through coil Q advances the ratchet so that the indicator advances from 0 to 1. There are three cams that rotate with the ratchet. The first closes *a*1 and opens *a*2 when Q advances from 9 to 0 and hence has no effect in this case. The second cam momentarily opens Q1 at the end of the ratchet pull. This is used only for resetting purposes as will be described hereinafter. The third cam opens *h*1 and *h*2 when Q is on "0" but leaves *h*1 and *h*2 closed at all other times. In this particular instance *h*1 and *h*2 were open up to now (since Q was on "0") and when contact W3 is closed contacts *h*1 and *h*2 close.

In the same manner by the action described above in the successive closing of contacts W4–W10, inclusive, Q advances from 1 to 2, and so on to 8. When, however, cam 98 closes contact W11, power is applied to contact W11 which is connected through wire 509 to the now open contact 326*d* corresponding to the standing pin No. 9 (Figure 6). Hence, there is no count here, but when contact W12 is closed, by the action described above, Q advances from 8 to 9, and in player A scoreboard panel, the score of 9 is shown for the first frame.

With respect to contacts W13, W14, W15, W16 which are next closed by cam 98, the action is as explained for ball 1, frame 1. No net effect takes place. When cam 98 closes contact W17, power is applied to contact W17, which is connected through the now closed contact SB6 through closed contact V2 through closed contact NN5 through disc 124 of the player switch through coil N to ground. This advances the frame counter of the panel corresponding to bowler A from 0 to 1. The frame counter shaft has two cams 60, 62 which rotate with it. Cam 60 opens contact N1 momentarily at the end of each ratchet pull. It is used only for resetting purposes and is described hereinafter. Cam 62 opens contact *n*1 and closes contact *n*2 when N reads "0" but closes contact *n*1 and opens contact *n*2 at all other times. Thus as cam 98 of sequence wheel WO passes contact W17, contact *n*1 changes from open to closed position and contact *n*2 changes from closed to open position.

Closing of contact W23 and opening of contact W24 have no effect, as described under ball 1, frame 1. Momentary opening of contact W25 causes power to be momentarily removed from contact W25 which is connected through now closed contact SB1 through relay coil SB through switch contact *db*4 to ground. Hence relay SB is deenergized and contact SB1 opens. The sequence wheel WO has now completed one revolution and contact W19 opens. This removes power from the motor 50 (Figure 3) and hence wheel WO comes to rest. Shortly after all the lighted pin lights go out since cam 600 on shaft 255 opens contact 600*a*. With the end of the cycle of pin spotter 2, cam 362 on shaft 255 has made one-half a revolution and power is applied to 362*b* instead of 362*a*. Also, cam 420 has made half a revolution so that the first ball light goes on. Player A scoreboard panel score indicator shows a score of 9, and frame indicator 30 shows that the first frame is completed. All relays of the mechanism are deenergized.

*Ball 1, frame 2*

It is assumed that nine of the pins were knocked down. The action of the pin spotter and totalizing mechanism is substantially the same as that described above for ball 1, frame 1, except that only one of the pin relays 326 is energized. The net result is no score, no frame advance and no memory relays closed.

*Ball 2, frame 2 (a spare)*

The action is as described under ball 2, frame 1, with one exception: No relays 326 are energized since there are no standing pins. Hence, all contacts 326*c* are open and there is no power delivered to relay NM. Thus NM is not energized indicating that a mark has been made. However, relay SB is energized. Motor 50 is set into motion as explained above, and wheel WO rotates. Cam 98 successively opens or closes the several contacts as follows: Contacts W1, W18 and W2 with no effect. The action is next applied to contact W3 through normally closed contact NM1 through closed contact FF2. At this point the circuit branches and goes to either the open contact U2 or the open contact YY2. Hence closing of contact W3 has no effect.

Contacts W4 to W12, inclusive, are next closed in succession. Power is supplied through each contact to the now closed contacts 326*d* to the normally open contact NM3. Hence there is no score.

The action resulting from the closing of contact W13 is as described above. There is no net effect in the scoring and totalizing operations. When contact W14 is closed, power is supplied through momentary contact. This power is applied through closed contact FF5 through closed contact NM4 through now closed contact SB3 through NN2 through disc 118 of the player advancing mechanism 110 through coil T to ground. This energizes relay T which closes contact T1 which then keeps T energized through contact R1 to the power line even after W14 is opened. Power is supplied through the now closed contact T2 through disc 122 of player switch 110 through coil U to ground, thereby pulling relay U. This is the first example of a memory relay closing.

Closing of contact W15 is as described above. There is no net effect. The same holds for contact W16. Power is applied to W16 which is connected through normally closed contact FF4 through closed contact NM5 to the now open contact SB4. In the closing of contact W17, the action is the same as described under ball 2, frame 1, except that the frame counter N advances from 1 to 2. Closing of contact W23 and opening of contact W24 has no effect as described above. When contact W25 is opened, as ex-

plained above, the SB coil is deenergized. The remainder of the cycle is as described under ball 2, frame 1.

*To recapitulate.*—The score remains 9. The frame counter is at 2. The memory relays T and U are set to indicate that the next ball to be rolled (ball 1, frame 3) is the first ball after a spare. The spare light of pin spotting machine 2 is energized.

*Ball 1, frame 3.*

Nine pins are knocked down (say pin 10 remains standing). The initial action is as described under ball 1, frame 1. When the sequence wheel WO starts to rotate SB is not energized but NM, T and U are energized. The opening or closing of contacts W1–W25, inclusive, is as follows:

*Contact W1.*—Power is applied through W1 through the now closed contact U1 through disc 116 of player switch 110 to the open contact Y5. Hence this has no effect. *Contact W18.*—The action is as described under ball 1, frame 1. *Contact W2.*—Power is applied through contact W2 to the now closed contact U2 through disc 115 of player switch 110 through the normally closed switch *a*2 through the coil of ratchet relay Q' to ground, thereby advancing the counter of this relay from 0 to 1, indicating now a score of 19.

There are three cams that rotate with the shaft of ratchet relay Q'. The first closes contact *a'*1 when the counter advances from 9 to 0 and hence has no effect in this case. The second cam momentarily opens contact Q'1 at the end of the ratchet pull. This is used for resetting purposes and will be described hereinafter. The third cam opens contacts *h'*1 and *h'*2 when the counter of ratchet relay Q' is on "0" but leaves contacts *h'*1 and *h'*2 closed at all other times. At this particular instant, contacts *h'*1 and *h'*2 were open up to now (since Q' was on "0"), and when contact W2 is made contacts *h'*1 and *h'*2 close.

*Contact W3.*—Power is applied through contact W3 through now closed contact NM2 through wire 517 through now closed contact 326*d* corresponding to pin No. 1 through now closed contact NM3 through normally closed contact FF3 through now closed contact U3 through disc 114 of player switch 110 through the coil of ratchet relay Q to ground. This advances the counter of ratchet relay Q from 9 to 0.

By the action described above, when the counter of relay Q advances from 9 to 0, contact *a*2 is momentarily opened and contact *a*1 is momentarily closed. This applies power from the line through contact *a*1 through the coil of Q' to ground and the counter of Q' advances from 1 to 2. Hence the score now reads 20. By the action described above contact *h*1 is open since the counter of Q reads zero.

*Contact W4.*—Power is applied through contact W4 through wire 516 through closed contact 326*d* corresponding to pin 2 through now closed contact NM3 through normally closed contact FF3 through now closed contact U3 through section 114 of the player switch 110 through coil Q to ground. This advances the counter of Q from 0 to 1. The score is now 21 in player panel A at 34.

Contacts W5, W6, W7, W8, W9, W10 and W11 close in succession as high portion 99 of cam 98 of wheel WO engages the same in succession. By action similar to that described for W4, the counter of ratchet relay Q advances one step for each contact from 1 to 8 and the score of player A reads 28.

*Contact W12.*—Power is applied through contact W12 through wire 508 to the now open contact 326*d* corresponding to standing pin 10. Hence there is no action.

*Contact W13.*—Power is applied through contact W13 through disc 117 of player switch 110 through coil R to ground. This momentarily opens contact R1 and hence the power circuit going to coil T, thereby deenergizing relay T and also relay U. Spare light SP goes out.

Contacts W14, W15, W16, W17, W23, W24 and W25 are next closed or opened as wheel WO continues its rotation and comes to a stop after opening contact W25. Action is as described under ball 1, frame 1.

*To recapitulate.*—The score is 28. The frame counter reads 2. No memory relays T, Y, Z or U are excited.

*Ball 2, frame 3*

No additional pins are knocked down. The action is similar to that described under ball 2, frame 1. The score is now advanced from 28 to 37. The frame counter advances from 2 to 3, and frame 3 is completed.

*Ball 1, frame 4*

A strike is delivered. The initial action is as described under ball 1, frame 1 except that now all pins are knocked down and hence none of the relays 326 are energized. Hence all contacts 326*c* remain open and relay NM is not energized (as a mark has been made). Also, SB is not energized since it is a first ball. Sequence wheel WO starts to rotate and the action is as follows:

*Contacts W1, W18 and W2.*—Action is as described for ball 1, frame 1.

*Contact W3.*—Power is applied through contact W3 through closed contact NM1 through closed contact FF2 to either open contact U2 or open contact YY2 or open contact W2. Hence closing contact W3 has no effect. Contacts W4, W5, W6, W7, W8, W9, W10, W11 and W12 are closed in succession.

Power is applied through each contact W4—W12 in turn to the corresponding now closed pin contact 326*d* to the open contact NM3. Hence there is no score recorded. *Contacts W13, W14 and W15.*—The action is as described for ball 1, frame 1. No relays are set. *Contact W16.*—Power is applied through contact W16 through closed contact FF4 through closed contact NM5 through closed contact SB4 through closed contact NN3 through section 121 of player switch 110 through the coil of relay Y to ground. Hence, relay Y is energized. This closes contact Y1 and this keeps relay Y energized even after contact W16 opens since power is applied through normally closed contact RR1 through now closed contact Y1 through coil Y to ground. This is the first example of the setting of the strike memory relay Y. Contact Y3 now closes and the strike light on the totalizer at 32 of player A panel is energized since power is applied through Y3 through the light to ground.

*Contact W17.*—Power is applied through contact W17 through closed contact NM7 through closed contact V2 through closed contact NN5 through section or disc 124 of player switch 110 through coil N to ground. This advances the frame counter N from 3 to 4.

*Contacts W24, W25.*—Action is the same as described under ball 1, frame 1. The rest of the

cycle is the same as explained under ball 1, frame 1 with one exception. The pinspotter control strike relay 350 is energized by suitable mechanism (not shown) similar in construction and operation to that shown in the above referred to Broekhuysen patent. This operates switch 350f so that at the end of the cycle the first ball light and not the second ball light is lighted.

*To recapitulate.*—The frame counter has advanced from 3 to 4. The score remains at 37. The strike light is lighted. The strike memory relay Y is energized to indicate that the next ball to be rolled is one ball after a strike.

*Ball 1, frame 5*

It is assumed that eight pins are knocked down (say No. 7 and No. 9 are still standing). The initial action is as described under ball 1, frame 1. Relays NM and Y are energized, whereas relay SB is not when WO starts to rotate, whereupon high portion 99 of cam 98 engages contacts W1–W18, inclusive, W23, W24 and W25. The action set up due to the engagement of contacts W1, W18 and W2–W13, inclusive, is the same as that described under ball 1, frame 1. The remainder of the action is as follows:

*Contact W14.*—Power is applied through contact W14 through section 119 of player switch 110 through now closed contact Y2 through coil Z to ground. This energizes relay Z which closes Z1 and Z is then held in by the power through normally closed contact R1 through contact Z1 through coil Z to ground. When contact Z2 closes power is applied through section 122 of player switch 116 through coil U to ground, thereby energizing relay U. When contact Z3 closes power is applied to the second strike light so that it goes on.

*Contact W15.*—Power is applied through contact W15 through section 120 of player switch 110 through coil RR to ground. This energizes relay RR momentarily and hence normally closed contact RR1 is momentarily opened. This breaks the circuit which delivered power through contacts RR1 and Y1 to relay Y which is deenergized, opening contact Y1 and hence relay Y remains deenergized even after contact RR1 closes again. Contact Y3 returns to its normally open position and the first strike light goes out.

Contacts W16, W17, W24 and W25 when closed or opened by cam 98 effect the operations as described under ball 1, frame 1. The remainder of this cycle is the same as described under ball 1, frame 1.

*To recapitulate.*—The score remains at 37. The frame count remains at 4. The first strike light goes out and the second strike light goes on (this indicates that there is one more ball to be bowled before the strike can be scored). The relays Z and U are energized indicating that the next ball to be delivered is the second ball after a strike.

*Ball 2, frame 5*

One more pin is knocked down (say only No. 9 pin remains standing).

The initial action is as described under ball 2, frame 1. When the sequence wheel WO starts to rotate the relays SB, NM, Z and U are all energized. The successive contact sequence of operations instituted by wheel WO is as follows:

*Contact W1.*—Power is applied through contact W1 through now closed contact U1 through section 116 of player switch 110 to the now open contact Y5. Hence there is no score.

*Contact W2.*—Power is applied through contact W2 through now closed contact U2 through section 115 of player switch 110, through closed contact *a*2 through the coil of ratchet relay Q' to ground. Hence the ratchet Q' advances the counter from 3 to 4 (indicating a score of 47 at this instant).

Power is also applied through contact W2 through now closed contact U2 through now closed contacts NM6 and SB5 and through normally closed contact NN7 through coil V to ground. This energizes relay V which closes contact V1. Since contact W18 is closed, power is now applied from the line through W18 through now closed contact V1 through coil V to ground which thus keeps relay V energized.

This is the first time relay V has been energized. Its action in causing a second rotation of the sequence wheel will be described hereinafter.

*Contacts W3 through W12.*—The action is as described under ball 2, frame 1. Nine more points are scored so that the scoreboard now indicates 56 (this is exactly the score that an official scorekeeper would place in box 4 of the chart described hereinabove).

*Contact W13.*—Power is applied through contact W13 through section 117 of player switch 110 through coil R to ground momentarily, thereby momentarily opening contact R1. Since power is supplied to relay Z through contacts R1 and Z1 then when R1 opens momentarily relay Z is deenergized and Z1 opens so that even after R1 closes again relay Z remains deenergized. This opens contact Z2 which deenergizes relay U since the power was supplied to this relay through Z2 through section 122 of player switch 110. Contact Z3 also opens and the second strike light is extinguished.

*Contact W14.*—The action of this contact is the same as described under ball 1, frame 1.

*Contacts W15 and W16.*—The action is as described under ball 2, frame 1.

*Contact W17.*—Power is applied through contact W17 through now closed contact SB6 to now open contact V2. Hence, there is no closed circuit to frame counter N and the frame count remains at 4 for the moment.

*Contacts W23 and W24.*—No action, as described under ball 2, frame 1.

*Contact W25.*—Note that power is applied from the power line through normally closed contact W25 through now closed contact SB1 through relay coil SB through normally closed contact *ab*4 to ground. Hence, even when the power is momentarily removed from W25 (which normally feeds relay SB through contact SB1) the relay SB is not deenergized.

The wheel WO now has made one complete revolution and contact W19 now opens. However, this does not now remove power from the sequence wheel motor 50 because contact V3 is now closed and thus shunts W19. Thus power is supplied through now closed contact V3 through motor 50 to ground. Hence the sequence wheel WO starts on its second rotation.

*Contact W18.*—Since power is applied through contact W18 through hold-in coil V1, through coil V to ground when W18 is momentarily opened, relay V is deenergized and stays deenergized. This opens contact V3 but this does not stop the rotation of the sequence wheel because before cam 98 of wheel WO reached contact W18, cam 100 of the wheel has already closed contact W19 through which power is supplied to motor 50.

Hence, conditions during the second rotation of wheel WO are exactly the same as those during the scoring of the second ball of frame 1, namely the SB and NM relays are energized but no memory relays are excited. The action, therefore, is that given under ball 2, frame 1.

At the end of the cycle the following conditions prevail: The score is 56 plus 9 or 65. The frame counter has advanced from 4 to 5. No lights are on at the totalizer (since all strikes and spares have been accounted for). No memory relays are energized since neither a strike nor a spare was made in frame 5.

*Ball 1, frame 6*

A strike. The action is as described under ball 1, frame 4. The score is unchanged—65. The frame counter has advanced from 5 to 6. The relay Y is energized. The first strike light is on.

*Ball 1, frame 7*

A strike. This is the second successive strike. The initial action is as described under ball 1, frame 4. When sequence wheel WO starts to rotate relays SB and NM are not excited but relay Y is energized. Wheel WO moves past contacts W1 through W15. The action is as described under ball 1, frame 5. There has been no score but memory relay Z has been energized and memory relay Y has been deenergized.

Contact W16 is next closed by high portion 99 on cam 93. Power is applied through contact W16 through normally closed contacts FF4, NM5, SB4 and NN3 through section 121 of player switch 110 through coil Y to ground. This reenergizes relay Y and it is held in as described above.

Then contacts W17, W23, W24, and W25 are engaged by cam 93 and the remainder of the cycle is as described under ball 1, frame 1.

*To recapitulate.*—The frame counter has advanced from 6 to 7. The score has remained at 65 due to the fact that two successive strikes have been made in frames 6 and 7, and there is one ball to be rolled before the score for frame 6 is totalized. Both the first strike and the second strike lights in player panel A are on. Memory relays U, Y and Z are energized.

*Ball 1, frame 8*

Nine pins are knocked down (say No. 10 remains standing). The initial action is as described under ball 1, frame 1. When the sequence wheel WO starts to rotate, relays NM, U, Y and Z are energized but relay SB is not excited. The contact sequence is as follows:

*Contact W1.*—Power is applied through contact W1 through now closed contact U1 through section 116 of player switch 110 through now closed contact Y5 through normally closed contact *a*2 through coil Q' to ground. Hence the ratchet Q' advances from 6 to 7 and the score at this instant is 75.

Continued rotation of cam 93 causes high portion 99 to open contact W18 and then successively close contacts W2 through W12, inclusive, which effect the operations described under ball 1, frame 3. The result of closing contact W2 causes counter ratchet relay Q' to advance from 7 to 8 giving a score of 85 at this instant. After contact W3 is closed the score is 86. After W4 is closed the score is 87. After W5 is closed, it is 88 and after contact W6 is closed it is 89. After contact W7 is closed, ratchet relay Q advances from 9 to 0. As noted in the description of the closing of contact W3 for ball 1, frame 3, as ratchet Q is advanced from 9 to 0, ratchet relay Q' is advanced one unit. In the present case it goes from 8 to 9. Hence the score is now 90. After contact W8 is closed the score is 91. After W9 is closed it is 92. After W10 is closed it is 93. After contact W11 is closed, it is 94. Since pin No. 10 is standing the score remains 94 after contact W12 is closed. It is to be remembered that contacts W2 to W12, inclusive, are closed momentarily, and reopen as soon as high portion 99 moves out of engagement therewith. The same holds true for all other contacts opened or closed by cam 93.

*Contact W13.*—Power is applied momentarily through contact W13 through section 117 of player switch 110 through relay R to ground. This opens contact R1 momentarily and by the action previously described relay Z is deenergized. Hence the second strike light is extinguished.

*Contact W14.*—Power is applied through contact W14 through section 119 of player switch 110 through now closed contact Y2 through coil Z to ground and coil Z is thereby energized. As described above relay Z remains energized. The second ball light goes on. Also relay U is energized again. When relay Z was de-energized, relay U was de-energized because either relay Z or T must be energized for relay U to be energized. Relay T is not energized at this time because a spare was not made.

*Contact W15.*—Power is applied momentarily through contact W15 through section 120 of player switch 110 through coil RR to ground. As described previously this deenergizes relay Y. The first strike light is extinguished.

*Contact W16.*—As described under ball 1, frame 1, no action takes place.

As the result of the rotation of cam 93, contacts W16, W17, and W23 are closed and contacts W24 and W25 are open. However, the device operates in the same manner as described under ball 1, frame 1.

*To recapitulate.*—The score has advanced to 94. The frame counter stays at 7. Memory relays Z and U are energized. The second strike light is on.

*Ball 2, frame 8*

A spare is made. The initial action is the same as described under ball 2, frame 2. When sequence wheel WO starts to rotate relays SB, Z and U are energized but NM is not excited. The operations effected by the closing or opening of the several contacts operated by cam 93 are as follows:

*Contact W1.*—Power is applied through contact W1 through now closed contact U1 through section 116 of player switch 110 to open contact Y5. Hence, there is no score totalizing operation.

*Contact W2.*—Power is applied through contact W2 through now closed contact U2 through section 115 of player switch 110 through contact *a*2, ratchet relay Q' is energized and the unit turns from 9 to 0. As ratchet relay Q' advances from 9 to 0 the cam on its shaft momentarily closes contact *a'*1 which applies power through contact *a'*1 through the coil of ratchet relay Q'' to ground. This advances ratchet relay Q'' from 0 to 1. Thus the score shown in player A's panel at 34 has now advanced from 94 to 104. Contacts Q''1, *h''*1 and *h''*2 operated by cams on the shaft of ratchet relay Q'' serve similar functions to contacts Q'1, *h'*1 and *h'*2 associated with ratchet relay Q'.

*Contact W3.*—Power is applied through contact W3 through closed contact NM1 through closed contact FF2 through now closed contact U2 through section 115 of player switch 110 through contact *a*2 through the coil of ratchet relay Q' to ground. This advances the ratchet thereof from 0 to 1 and the score now reads 114.

*Contacts W4 through W12, inclusive.*—Power is applied through each contact in turn through closed contact 326*d* to the open contact NM3. Hence, no further scoring is done.

*Contact W13.*—By the action described under ball 1, frame 8, the effect of applying power to contact W13 is to deenergize relay Z and to extinguish the second strike light. The effects of closing or opening contacts W14, W15, W16, W17, W23, W24, W25 and the remainder of the cycle are as described under ball 2, frame 2. The net result is: The score is 114. The frame counter has advanced from 7 to 8. The spare memory relays T and U are energized and the spare light is on.

*Ball 1, frame 9*

A strike is delivered. The initial action resulting from a strike is as described above. When the sequence wheel WO starts to rotate relays T and U are energized but relays SB and NM are not. The operations effected by successive closing or opening of the contacts engaged by cam portion 99 are as follows :

*Contacts W1 through W12, inclusive.*—The action is similar to that described under ball 2, frame 8. Closing of contact W2 results in the counter of ratchet relay Q' advancing from 1 to 2, indicating a score of 124. When contact W3 is closed ratchet relay Q' counter advances from 2 to 3, indicating a score of 134. No further scoring is done.

*Contacts W13, W14, W15 and W16.*—By action similar to that described relay T is deenergized when contact W13 is closed, the spare light goes out, relay Y is energized by closing of contact W16 and the first strike light goes on.

When contact W17 is closed the frame counter advances from 8 to 9 which appears at 30 in player A's panel. Opening of contacts W24, W25 effects the same action as described under ball 1, frame 4. The status of the scoring and totalizing mechanism at this point is:

The score of 134 is shown at 34 in the panel of player A. The frame counter reads 9. Memory relay Y is energized. The first strike light is on.

*Ball 1, frame 10*

A strike is delivered. The entire action is the same as described under ball 1, frame 7. The result is, the score remains at 134. The frame counter advances from 9 to 0. The first strike light and the second strike light are both on. The memory relays Y, Z and U are energized.

In addition one new action has taken place. When cam 98 of wheel WO reaches contact W17, the counter of ratchet relay N advances from 9 to 0, its cam closes contact *n*2 and opens contact *n*1 (see under ball 2, frame 1). The effect of closing *n*2 is to energize relay NN. Thus power is applied through now closed contact *n*2 through closed contacts *h*2, *h'*2 and *h''*2 in parallel through now closed contacts T4, Y4 and Z4 in parallel through section 123 of player switch 110 through the coil of relay NN to ground. Thus relay NN is excited. The action of relay NN, which is termed the "tenth frame" relay is described hereinafter.

The reason for the parallel combination of contacts *h*2, *h'*2 and *h''*2 can now be explained. Suppose that it is the beginning of a game so that the frame counter of relay N reads 0 and hence contact *n*2 is closed. Suppose further that the first ball delivered is a strike so that when the sequence wheel cam 98 of sequence wheel WO or WT (depending upon which alley is being bowled), closes contact W16, relay Y is energized and contact Y4 closes, the coil of relay NN would be energized by power through contacts *n*2 and Y4 through section 123 of player switch 110 through coil NN to ground. But relay NN must only be energized in the tenth frame when the bowler is entitled to bonus balls for having made a spare or strike. At the beginning of a game the score is zero and hence the counters of relays Q, Q' and Q'' all read zero and therefore contacts *h*2, *h'*2 and *h''*2 are all open. Hence, the power from contact *n*2 comes to an open circuit at this parallel combination and cannot energize NN. However, in the tenth frame, if the score is other than zero, at least one of the contacts *h*2, *h'*2 and *h''*2 is closed and hence relay NN can be energized.

*Ball 2, frame 10 (first bonus ball)*

A strike is delivered. The initial action for a strike is as described above. When the sequence wheel WO starts to rotate relays Y, Z and U are energized whereas relays SB and NM are not. The action resulting from successive engagement of high portion 99 of cam 98 with the several contacts is as follows:

*Contacts W1 and W2.*—The action is as described under ball 1, frame 8. The result is that the counter of ratchet Q' advances from 3 to 5 indicating a score of 154 at this instant.

*Contact W3.*—Power is applied through contact W3 through normally closed contacts NM1 and FF2 through now closed contact U2 through section 115 of player switch 110 through closed contact *a*2 through the coil of ratchet relay Q' to ground. Hence, the counter of ratchet relay Q' advances from 5 to 6 indicating a score of 164.

*Contacts W4 through W12.*—Power is applied through each W contact in turn through the closed contact 326*d* to the normally open contact NM3. Hence no further scoring is done.

*Contact W13.*—By the action described previously the effect of applying power to contact W13 is to deenergize relay Z.

*Contact W14.*—Power is applied through contact W14 through section 119 of player switch 110 through now closed contact Y2 through coil Z to ground. Hence, relay Z is now energized again.

*Contact W15.*—By the action described previously, the effect of applying power to contact W15 is to deenergize relay Y.

*Contact W16.*—Power is applied through contact W16 through normally closed contacts FF4, NM5 and SB4 through now closed contact NN4 through coil YY to ground. This closes contact YY1 and power is applied through contact YY1 through contact NN4 through coil YY to ground which keeps relay YY energized even after contact W16 opens. Power through contact YY1 is also applied through now closed contact YY4 through coil PP to ground and hence relay PP is energized.

*Contact W17.*—Power is applied through W17 through normally closed contacts NM7 and V2

to now open contact NN5. Hence no energy gets to frame counter N.

*Contact W24.*—Removing power from contact W24 momentarily has no effect since relay NN is kept energized by the circuit discussed under ball 1, frame 10.

*Contact W25 and the rest of the cycle.*—The action is the same as described under ball 1, frame 4. The net result is: The score is 164. The frame counter is at 0. The second strike light is on but the first strike light is off. Relays Z, U, NN, YY and PP are energized.

*Ball 3, frame 10*

It is assumed that on the second and last bonus ball for the strike made in the tenth frame, all pins are knocked down. The initial action is the same as described above in case of a strike. When the sequence wheel WO starts to rotate, relays Z, U, NN, YY and PP are energized but relays SB and NM are not. The operation effected by cam 98 engaging the several contacts of the alley sequence wheel WO is as follows:

*Contact W1.*—Power is applied through contact W1 through now closed contact U1 through section 116 of player switch 110 to now open contact Y5. Hence there is no action through this circuit. However, power is also applied through contact W1 through now closed contact YY2 through now closed contact U2 through section 115 of player switch 110 through contact *a2* through coil Q' to ground. Hence the counter of ratchet relay Q' advances from 6 to 7.

*Contacts W2 and W3.*—The action is the same as described under ball 2, frame 10; the result is that the counter of ratchet relay Q' advances from 7 to 9 indicating a score of 194.

*Contacts W4 through W12.*—By the action described under ball 2, frame 10 no further scoring is done.

*Contacts W13, W14 and W15.*—By the action described previously the result is that relays T, Z and Y are left unenergized.

*Contact W16.*—Power is applied through contact W16 through normally closed contacts FF4, NM5 and SB6 through contact NN4 through coil YY to ground or through contact YY4 through coil PP to ground. Since relays YY and PP are already held in by power through contact YY1, the application of power to contact W16 has no effect.

*Contacts W17, W23, W24, W25 and the rest of the cycle.*—The action is the same as described under ball 1, frame 4. The net result is: The final game score is 194. The frame counter is at 0. There are no mark lights on. The game is completed.

*The player switches*

It has been assumed one player, say A, is bowling on alley $A_1$. In the case of team play in which five players, say A, B, C, D and E are on team I, and five players, say F, G, H, I and J are on team II, according to the American Bowling Congress rules, each player of team I bowls in succession, one frame on alley $A_1$ and each player of team II bowls in succession one frame on alley $A_2$. Then the teams change alleys and players of team II bowl in succession one frame on alley $A_1$ whereas players of team I bowl in succession one frame on alley $A_2$. If all the players of team I complete their first frame before all the players of team II have completed their first frame, then they must wait before changing alleys. In order to allow for this team play, player switches 110 and 112 are provided, one for each alley. Each switch has 14 sections or discs and each section has 12 positions, as described hereinabove. There is one position for each player and two blanks or "wait" positions. In clockwise rotation these are labelled, A (for player A), B (for player B), C, D, E, $X_1$ (for wait), F, G, H, I, J and X (the second "wait" position).

Each section of the player switch serves a specific purpose. Thus, section 114 of either switch 110 or 112 connects the units counter, relay Q, of the particular player bowling to the alley on which this player is bowling. In the position shown, in Figure 2, relay Q for player A is connected to alley $A_1$, whereas relay Q for player F is connected to alley $A_2$. This means that at this time, player A is bowling on alley $A_1$ and player F is bowling on alley $A_2$. It should be noted that whereas only two units relays Q and counters are shown on the diagram (one for A and one for F) actually there are ten such counters, one for each player . This is to be understood throughout, namely, wherever a physical assembly is shown for players A and F, this assembly is really repeated ten times, one for each player, A, B, C, D, E, F, G, H, I and J.

The purposes served by each section of the player switch have been discussed hereinabove.

In addition to the fourteen sections 114 to 127, inclusive, which are all mounted on shafts 130, 131, two cams 134, 136 are also mounted on each shaft. Cams 134, 136 are used for team scoring and will be discussed hereinafter. Shafts 130, 131 are driven by ratchets 44. It will be shown that the totalizer causes the player switch to advance automatically in such a manner that the American Bowling Congress rules are always obeyed.

To illustrate the advance of a player switch, reconsider the example given above for the scoring of the assumed game. It is assumed, however, that each frame is bowled by a different player. Thus, frame 1 by A, frame 2 by B, 3 by C, 4 by D, and 5 by E.

*Ball 1, frame 1*

Eight pins are knocked down. Player A is bowling on alley $A_1$. Section 125 of player switch 110 shows that power is applied through the light corresponding to player A (at 36 in the scoreboard) on alley $A_1$ through normally closed contact *db2* to ground. Hence this light is on.

The scoring is as already described and will not be repeated. It is contact W23 of alley sequence wheel WO which controls the advance of the player switch 110 and hence only the action resulting when sequence wheel WO cam 98 applies power to contact W23 need be considered.

For the case under consideration relay SB is not energized but the relay NM is energized. Hence power from contact W23 goes to either the normally open contact SB7 or the now open contact NM8. Hence this power does not reach 1LL and the player switch 110 does not advance. This means that player A must bowl the second ball also on alley $A_1$.

*Ball 2, frame 1*

One additional pin is knocked down (nine in all). Now SB and NM are both energized. Relays V and NN are not energized. Power from contact W23 which is closed by rotating cam 98 of alley sequence wheel WO is applied through

now closed contact SB7 through normally closed contacts V6 and NN6 and through coil 1LL to ground. This sends current through coil 1LL and this opens contacts 1LL1 and 1LL2. These contacts play no part in the present discussion and will be considered hereinafter.

When contact W23 is broken, current is released from coil ILL, whereupon due to the action of spring 46 having one end attached to the lever which supports pawl 48, ratchet 44 advances player switch 110 one step or to the next position. Reference to section 125 of player switch 110 shows that the light corresponding to player A on alley A1 has now gone out and the light corresponding to player B (at 36 on the scoreboard, Figure 9) on alley A1 is on.

*Ball 1, frame 2*

Of the assumed game described hereinabove: Nine pins down. Player B on alley A1. Relay SB is not energized and NM is energized. By the above described action coil ILL received no power from contact W23.

*Ball 2, frame 2 (of our previous play)*

A spare is made. Relay SB is energized but relays NM, V and NN are not. Power is applied through contact W23 through now closed contact SB7 through normally closed contacts V6 and NN6 through coil 1LL to ground. By the above action player switch 110 advances to player C position. The alley light (section 125) shows that player C should now bowl on alley A1.

*Ball 1, frame 3*

Of the game described hereinabove, except that player C bowls the frame, nine pins down on alley A1. By the previous action player switch 110 does not advance.

*Ball 2, frame 3*

No additional pins are knocked down. Relays SB and NM are both energized. Relays V and NN are not. Power is applied through W23 through contact SB7 through normally closed contacts V6 and NN6 through coil 1LL to ground. The player switch advances to position D. The alley light shows at 36 in player panel D that player D should now bowl on alley A1.

*Ball 1, frame 4*

Of the assumed game except that player D bowls on alley A1 and makes a strike. None of the relays SB, NM, V and NN is energized. Hence power is applied as cam 98 rotates and closes contact W23 through NM9 through V6 through NN6 through relay 1LL to ground and the player switch advances to player E position. On the scoreboard player D alley light at 36 goes out and the corresponding light for player E glows showing that player E should now bowl on alley A1.

*Ball 1, frame 5*

Of the assumed game. Player E knocks down eight pins. Since it is the first ball and the frame is incomplete relay 1LL is not actuated.

*Ball 2, frame 5*

One additional pin is knocked down. Relays SB and NM are energized. Relay NN is not. Referring to the description under the scoring of ball 2, frame 5, hereinabove, it is found that when cam 98 closes contact W2, relay V closes. Thus when cam 98 closes contact W23, power is applied through contact W23 through now closed contact SB7 to now open contact V6. Hence power does not get to relay 1LL to advnace the player switch. However, as seen previously with relay V energized, the sequence wheel makes a second revolution. When contact W18 is closed in this second rotation relay V is deenergized and when contact W23 is closed in this second rotation power is applied through contact W23 through now closed contacts SB7, V6 and NN6 through the coil of relay 1LL to ground. The player switch 110 thereupon advances to the wait position X'.

This explains how each player is kept from advancing until all the scoring is completed for each team even for the special case X -- (strike, ball, ball), which requires a double rotation of the sequence wheel WO or WT, depending upon the player, and alley being bowled.

A glance at section 125 of either player switch 110 or 112 shows that in the wait or alley changeover position, none of the alley lights is lighted. This indicates that no player should be on alley A1. In other words alley A1 must remain vacant until all members of team II have each bowled one frame on alley A2. The advance of alley A2 player switch 112 by ratchet relay 2LL is exactly analogous to that for player switch 110 of alley A1 by ratchet relay 1LL. In the interest of brevity it is deemed unnecessary to describe it further.

In the team play described hereinabove, the operations of the player advancing switch 110 have described under normal conditions of play for team I (players A, B, C, D and E). While team I is rolling on alley A1, team II is also rolling on alley A2 and consequently player switch 112 has been operated in the same manner as described in connection with player switch 110 while team II (players F, G, H, I and J) are rolling on xalley A2. Therefore, when player J completes his frame on an alley, say alley A2, player switch 112 has advanced to wait position X.

Section 126 of each player switch 110, 112 shows that at the wait positions, contacts 1t1, 1t2, 2t1 and 2t2 will be closed, and 1t3 and 2t3 will be open. Hence, power will now be applied from the power line through normally closed contacts 1LL1 and 2LL1 in parallel through now closed contacts 2t2 and 1t2 in series, to point P' at which the power branches and goes through now closed contact 1t1 through 1LL to ground and also through now closed contact 2t1 through 2LL to ground. Thus both ratchet relays 1LL and 2LL are energized. Current through 1LL opens contact 1LL1 and current through 2LL opens contact 2LL1. When both of these contacts are open, current ceases through ratchet relays 1LL and 2LL and by means of springs 46, 49 and pawls 43, 47 engaging ratchets 44, shafts 130 and 131 are turned 30° and both player switches advance simultaneously. It is to be noted that ratchets 44 advance on the balance of the current and by connecting contacts 1LL1 and 2LL1 in parallel both player switches 110, 112 will advance together.

As a result of the operations described, player switch 110 for alley A1 has advanced to position F. A reference to section 125 shows that the alley light is on corresponding to player F on alley A1 which shows at 36 in player panel F (Figure 9). At the same time player switch 112 for alley A2 has advanced to position A, so that the alley light is on corresponding to player A on alley A2 at 36. It will be noted in Figures 4 and 7 that the sections of player switch 110 advance clockwise, whereas those of player switch 112 ad-

vance counterclockwise. Obviously both switch mechanisms could advance in the same direction if desired with a rearrangement of the player positions. Thus the two teams have interchanged alleys which is the desired action.

*Special case—player switch advance*

There is one special case to be considered in connection with the advance of each player switch. This is where a player has made a strike or a spare in the tenth frame and hence is entitled to one or two bonus balls, which must be rolled off to complete the game.

Consider for example, the tenth frame of the player assumed to illustrate the scoring of the totalizer discussed previously. This was the case where a strike was rolled in the tenth frame and each of the two bonus balls was a strike.

*Ball 1*

Relays SB and NM are not energized. It was shown previously that as alley sequence wheel WO turned and cam 98 closed contact W16 a pulse was delivered to frame counter N and that it advanced from 9 to 0. This closed contact *n*2 and relay NN was activated. Hence contact NN6 is open. When contact W23 is closed, power is applied through contact F23 through NM8 through contact V6 to now open contact NN6. Thus ratchet relay 1LL receives no power and player switch 110 does not advance.

*Ball 2*

As described previously, relay NN remains energized and by the action just discussed player switch 110 does not advance.

*Ball 3 (which completes the game)*

Relays SB and NM are not energized. It was shown previously that now as contact W24 is broken by rotating cam 98 relay NN is deenergized. Then power is applied through contact W23 through closed contacts NM8 and V6 through now closed contact NN6 through coil 1LL to ground and player switch 110 advances. Since contacts W23 and W24 are the two contacts of a single pole double throw switch, the duration of this throw must be long enough so that relay NN releases in time to allow the power through contact W23 to energize ratchet relay 1LL, and effect the advance of sections 114–127 of player switch 110.

*Non-team play*

Occasionally teams have less than five bowlers. For example each team may have only four bowlers on each side, there being no player E on team I, and no player J on team II. This situation is taken care of by using the "omit switches" of section 127 of player switches 110, 112. Under these conditions OE (omit player E) and OJ (omit player J) are closed manually.

Assume the player D on team I has just completed his frame and that player switch 110 has advanced to position E. Power is now applied through now closed switch OE through contacts KK2, W20, 1LL2, V6 and NN6 through coil 1LL to ground (provided these switches are all in their normally closed positions). This energizes ratchet relay 1LL which moves the lever which supports pawl 48 away from ratchet 44 and breaks contact 1LL2. This action releases the current, spring 46 pulls pawl 48 into engagement with ratchet 44 and advances the player switch to the next position. In this manner position E is passed over. Similarly position J is passed over. In a similar manner any number of players can be handled. If, for example, there are only two players bowling, say A and F, then all the switches OB, OC, OD, OE, OG, OH, OI and OJ will be closed.

*Delayed bowling by a player*

Under normal use the omit switches would be thrown at the begining of a game and left alone. However, it is possible to take care of unusual circumstances with the omit switches. For example, suppose player A becomes indisposed and it is necessary for him to stay out of play for one frame. The mechanism provided allows him to be omitted and later reinstated. If the rules allowed it, he could make up the frame he had lost at any time by throwing all the omit switches except OA. The player switch would then rotate until it came to player A. He would bowl and then the specially adjusted player switch would return to position A. All the other players would be reinstated merely by opening the other omit switches.

Under such circumstances (or quite by accident) it may happen that an omit switch is thrown during regular play. For example, player A is bowling and someone accidentally closes the OA switch. If no safety devices were used, the player switch would advance to position B and part of player A's score would be given to B. The normally closed contacts KK2, W20, V6 and NN6 are the safety devices used to ensure that player A's score is completely recorded before player A is omitted. Consider for example that player A is bowling in the tenth frame and that he has made a strike or a spare, and hence is entitled to bonus balls. Under these conditions relay NN is energized as explained above. Hence contact NN6 is open and power cannot be applied to relay 1LL or 2LL (depending on which alley player A is bowling) through the omit switch. Thus player A cannot be omitted until he has rolled his bonus balls. Consider next that player A has finished bowling but that the sequence wheel WO (or WT depending on the alley being bowled) is still rotating. Then contact W20 will be open and no power gets to relay 1LL (or 2LL) from the omit switch. When the wheel WO (or WT) stops rotating contact W20 closes and player A can be omitted.

There is one exception to the above. This is the second rotation case: (× or strike, ball, ball). During a short interval just before and after the start of the second rotation of cam 100 of wheel WO (or WT) contact W20 is closed because of the low portion 104 of cam 100, of the sequence wheel. In order to prevent operation of the omit switch during this short interval, contact V6 is provided. Thus for the second rotation case, relay V is energized and hence contact V6 is open. Hence power does not reach ratchet relay 1LL (or 2LL) and it cannot advance the player switch until it should do so.

The series combination of contacts W20 and V6 is open whenever the sequence wheel is in rotation and neither player switch 110 or 112 advances when WO or WT, respectively, is rotating. However, relays 1LL and 2LL must also be prevented from advancing at other times. For example, suppose player A has bowled the first ball of a two ball frame. Even after the sequence wheel WO or WT depending upon which alley player A is bowling stops rotating, relay 1LL (or 2LL) must not be energized since player A must not be omitted until he has bowled his second ball

and its score has been recorded. Furthermore, it is not desired that player A be omitted at any time from the instant he has let a ball roll down the alley until he has completed the frame and his score has been recorded. Contact KK2 is provided to ensure these conditions. Thus as explained under ball 1, frame 1 and ball 2, frame 1 of the assumed game bowled by player A, relay KK is energized the instant a ball hits the pit of the alley and closes switch 300 and remains energized until after the second ball of the frame is rolled and the sequence wheel WO (or WT) engages and opens contact W18, which de-energizes relay KK. By this time the high portion 102 of cam 100 has engaged and opened contact W20. Hence relays LL1 and 2LL are so controlled that they cannot operate at the wrong time.

*Team scoring*

The indicators for teams I and II are shown in Figure 1. As mentioned hereinabove, each team has four indicators; a units, a tens, a hundreds and a thousands indicator. The ratchets, cams, etc. of the units, tens and hundreds indicators, are identical in construction and operation with those of the corresponding individual player indicators and hence need not be described further. Each team thousands indicator has only two cams operating switches Q'''1 and H'''1 (for team I) and these are used for resetting purposes to be described hereinafter, and are analogous to switches Q1 and H1 of the player units indicators.

Any score obtained by any player of team I must be added to the team I score. Consider player A on alley $A_1$, as shown in Figure 1. Any pulse from bowling pin spotting machine 2 which reaches section 114 of player switch 110 also goes through switch 138*a* through wire 290 through the coil of team indicator relay QT1 to ground. Hence, every unit added to player A's score is added to the score of team I. Similarly cam 134 allows the unit score of any player A, B, C, D, or E while on alley $A_1$ to be added to the unit indicator of team I. When all players of team I have completed a frame, then player switches 110 and 112 will have rotated through 180°. Cams 134 and 135 will have rotated through 180° and contacts 138*a* and 139*b* will now open whereas contacts 138*b* and 139*a* will close. Thus any player unit pulses for a member of team I which is now bowling on alley $A_2$ and which arrive at section 114 of player switch 112 go through now closed switch 139*a* through wire 290 through normally closed switch *r*3*a* through the coil of team ratchet relay QT1 to ground. Hence, regardless of which alley team I is bowling on its unit score is added to the unit indicator QT1 of team I.

In an exactly similar manner the unit score of any member of team II is added to the unit indicator QT2 of team II.

Similarly any tens pulse for any member of team I, reaching section 115 of player switch 110 or 112 gets through either switch 140*a* or 141*a* through wire 280 through normally closed contact *r*3*a* through normally closed switch *a*2 through the coil Q'T1 of team ratchet relay Q'T1 to ground. Hence, any tens score obtained by any member of team I on either alley is added to the tens indicator of team I. In an analogous manner any tens score of any member of team II is added to the tens indicator of team II (via contacts 140*b* and 141*b*.

Whenever the units indicator QT1 advances from 9 to 0, contact *a*2 opens and *a*1 closes momentarily. This applies a pulse of power from the line through now closed team indicator contact *a*1 through team indicator coil Q'T1 to ground and the team tens indicator Q'T1 advances one digit, as it should. Whenever the team tens indicator Q'T1 advances from 9 to 0, contact *a'*1 closes momentarily and power is applied through now closed team indicator contact *a'*1 through team indicator coil Q''T1 to ground. This advances the hundreds indicator one digit, as it should. Whenever the hundreds counter Q''T1 advances from 9 to 0, team indicator switch *a''*1 closes momentarily. This applies power through now closed switch *a''*1 through coil Q'''T1 to ground. This advances the thousands indicator one digit, as it should. The carry over action of the several team II indicators is the same as that described for team I. It is evident, therefore, that any score of any member on team I or team II is added progressively to accurately totalize each team's score during frame to frame play and also the final score.

*Single alley operation*

In non-team play it may be desirable for all players to bowl on one alley instead of alternating between two alleys. One way of obtaining this result is accomplished by the provision of a manually closed switch 61 which holds relay SA energized (Figure 7). This connects positions F, G, H, I, J, X and X' of section 127 of player switch 110 associated with alley A1 to the high side of the line. Relay SA when energized also connects positions A, B, C, D, E, X and X' of section 127 of player switch 112 associated with alley $A_2$ to the high side of the line. By the action described hereinabove, when discussing the action of the omit switches, this effectively omits players F, G, H, I and J from alley $A_1$ and players A, B, C, D and E from alley $A_2$. It also omits the "wait" positions "X" and "X'" so that each alley can be used independently.

This allows any number of players (the preferred embodiment discussed herein limits the maximum number to five, but any number could be handled by increasing the number of positions on each disc of the player switches) to play on one alley. For example, if four players wish to bowl on alley $A_1$, these could be called A, B, C and D and switches 61 and OE would be left closed. If at the same time three players wish to bowl independently on alley $A_2$, these could be called F, G and H and switches 61, OI and OJ are left closed.

*Default*

In league play, under rules of the American Bowling Congress, a player may arrive late and yet be allowed to play provided that his score counts beginning with the frame then being bowled by his team. Suppose for example, player E has arrived after his team has completed two frames and it is desired that he enter the game, then when player E starts to bowl his frame indicator must show 2 and not zero.

This can be accomplished manually by a referee who closes key DD2 and then pushes button DD1 (Figure 3) twice in succession before player E starts bowling. This applies power through now closed switch DD1 through now closed switch DD2 through normally closed contact KK3 through normally closed contact NN5

through section 124 of the player switch 110 through coil N to ground. This energizes ratchet relay N and the frame counter advances from 0 to 1 the first time DD1 is depressed, and from 1 to 2 the second time DD1 is depressed.

The purpose of switch DD2 is to prevent tampering with the frame indicator. It is key operated and normally is locked open. Only the referee or other designated person has the key and can use it, to default the frames of a tardy player as discussed hereinabove. To help prevent an accidental change in frame number during the play of any frame of a game, frame contact KK3 is added in series with switches DD1 and DD2.

*Overzealous bowler*

Consider the following situation. Team I (league play) (A, B, C, D and E) has completed bowling a particular frame on alley $A_1$, whereas not all of the players (F, G, H, I and J) of team II have completed the corresponding frame on alley $A_2$. Then player switch 110 of alley $A_1$ is on the wait position X'. The arrow lights on the scoreboard (Figure 9) indicate that one player of team II, say J, is bowling on alley $A_2$ but there is no lighted arrow indicating play on alley $A_1$. Assume that despite this definite indication that no one should be bowling on alley $A_1$, player F is overzealous and knowing that he is the next player to bowl on alley $A_1$ delivers a ball on alley $A_1$. The pinspotter must not be allowed to go through its sequence under these conditions since the totalizer is so designed that it cannot function properly on either of the wait positions X, X'. This is accomplished by means of switch *1t3* of section 126 of player switch 110. Normally the pinspotter sequence starts as follows: The ball drops in the pit of alley $A_1$. This closes switch 300 which is connected by wire 301 to the delayed closing relay 302 (Figure 6). After a predetermined time relay 302 is activated and closes contact 304. This completes a circuit from the power line through contact 304 through normally closed contact *348b* of the pin spotting machine control through wire 522 through normally closed contact SS1 (Figure 3) through normally closed contact *1t3* (Figure 7) through wire 521, through switch 305 through contact *402a* through relay 308 to ground. The energizing of relay 308 starts the pin spotter sequence. Under the circumstances pictured above, however, switch *1t3* is open and hence no power reaches relay 308. Therefore, the pinspotter sequence does not start.

The ball delivered by the overzealous player F remains in the pit of alley $A_1$ until all the players of team II have completed bowling on alley $A_2$. This advances player switch 112 to position X'. However, by the action described hereinabove when both player switches 110 and 112 are on positions X' and X, respectively, they will advance together to the next position which will be player F on alley $A_1$ and player A on alley $A_2$. When this advance takes place switch *1t3* closes again and now the pinspotter sequence takes place, the ball previously delivered by player F is returned by suitable mechanism (not shown) and the proper score is indicated. A similar operation takes place, if for example, all bowlers on team II rolling on alley $A_2$ complete the play of a frame before the bowlers on team I. It is also to be noted that each player switch might also be at position X instead of position X' as described above.

*Stop switch*

If either switch SS1 or SS2 is open, pinspotter 2 or 4, respectively, cannot go through its operating sequence. There are, therefore, provided manually operated push buttons 150, 150' (Figures 3 and 5) which can be operated by the referee or designated player whenever any one of the following events takes place or is suspected to have taken place, and since switch SS1 or SS2 is opened thereby, the pinspotter operation is not allowed to take place.

1. A foul is committed.
2. A dead-ball is delivered.
3. There is disagreement between the player arrow indications on the display panel and the player bowling.

Each of these situations will now be considered separately hereinbelow.

*Foul*

If a foul is committed then relay FF (Figure 3) is energized and as will be described hereinafter the contacts of relay FF will be used to cause the totalizer to function properly. If the pinspotter 2 or 4 is equipped with an automatic foul detector, for example, a photoelectric foul detector such as 408 (Figure 6), which can be similar in construction to that shown and described in the above referred to Broekhuysen patent, relay 409 will be automatically energized when a foul is made. A foul control mechanism is provided for each machine 2 and 4. Only one is illustrated (see Figure 6). Since the same device is used on machine 4, further showing has been omitted in the interest of brevity. Energization of relay 409 closes switch 411 momentarily. Hence, power is now applied through wire 519 (Figure 3) through now closed contact 411 through wire 518B through the coil of relay FF through normally closed contact *db4* to ground. This energizes relay FF which closes contact FF1. Then power is applied through normally closed contact W25 of wheel WO through contact FF1 through normally closed contact *f2* through coil FF through normally closed contact *db4* to ground and this holds coil FF energized even after 411 opens. Across coil FF there is a "foul light" 33 which is illuminated whenever FF is energized. This is indicated in Figure 9 and tells the audience and players that a foul has been committed. Each team panel is provided with a foul light 33.

If no automatic foul detector is used in conjunction with the pinspotter then the referee must push the foul button of Figure 3 which closes switch *f1*. It must be remembered that the referee has already manipulated button 150 which has opened contacts SS1 and SS2 and closed contact SS3. Hence, power is now applied through now closed switch *f1* through now closed contact SS3 through the coil of relay FF through normally closed contact *db4* to ground. Relay FF is kept energized by hold-in contact FF1 in the manner described hereinabove through contact W25. Since W25 is opened momentarily by cam 99 on WO after all the scoring is completed and after all memory circuits have been activated (or deactivated) then relay FF will be held energized from the time a foul is declared (either automatically or manually) until all scoring is completed. The case X- - requires special consideration since under this condition the wheel WO must make a second revolution before the scoring is complete, as described hereinabove. For this case contact V5

is closed during the first revolution and hence even though contact W25 opens up in the interval between the first and second revolutions, the power continues to flow through coil FF through the following path: Through contact V5 through contact FF1 through *f*2 through FF through *db*4 to ground. Thus even for this double rotation case, relay FF is kept energized until all the scoring is completed.

To see that relay FF controls the proper scoring in the case of a foul consider separately:

(*a*) A first ball foul.

(*b*) A second ball foul.

(*c*) A first ball foul followed by a second ball foul.

(*a*) A first ball foul must count zero pins down. That is, no score for pinfall resulting from the foul ball. Assume that, say, nine pins have been knocked down by the foul ball. Then when wheel WO starts to rotate, relay NM will be activated but relay SB will not be energized. The action resulting from successive closing and opening of the several WO contacts is as follows:

*Contact W1*

Power will be applied through contact W1 through contact U1 (if closed) through section 116 of the player switch 110 or 112 through contact Y5 (if closed) through normally closed contact *a*2 through coil Q' to ground. Thus the score will increase by 10 provided that both relays U and Y are energized. These will both be energized as explained hereinabove only if the two frames preceding the foul ball were both strike frames.

*Contact W2*

Power will be applied through contact W2 through contact U2 (if closed) through section 115 of player switch 110 (or 112) through normally closed contact *a*2 through coil Q' to ground. Hence, the score will increase by 10 provided that relay U is energized which means that this foul ball is the first ball after a spare or the second ball after a strike. It can only be the second ball after a strike and still be the first ball of a frame if two successive strikes have been made.

*To recapitulate.*—If two successive strikes are followed by a foul the score is increased by 20. If a spare is followed by a foul the score is increased by 10. If neither of these combinations has been bowled the score is not increased at all by the action resulting from closing of contacts W1 and W2.

Since the above is exactly what should happen for a first ball foul there must be no further scoring as the result of the continued rotation of wheel WO.

*Contact W3*

Power is applied through contact W3 through now closed contact NM2 through wire 517 through contact 326*d* corresponding to pin 1 (if it was knocked down) through wire 507 through now closed contact NM3 to either now open contact FF3 or through closed contact PP1 to open contact SB2. Hence, no score is added by the action of W3.

*Contact W4*

Power is applied through contact W4 through wire 516 through contact 326*d* corresponding to pin 2 (if it was knocked down) through wire 507 through now closed contact NM3 to either now open contact FF3 or through closed contact PP1 to open contact SB2. Hence no score is added by the action of W4.

*Contacts W5, W6, W7, W8, W9, W10, W11 and W12*

The action is as explained for W4. No score added.

As wheel WO continues to rotate through contacts W13, W14, etc. the action is exactly the same as described hereinabove for a non-foul ball, no further scoring being done. Hence, it is evident that for a non-strike first ball foul the correct score is obtained.

Consider now that a strike is made but that it is declared a foul. Then neither NM nor SB is energized when wheel WO starts to rotate and effects the following action:

*Contacts W1 and W2*

The action is as described for a first ball non-strike foul.

*Contact W3*

Power is applied through contact W3 to now open contact NM2 or through now closed contact NM1 to now open contact FF2. Hence momentarily closing W3 does not add to the score.

*Contacts W4 through W12*

No score for the reason described under a first ball non-strike foul.

As wheel WO continues to rotate through contacts W13, W14, etc. the action (except for contact W16) is exactly the same as described hereinabove for a non-foul strike, no further scoring being done. For a non-foul strike, however, the strike memory relay Y would be energized by closing of contact W16, as described hereinabove. Now, however, when contact W16 is closed power is applied through contact W16 to the open contact FF4. Hence, the strike memory relay is not energized.

*To recapitulate.*—For a first ball foul (strike or not) the score is increased by 20 if the foul is preceded by two strikes, the score is increased by 10 if the foul is preceded by a spare and the score is unchanged under all other circumstances. This is exactly the correct scoring action.

(*b*) A second ball foul. The pins knocked down by the first ball are the only pins which can be considered to have been knocked down in this frame. Hence the pinspotter must retain the information of which pins were standing after the first ball was delivered. It retains this information as follows: As described hereinabove, relays 326 are activated by standing pins from the instant table 10 descends and these pins close contacts 320 until just before the table descends again after the next ball is rolled at which time the hold-in circuit for relay 326 is broken by the opening of contact 406R*b* by cam 406 on shaft 255 (Figure 6). This hold-in circuit is from power through contact 406R*b* through normally closed button 602 through contact 326*b* through relay 326 through normally closed contact 416*d* to ground. Now if a second ball foul is made, relay 412 will be energized. If an automatic foul detector such as detector 408 is used relay 409 is energized and power is fed from the line through contact 362*b* of cam 362 through now closed contact 410 of foul detector 408 (Figure 6) through coil 412 to ground. If an automatic foul detector is not used, then power is fed from the line through now closed contact FF7 (Figure 3) through coil 412 to ground. In either event coil 412 is energized for a foul and contact 412*g* is closed. Then power

is fed from the line through now closed contact 412*g* through those hold-in contacts 326*b* which were closed by standing pins through their relay coils 326 through normally closed contact 416*d* to ground. Hence, by means of the hold-in circuit just described, even when table 10 descends and contact 406R*b* opens momentarily, the relays 326, which were energized by the pins standing after the first ball was delivered, remain energized. Thus the pinspotter retains the first ball information.

When wheel WO starts to rotate, both relays NM and SB are energized and the totalizer action is exactly that described hereinabove for a second ball non-mark non-foul ball except that only the pins knocked down by the first ball are counted, which is exactly the desired action.

(*c*) A second ball foul following a first ball foul. By the action described above this would score as a non-mark frame with pins knocked down by the first ball only. This action, however, is incorrect since two successive fouls must score as zero pins knocked down. The correct scoring is obtained with the aid of DF or double foul relay, shown in Figure 3.

In the control shown and described in the above mentioned Broekhuysen patent, it is explained that relay 418 is activated while the pinspotter is at rest following a first ball foul. In order to send the necessary pulse from machine 2 (or 4) after a double foul, an additional contact 418*e* is added to relay 418. When, therefore, relay 418 is energized power is applied from the line through wire 519 through now closed contact 418*e* through wire 520 through now closed contact FF6 through the coil of relay DF to ground. This energizes relay DF which is then held in because power is fed from the line through now closed contact DF1 through now closed contact FF6 through coil DF to ground. The energizing of relay DF opens contact DF2 which is in series with the coil of relay NM (Figure 3). Hence relay NM is not now energized whereas relay SB is activated. Therefore, as wheel WO rotates the following action takes place:

*Contact W1*

Power is applied through momentarily closed contact W1 through contact U1 (which will be closed if the previous frame was a strike frame) through section 116 of player switch 110 to open contact Y5. Hence there is no scoring effect.

*Contact W2*

Power is applied through momentarily closed contact W2 through contact U2 (if closed) through section 115 of player switch 110 through normally closed contact *a*2 through coil Q' to ground. Hence the score is increased by 10 if the previous frame was a strike or is not increased at all if the previous frame was not a strike. This is the correct scoring according to prescribed rules of play and hence it remains to show that no further scoring is done as wheel WO continues to rotate.

*Contact W3*

Power is applied through contact W3 through normally closed contact NM1 to now open contact FF2. No effect.

*Contact W4*

Power is applied through contact W4 through wire 516 through closed contct 326*d* corresponding to pin 2 through wire 507 to now open contact NM3. No effect.

*Contacts W5 through W12, inclusive*

The action is the same as that described for contact W4. There is no further scoring.

The remaining action as WO continues to rotate is as for a second ball mark frame (since relay NM is not energized, but SB is)—in other words, a spare frame. However, this would be incorrect since spare memory relay T would be activated. This is prevented from taking place by contact FF5. Thus when power is applied from the line through W14 it comes to the open contact FF5 and hence does not activate the spare relay T.

Thus all possible foul situations have been accounted for and completely accurate scoring and totalizing results obtained.

Consider a game in play. As soon as the foul judge suspects a player has fouled he pushes switch 150 which opens contacts SS1 and SS2 and closes contact SS3. When it is decided that a foul has been made, then switch *f*1 is closed and switch 150 is returned to its normal position. As explained hereinabove, this allows the pinspotter machine 2 or 4, depending upon whether the foul was made on alley $A_1$ or $A_2$, to go through its normal sequence, and the foul is properly scored.

If it is decided that no foul was made then switch *f*1 is not closed but switch 150 is returned to its normal position. This allows the pinspotting machine 2 or 4 to go through its normal sequence and the pins knocked down are credited to the bowler.

Imagine now that switch *f*1 was closed but the foul is protested. If after further discussion it is decided that no foul was committed then switch *f*2 is opened momentarily. This will deenergize relay FF because power is removed from the hold-in contact FF1. Thus power fed from the line through contact W25 that would normally pass through contact FF1 now goes to either open contact SS2 or open switch *f*2. Thus relay FF is deenergized and when switch 150 is returned to its normal position, the scoring is normal (no foul). Thus the use of switch *f*2 allows protesting of a hasty foul decision in accordance with American Bowling Congress rules.

*Dead ball*

Under American Bowling Congress rule, No. 10, pins knocked down by a dead ball are not counted in the score.

As mentioned hereinabove, stop switch 150 is pushed when a dead ball is suspected and this keeps the pinspotting machine (either machine 2 or 4, depending upon whether the dead ball occurs on alley $A_1$ or $A_2$) from going through its normal cycle. If a dead ball is declared then switch 151 (Figure 3) is pushed manually. This opens contacts *db*1, *db*2 and *db*4 and closes contact *db*3 (Figure 3). The opening of contact *db*2 removes power from the arrow or alley signal 36 of Figure 9 corresponding to the player and the alley on which the dead ball was declared. This indicates that this player must stop bowling for the time being. This can be seen by tracing the circuit from ground through switch *db*2 through the arrow light through section 125 of player switch 110 (or 112) to the high side of the line; thus if switch *db*2 is opened the light 36 representing the player making the dead ball is extinguished.

The closing of switch *db*3 puts on a dead ball light 80 since there is now a complete circuit

from power tnrough this light through now closed contact *db*3 to ground.

In the embodiment illustrated a dead ball light **80** is provided for each main panel **22**, **24**. Light **80** can be situated as shown in Figure 9 in the team panel next to the foul light. When either light glows or both lights glow, it indicates that a dead ball has been made by the particular player or players bowling.

Opening of switch *db*4 removes ground from relays SB, KK and FF and hence deenergizes any of these relays that might be held in.

When switch **150** is returned to its normal position, pinspotting machine **2** (or **4**) now runs through its normal cycle. However, the totalizer is inactive because the sequence wheel WO (or WT) does not rotate since power from the line through drive motor **50** (Figure 3) comes to the now opein switch *db*1.

If the dead ball was a first ball (not a strike) the pinspotting machine **2** (or **4**) runs through a first ball cycle. Next, roll a gutter ball keeping switch **151** operated. The pinspotting machine **2** (or **4**) sets up a new set of pins and shows a first ball light while the scorer remains inactive. This is exactly the desired action for a dead ball and conditions are exactly as they were before the dead ball was delivered. Hence, switch **151** is now returned to its normal position, the dead ball light goes out, the player alley arrow light **36** goes on again and the bowler resumes play. A gutter ball is not needed if the dead ball is a strike since then pinspotting machine **2** (or **4**) sets up all the pins again and shows a first ball light.

If the dead ball is a second ball of a frame, the pinspotting machine runs through a second ball cycle and sets up a new set of pins, the scorer remaining inactive. Next, manually remove the pins that fell on the preceding first ball play. Following this a gutter gall is rolled. Pinspotting machine **2** (or **4**) interprets this as a normal first ball with the pin fall previously obtained and the second ball light goes on. This is exactly the desired condition. Hence, switch **151** is now returned to its normal position, the dead ball light goes out, the player alley arrow light **36** goes on again and the bowler resumes play.

*Disagreement*

Between player arrow indications on the display panel and the player bowling. Occasionally there may be a disagreement between the player alley indicators **36** and the player who is bowling. For example: If the wrong player has bowled and the player switch is correctly set proceed as with a dead ball. The stop switch button **150** is operated. As explained hereinabove this will return conditions to what they were before the wrong player bowled and no score is recorded. Hence the correct bowler can now play.

If the correct bowler has bowled but player switch **110** or **112**, depending on the alley on which he is bowling is incorrectly set, then this is remedied by manipulation of the omit switches, referred to hereinabove. When the player alley arrow light **36** of Figure 9 is correctly set then switch **150** is returned to its normal position, the pinspotting machine **2** (or **4**) and the totalizers go through their normal cycles and the proper score is accredited to the player who has just bowled.

*Resetting*

At the end of a game the totalizer should be cleared or reset before a new game is begun. This consists in bringing all indicators to zero and in causing all hold-in switches to be released. This is accomplished with the aid of a reset switch, designated generally **160**, which may be of the type shown in Figure 1 having a plurality of control contacts. If this switch, which is of a well known conventional type, is operated, contacts *r*3, *r*3*a*, *r*3*b* *r*3*c* and *r*4**1** are opened and all other contacts *r*2F, *r*1A *r''*1*f*, *r'*1A, *r'*1F, *r''*1A, *r*1F, *r*2A, *r*PF1 *r*T2, *r*PF2, *r*PF, *r*T1, *r*1PF, *r*2PF and *r*3PF which operate the several associated totalizing scoring and indicating mechanisms which are closed.

We have found that a satisfactory method of bringing an indicator to zero is to employ the "buzzer principle." Consider for example, the frame indicator of player A (Figure 7). If the reset switch is operated then power is applied through now closed contact *r*2A through a wire through normally closed contacts *n*1 and N1 through coil N to ground. This sends current through coil N and at the end of the ratchet pull contact N1 opens and indicator N advances one step. As mentioned hereinabove contact N1 opens only momentarily at the end of the ratchet pull. When it closes again the power again flows through *r*2A through *n*1 through N1 through the coil of ratchet relay N to ground, the ratchet advances another step and again N1 opens momentarily. This buzzer action continues until indicator N reads zero, at which time contact *n*1 opens and remains open. Thus no further power can get to the coil or relay N and this indicator stays at zero. Exactly the same action resets all frame indicators to zero.

The units, tens, hundreds and thousands indicators for either a player or a team are reset in an analogous manner. Only one illustration, for example, the units counter of player A need be given. Power is applied through now closed contact *r*1A (Figure 1) through wire **240** through normally closed contacts *h*1 and Q1 (Figure 2) through coil Q to ground, thereby energizing ratchet relay Q. At the end of the ratchet pull contact Q1 opens momentarily and the indicator Q advances one step. When contact Q1 closes again, power is once more sent through coil Q and the ratchet advances another step. This continues until the indicator reads zero, at which time, as explained hereinabove, contact *h*1 opens and remains open. Hence, this indicator has been reset to zero.

As explained hereinabove, any pulses which reach an indicator of any player of team I will simultaneously reach the corresponding indicator of team I. The same operation also holds for players of team II. Thus the resetting pulses going to the units indicator of player A could pass through section **114** of player switch **110** (if it were on position A) through contact **138***a* (if it were closed) through wire **290** through *r*3*a* (if it were closed) through coil QT1 of the units counter of team I (Figure 1). However, the resetting pulses of a player indicator must be kept from a team indicator since otherwise neither indicator will ever settle down to zero. This is the function of contact *r*3*a*. Since it is always open upon resetting then the player and team I units resetting pulses are isolated from one another. The contacts *r*3, *r*3*c* and *r*3*b* serve similarly to isolate the player and team I tens resetting pulses and the player and team II units and tens resetting pulses, respectively.

The second function of reset switch **160**, i. e. that of breaking all hold-in circuits is accom-

plished by opening normally closed contact r4I (Figure 1). It should be observed that normally power from the line going to any element of the totalizer must pass through contact r4I. Hence, if upon resetting, when switch 160 is operated for resetting, contact r4I opens then all power is removed from the totalizer (except that needed for the buzzing action described hereinabove to bring all indicators to zero) and thus the power is removed from all hold-in circuits and all relays are thereby deenergized. After the resetting has been effected, switch 160 is restored to the position shown in Figure 1.

The reset switch should not be considered limited to a manually operated single throw multiple switch as shown in Figure 1. It could equally well be a multiple relay with the power for the relay coil coming from the line through a single pole normally open switch, this switch only being closed for resetting. Or if it is found that the power drain due to the simultaneous buzzing of the forty-eight indicators (ten players, each with a units, a tens, a hundreds and a frame indicator and two teams, each with a units, a tens, a hundreds and a thousands indicator) is excessive then the resetting can be done in several steps with either a manual multiple pole multi-throw switch or a multiple pole stepping relay. A manual push button could be used to advance this relay step by step until all indicators are cleared.

If single alley operation is to be taken into account then the resetting must be done independently for each alley. The reset switch 160 must be constructed as two independent switches (as shown in Figure 10). All resetting contacts associated with players A, B, C, D, and E and also all resetting contacts associated with alley $A_1$ are on one switch 500 and all resetting contacts associated with players F, G, H, I and J, and also all resetting contacts associated with alley $A_2$ are on the second switch 499. The power going to all units associated with alley $A_1$ now comes from the main power line through the normally closed contact r4I, whereas the power going to all units associated with alley $A_2$ now comes from the main power line through normally closed contact r4II. Obviously, now the resetting can be done independently for each alley, switch 500 being used for alley $A_1$ and switch 499 for alley $A_2$.

Operation of switch 500 opens contacts r3a, r3 and r4I, and closes contacts r1A, r'1A, r''1A, r2A, rT1, r2PF, rPF, and rPF1. In the same manner operation of switch 499 opens contacts r3c, r3b and r4II and closes contacts r1F, r'1F, r''1F, r2F, rT2, r3PF, rIPF and rPF2. These operations effect the clearing of the indicators and associated scoring and totalizing mechanisms in readiness for the play of the next game on alleys $A_1$ and $A_2$.

*Control box*

This can take any number of different forms as long as it contains all the control switches, buttons and keys. It need not be seen by the players or audience and should only be manipulated by the referees. It contains the ten omit switches OA, OB . . . OJ, a stop switch for each alley, a foul switch for each alley, a dead ball switch for each alley, a default switch and a default key (DD1 and DD2) for each alley, a main power switch for each alley, a single alley switch (61) and a reset switch (or switches). It might be desirable not to house all these elements in one box but to use several. For example, if there is a referee for each alley each should have in his hand a tiny control box containing the stop switch, the foul key and the dead ball key.

*Pinspotter tenth frame memory relay, PP*

At the end of a game the pinspotter must be ready for a first ball cycle since the next player will obviously bowl the first ball of a frame. There are two possible types of play that a game can end with such that the pinspotter will be ready for a second ball cycle. These are /– and × × –.

Consider /–. After the second ball of the spare has been rolled, the initial action described hereinabove takes place until cam portion 99 of WO (or WT) closes contact W17 when the following new action occurs. Power is applied momentarily through contact W17 through now closed switch SB6 through normally closed relay contacts V2 and NN5 through section 124 of player switch 110 (or 112 depending on the alley being bowled) through coil N to ground. This advances frame indicator N from 9 to 0. Cam 62 of frame indicator N then closes contact n2 and this remains closed even after cam portion 99 of WO opens contact W17. Power is now applied through now closed contact n2 through the parallel contacts h2, h'2 and h''2 (at least one of these will be closed unless no score at all has been made in the first nine frames) through now closed contact T4 through section 123 of player switch 110 (or 112) through coil NN to ground. This energizes relay NN and closes contact NN8. Now power is applied through normally closed contact R1 (Figure 2) through now closed contact T1 (Figure 4) through section 118 of player switch 110 (or 112) through now closed contact NN8 (Figure 3) through normally closed contact YY3 through coil PP to ground. Thus when motor 50 stops rotating, contact PP2 is closed. Then when pinspotter 2 (or 4) completes its sequence, cam 362 causes contact 362b to close. Since the pinspotter "thinks" that the next ball to be rolled is a first ball then contacts 350f and 428a (Figure 6) will be in such positions that power will be applied through now closed contact 362b through contacts 350f and 428a through the first ball light 424 to ground. However, this same power will also flow through parallel circuits from the contacts 428a through wire 503 through now closed contact PP2 through coil 350 to ground. This energizes ratchet relay 350 which when energized causes a shifting of contacts (not shown), including a contact 350f (Figure 6), back and forth from full line position to dotted line position in a manner similar to that described in said Broekhuysen patent. This will cause pinspotter 2 (or 4) to go through a second ball cycle on the next ball rolled—which is the desired action.

After the next ball is delivered the action is as described hereinabove and as explained previously when motor 50 has rotated cam portion 99 so that it closes contact W13 momentarily relay T is deenergized. This opens contact T4 but relay NN is held energized by power through normally closed contact W24 through hold-in contact NN1 through coil NN to ground. However, after cam portion 99 rotates further, and opens contact W24 momentarily then the power circuit to relay NN is broken and this relay is deenergized. This is the desired action since NN has served its purpose of causing pinspotter 2 (or 4) to go through a first ball sequence.

Consider the second case ×××−. After the first strike is delivered, the action is as described hereinabove. After motor **50** has turned cam portion **99** so that it momentarily closes contact W**17**, frame indicator N advances from 9 to 0 and cam **62** closes contact *n***2**. Power is now applied through contact *n***2** through the parallel contacts *h***2**, *h'***2** and *h''***2** through now closed contact Y**4** through section **123** of player switch **110** (or **112**) through coil NN to ground. This energizes relay NN. This opens contact NN**3** and closes contact NN**4**.

After the second strike is delivered, the action is as described hereinabove until motor **50** rotates cam portion **99** to momentarily close contact W**16**. Then power is applied through contact W**16** through now closed switches FF**4**, NM**5**, SB**4** and NN**4** through coil YY to ground. This energizes relay YY which closes contact YY**1**. This applies power through now closed contact YY**1** through coil YY to ground and keeps this relay energized. This opens contact YY**3** and closes contact YY**4**. Thus power is applied through closed contacts YY**1** and YY**4** through coil PP to ground. As just described relay PP now causes pinspotter **2** (or **4**) to go through a first ball cycle after the next ball is rolled. This is the desired action.

When relay PP is energized normally closed contact PP**1** opens. This is used to prevent a score from getting to the units indicator Q in case the last ball of the game is a foul, that is, if the tenth frame play is strike-strike-foul. Thus for this last ball relay SB is energized, since the pinspotter has been prepared for a second ball sequence by relay PP, and relay V is energized because it is the second ball after a strike, a circuit being made from ground through coil Q through section **114** of player switch **110** (or **112**) through either now closed contact SB**2** to open contact PP**1** or through now closed contact U**3** to now open contact FF**3**. Thus either path leads to an open circuit and no score can be added to the units indicator Q which is the desired action for a first ball foul.

*Off-center pins*

In case the pinspotter table **10** cannot descend due to a pin which is too far off-center, and cannot be lifted and reset by a unit **11**, the pinspotter sequence stops before contact **406**L is closed and hence before the totalizer starts its cycle. This operates a sweep interrupting solenoid (not shown) and the machine stopping relay **402**. If the off-center pin occurs with the second ball, stopping relay **402** receives a pulse directly at the time cams (not shown) on shaft **255** make a circuit through contacts closed thereby and through contact **366***d* of relay **366**.

After the pinspotter is at rest, a person, for instance the referee or a bowler pushes buttons **601** corresponding to each standing pin (Figure 6). This applies power through now closed contact **362***a* through now closed contact **601** through coil **326** through normally closed contact **416***d* to ground. This energizes relays **326** (corresponding to each pin standing) which is exactly what would have happened had there been no off-center pin to prevent the table from descending. The corresponding pin lamps light. If an error is made and a wrong button **601** is closed the button **602** is pushed and this removes the power from all the hold-in contacts **326***b* and all relays **326** are deenergized. This is seen by tracing the power through closed contact **406**R*b* through normally closed hold-in contact **326***b* through coil **326** through contact **416***d* to ground. If switch **602** is opened then coil **326** must become deenergized. All the pin lights go out and now the correct buttons **601** are closed. After the proper pin lights are on the dead wood is removed manually (in the case of a first ball) and the machine is started by opening and then closing switch **305** in a manner similar to that described in the above-mentioned co-pending Broekhuysen patent. The totalizer starts its normal sequence when contact **406**L closes.

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

What we claim is:

1. In combination, a bowling pin spotting machine, a scoring and totalizing device, said machine being provided with a plurality of pinfall registering elements, comprising a scoreboard, automatic computing and indicating mechanism in said scoreboard, including means actuated by said pinfall registering elements of said machine for automatically tabulating the pinfall results for each ball rolled in a normal ten frame game, operating means for said mechanism including an electric circuit, means connecting said pinfall registering elements in said circuits for sending selective scoring impulses to said operating means and means operative in response to impulses received from said bowling pin spotting machine as the result of the rolling of a ball for energizing said circuit and actuating said indicating mechanism to indicate the score resulting from said pinfall.

2. In combination with a bowling pin spotting machine, a scoreboard and bowling totalizing device comprising a pair of team panels, each of said panels including a plurality of individual player panels, a team score computing device, a team score register in each of said team panels operatively connected to said device, frame signal means, strike and spare signal means, and a score register for each of said individual player panels, a computing device operatively connected to each of said individual player panel registers, automatically operated activating mechanism in said machine interconnecting each of said team and player panels, and detecting means in said machine operative in response to the number of pins knocked down in each frame rolled for selectively operating said signal means and said registers of a selected one of said team panels to totalize and score each individual player's score and each team score for each game played.

3. In combination with a bowling pin spotting machine, a bowling scoring and totalizing device comprising a scoreboard, a plurality of player panels in said scoreboard, each of said panels including a selectively operable electric circuit, an electric frame indicator, and electric spare and strike registers and electric scoring registers operatively connected in each of said circuits; and means on said machine and operative in response to the number of pins knocked down in each frame for selectively energizing said circuits to indicate the frame score and tabulate the final score of each player, said last-named means including a multiple contact switch connected in each of said circuits, a positively actuated and selectively driven movable contact closing and

opening member for operating said indicators and registers of said player panels, and means for moving said member after each ball of a frame is rolled by a player to energize selected circuits for recording and registering the pinfall result obtained by the player.

4. In combination with a bowling pin spotting machine, said machine including a pinfall detecting device, a bowling scoring and totalizing apparatus comprising means operative in response to the rolling of a ball for positioning said device adjacent a bowling alley to test for the number of pins knocked down, a plurality of individual player scoring and totalizing units, automatically actuated means operated by said detecting device in response to the positioning of said device adjacent said bowling alley and the detection thereby of the number of pins knocked down for actuating a selected player unit to indicate the pinfall results obtained in each frame bowled by a selected player, and automatically actuated mechanism operative after each player bowls one frame for inactivating the player unit corresponding to the player who has just completed a frame and activating the player unit corresponding to the player who is about to bowl a frame.

5. A bowling, scoring and totalizing device for use with two bowling pin spotting machines comprising, two interconnected, electrically and automatically operated sets of scoring and totalizing units, each of said sets including a plurality of individual player units, and a team scoring unit, an electrical circuit connecting said units, means for concurrently operating one player unit of one team and one individual player unit of the opposing team to indicate and score the results obtained in each frame rolled, a movable selective circuit activating switch mechanism associated with each of said sets of scoring and totalizing units, said mechanism including a plurality of movable contacts, a plurality of player unit circuits operatively connected in said first-named circuit, fixed contacts connected in said player unit arranged to be engaged by said movable contacts, means automatically operative after each player on an opposing team completes his frame for automatically moving the respective switch mechanisms to separate said contacts for inactivating the circuits of the player units of said opposing team players who have just completed a frame, and for engaging other player unit control contacts for preparing the circuits of the player units of the opposing team players who are about to bowl, and mechanism for maintaining all player units of one set of player units operative until each of the players of one team has completed rolling one frame on a bowling alley and said team is ready to exchange alleys with the other team.

6. The combination with a bowling pin spotting machine, of a scoring and totalizing device, comprising a scoreboard, an electric circuit, a score registering mechanism in said electric circuit, means for operating said mechanism, pinfall detecting means on said machine, and instrumentalities automatically operative in response to the operation of said detecting means and the pinfall resulting from the rolling of each ball of a frame and the completion of each frame for automatically energizing said circuit means and actuating said registering mechanism to register the score resulting from said pinfall, said instrumentalities including strike relay means, and spare relay means for accumulating the proper count in the event of a strike or a spare in a frame.



7. The combination with a bowling pin spotting machine of a scoring and totalizing device, comprising a scoreboard, an electric circuit, a score registering mechanism in said electric circuit, means for operating said mechanism, pinfall detecting means on said machine, instrumentalities automatically operative in response to the operation of said detecting means and the pinfall resulting from the rolling of each ball of a frame and the completion of each frame for automatically energizing said circuit means and actuating said registering mechanism to register the score resulting from said pinfall, said instrumentalities including strike relay means, and spare relay means for accumulating the proper count in the event of a strike or a spare in a frame, means for preventing the operation of said mechanism when an illegal ball is rolled in any frame, and means for restoring said mechanism to normal operation pending delivery of the next ball.

8. The combination with a bowling pin spotting machine, of a bowling totalizer and scoring apparatus, devices connected to said machine for detecting the number of pins knocked down in a frame, comprising a panel, a plurality of individual electrically operated player units mounted on said panel, each of said units including a pinfall scoring totalizer and register, an electric circuit connecting each of said registers, an actuating circuit in said machine, interconnections associating said circuits, and selectively operated mechanisms in said interconnected circuits operated by said devices of said machine for energizing said circuits to actuate each of said registers successively after each frame is rolled to indicate the results obtained by each player during the progress of the game and the final score, said mechanism including means for energizing the actuating circuit of a selected unit to compute and register the pinfall results for each frame of a game rolled.

9. The combination with two bowling pin spotting machines of a bowling totalizing and registering mechanism operatively connected to said machines comprising mechanisms forming a part of each machine for detecting the number of pins knocked down in each frame rolled, a common circuit actuated by said detecting mechanisms in response to the operation of said detecting mechanisms for selectively transmitting impulses from each bowling pin spotting machine corresponding to pinfall results on each alley by different bowlers, a score totalizing and registering unit for each player, circuits associating each of said units with said common circuit, devices for successively connecting selected units in said common circuit, and means operated by said impulses from said machines for actuating each of said units alternately in response to the operation of said mechanisms to record the pinfall results for each frame rolled alternately on each of said alleys and the total game score of each bowler.

10. The combination with a bowling pin spotting machine of a bowling scoring and totalizing apparatus, mechanism forming a part of said machine for determining the pinfall result after each ball of a frame is rolled, a plurality of individual player scoring and totalizing devices, group totalizing devices for progressively totalizing the scores of several of said individual players bowling as teams, means connect-

ing said player scoring and totalizing devices to selectively operate said scoring and totalizing devices by said mechaniscm, means responsive to the determination by said mechanism of the number of pins knocked down in a frame for actuating the selected player device, and a selected group totalizing device effective after each of a plurality of players completes a frame to progressively totalize and indicate each player's individual and team frame by frame and final score, and means for resetting each of said devices.

11. In combination, a bowling pin spotting machine, pinfall detecting means on said machine, a bowling totalizing and scoring device, comprising a totalizing unit, a rotary sequence operating mechanism, means operative in response to the determination by said detecting means of the number of pins knocked down by a ball for rotating said mechanisms, actuating means for said unit including a circuit, means operated by said member after the last ball of each frame is rolled when neither a strike nor a spare is made for automatically operating said actuating means to totalize the pinfall for all balls of said frame if less than ten pins are knocked down, other means actuated by said member for preventing the operation of said unit actuating means if a spare or strike is made in a frame, said other means being constructed and arranged to delay the operation of said actuating means until the next or next two balls allowed for a spare or a strike, respectively, are rolled, said other means including a spare delay relay, and strike delay relay in said circuit, means operative in response to the knocking down of all pins by the first ball or the second ball of a frame for energizing a selected relay, and means for de-energizing said selected relay, and mechanism to operate said actuating means to complete the totalizing of the score for the frame in which said spare or strike was made.

12. In combination, an automatic bowling pin spotting machine, a bowling scoring and totalizing device comprising, a scoreboard, a plurality of player panels in said scoreboard, each of said panels including a selectively operable circuit, an electric frame indicator, an electric spare and strike indicator and computing units, and an electric scoring unit connected in each of said circuits; pinfall recording means on said machine, means operative in response to pinfall signals from said machine recorded by said pinfall recording means for automatically and selectively energizing said circuits to indicate the frame to frame score and tabulate the final score of each player, said device including mechanism operative if a spare or a strike is made by a player in the tenth frame of his game to record said strike or spare in said player's panel, and means operated by said mechanism for actuating said player's scoring device for properly actuating said player's scoring unit totalizing and registering in the said player's panel the score made by the bonus balls allowed for said strike or spare.

13. The combination with a bowling pin spotting machine, of a bowling score totalizing and registering device comprising an automatically operated bowler's score totalizing unit, pinfall detecting means on said machine, means for operating said unit after the last ball of each frame is rolled in response to the operation of said detecting means and the number of pins knocked down in each frame to totalize and register the frame pinfall, means for operating said unit after the last ball of each game is rolled to totalize and register the game score, mechanism for automatically delaying the operation of said unit in totalizing and registering a frame score if a spare or a strike is made in that frame, including means for operating said unit after the next ball or the next two balls are rolled in the case of a spare or a strike, respectively, for totalizing and registering the total score up to and including the frame in which said spare or strike was made, said mechanism including means for automatically delaying the operation of said unit if a spare or strike is made in the tenth frame of a game, and means for operating said unit after all the bonus balls allowed for a spare or a strike in said tenth frame have been rolled in order to totalize and register the complete game score.

14. The device defined in claim 11, a relay operable only if a mark is made in the tenth frame of a game, means for energizing said relay if a mark is made in said tenth frame, means for de-energizing said relay only when all bonus balls allowed for said tenth frame mark have been rolled, and means operative while said relay is energized for actuating said unit to totalize the pinfall resulting from said bonus ball or balls and score the final complete game score.

15. In combination, two bowling pin spotting machines mounted on two bowling alleys, a bowling totalizer and scoring device operatively connected to said machines for conjoint operation therewith, a player totalizing and scoring unit, operating mechanism for said units, an electric circuit for each of said machines, said circuit including means for detecting pinfall resulting from the rolling of each ball of a frame on said alleys, an electric circuit connecting said unit in each of said circuits of said machines and selectively operated mechanism operative in response to the alternate actuation of said detecting means of each of said machines in response to the determination by said detecting means of the pinfall resulting from each ball rolled for alternately energizing said circuits connecting said unit to said corresponding machine circuit for automatically actuating said operating mechanism thereof to compute and totalize the frame to frame, and final score of a game.

16. In combination, two bowling pin spotting machines, a scoring and totalizing device operatively connected to said machines for conjoint operation therewith, pinfall detecting means for each of said machines, a scoreboard, said scoreboard having two team panels, a plurality of individual player totalizing and scoring units and a team totalizing and scoring unit mounted on each of said panels, operating means for each of said player units, and said team units, an electric circuit connecting said detecting means of said machines to said individual player units and said team units, an electric circuit for each of said detecting means of said machines and said operating units, and mechanism operative in response to the operation of said detecting means in determining the number of pins knocked down in a frame for energizing said circuits for selectively operating said player units and said team units to progressively totalize and score the frame to frame and final game score of each player, and the team score of each team.

17. In combination with a pair of bowling pin spotting machines, a bowling scoring and totaliz-

ing device, each of said machines having detecting devices on tables adapted to be moved to and from the beds of bowling alleys to test for the number of pins knocked down in each frame rolled, a plurality of totalizing and scoring units for totalizing and registering the individual scores of a plurality of bowlers representing two opposing teams, a totalizing and scoring unit for each team, operating mechanisms for each of said player and team units, electric circuit means connecting said operating mechanisms of said units, and said detecting devices, mechanism operative in response to the operation of said detecting devices on said machines for selectively actuating the operating unit of opposing teams after each frame is rolled to totalize and score each individual bowler's frame by frame and final score, and means for selectively operating each team unit to totalize the team play frame by frame and final score.

18. The combination with a plurality of pin spotting machines, of a scoring and totalizing device operatively connected thereto for conjoint operation therewith comprising, a scoreboard, said scoreboard having two panels, a plurality of individual player totalizing and scoring units mounted on each of said panels, pinfall detecting elements for each of said machines, operating mechanism for each of said units, electric circuit means connecting each of said detecting elements and said mechanisms of said units for selective operation, and automatically operated mechanisms in said machine for energizing said circuit means in response to the operation of said detecting elements and the determination by said detecting elements of the number of pins knocked down in a frame for selectively energizing a selected operating mechanism of said player units to progressively totalize and score the frame to frame and final game score of each player.

19. A bowling scoring and totalizing apparatus for a bowling pin spotting machine, comprising two sets of scoring and totalizing units, each of said sets including a plurality of individual player units, and a team scoring unit, a common unit actuating electric circuit connecting said sets of units, means for concurrently activating one player unit of one team and one player unit of the opposing team, a movable selective circuit actuating mechanism associated with each of said sets of scoring and totaling units, each of said mechanisms including a plurality of contacts, a shaft supporting said contacts, a plurality of fixed player unit control contacts arranged to be engaged by said first-named contacts, means for turning said shafts through fixed increments of travel after each player of each team has bowled to advance said contacts successively into engagement with said fixed contacts and thereby successively prepare said actuating circuit for energizing said player units for totalizing and scoring the frame to frame and final game scores, automatically actuated mechanism for operating said last-named means and selectively operable means for turning said shafts through a plurality of increments of travel if the number of players on a team is less than a predetermined number in order to conform the operation of said machine with the actual number of players on each team.

20. The combination with a bowling pin spotting machine of a bowling scoring and totalizing device comprising, a score totalizing and registering unit, means for operating said unit after each frame of a normal ten frame game is bowled, said means including means on said machine for detecting the occurrence of a strike or a spare, mechanism operated by said detecting means for operating said unit and registering each score or the occurrence of a mark after each frame is completed, means operated by said detecting means for preventing the operation of said mechanism to delay the registering of the score after a mark is made in a frame until the last ball allowed for the type of mark is rolled, and means operative after the last ball required by the type of mark is rolled for actuating said mechanism for registering the complete score for all frames rolled including the score due because of said mark.

21. The combination with a bowling pin spotting machine of a bowling totalizing and scoring apparatus comprising a device for registering a spare, including a relay and an operating circuit therefor, a device for registering and totalizing a strike including a relay and an operating circuit therefor, a score totalizing unit connected in said circuits, means on said machine for detecting the pinfall result for each frame, automatic selectively operated mechanism operative in response to the operation of said means for actuating a selected relay circuit in accordance with the knocking down of all pins by the first or second ball of a frame, means associated with the relay circuit selected and operative in response to the rolling of all balls allowed for counting a spare or a strike for actuating said unit and totalizing the score of the frame in which said spare or strike was made, and mechanisms operative if a mark is made in the tenth frame for preventing the operation of said means until all bonus balls allowed for said mark have been rolled.

22. The combination with a bowling pin spotting machine of a bowling scoring and totalizing device comprising a score totalizing and indicating unit, pinfall detecting mechanism on said machine for determining the number of pins knocked down in a frame, means for automatically operating said unit in response to the operation of said mechanism in determining the number of pins knocked down after each frame of a normal ten frame game is bowled and the failure of a player to make a mark, said mechanism including means for registering the occurrence of a mark, automatically actuated means for registering each score after each frame is completed in normal pinfall, including means associated with said mark registering means for delaying the actuation of said unit and preventing the registering of the score after a mark is made until the last ball corresponding to the type of mark is rolled, means operative after the last ball required by the type of mark is rolled for activating said unit for registering the complete score for all frames rolled including the score due because of said mark, and automatically actuated mechanism operative by said means for detecting a mark if a mark is made in the tenth frame for delaying the operation of said means for operating said unit until all bonus balls allowed for said mark have been rolled.

23. The combination with two bowling pin spotting machines of a bowling totalizing and scoring device associated with said machines, mechanism forming a part of each machine for recording pinfall results obtained by bowlers rolling on each alley, a plurality of player totalizing and scoring units, means connecting each

of said units to said mechanism of each of said machines for selective operation with each machine, a selector mechanism for each machine, each of said selector mechanisms being operative in response to the operation of said pinfall recording mechanisms of said two pin spotting machines after each ball of a frame is rolled to actuate a selected player unit, whereby two units are operated in conjunction with said two bowling pin spotting machines to totalize the score of each player after each frame is completed by each player if less than ten pins are knocked down by the number of balls allowed per frame, and means controlled by said pinfall recording mechanism and actuated by said selector mechanisms for preventing the actuation of either or both of said selected player totalizing and scoring units if a spare or a strike is made by either or both of the bowlers rolling on said two alleys until all balls allowed for a spare or strike are rolled.

24. The combination with a bowling pin spotting machine of a bowling scoring and totalizing device comprising a plurality of totalizing and registering units for totalizing and registering progressively the individual scores of a plurality of players, a pinfall detecting device on said machine, each of said units including interconnected actuating mechanism actuated by said pinfall detecting device for normally selectively and progressively operating a different player unit one after another as each player finishes rolling a frame to totalize and register the pinfall results or score of each player in frame to frame bowling up to and including the frame last bowled, said mechanism including means for delaying the operation of a selected player unit in totalizing and scoring a frame if a spare or strike is made and means actuated by said detecting device in response to the pinfall resulting from the number of pins knocked down by the first or second ball of the next frame for again operating the selected player unit to complete the scoring of the frame in which the spare or strike was made when all balls allowed for the spare or strike have been rolled.

25. In combination, a bowling pin spotting machine, a bowling scoring and totalizing apparatus, said machine having a spotting and respotting table adapted to be moved within predetermined limits towards and from a bowling alley to test for pinfall in each frame, comprising pinfall detecting mechanism on said table, a plurality of totalizing and registering units for totalizing and registering the individual scores of a plurality of players representing two opposing teams, a team totalizing and registering unit for each team, operating mechanism carried by each of said units, means operatively connecting each of said team units with a plurality of said player units for progressively and automatically totalizing the team score after each player has completed a frame, means actuated by said pinfall detecting mechanism in response to the movement of said table towards said alley and the detection of the presence or absence of standing pins for actuating said operating mechanism for totalizing the final score of each team, and means for incapacitating said device whenever a too far off-spot pin prevents said table from moving to its prescribed limit of travel towards said alley.

26. The combination with two bowling pin spotting machines, of a bowling scoring and totalizing device, said machines having devices mounted on tables adapted to be moved to and



from the beds of bowling alleys to test for pinfall resulting from balls rolled in each frame, each of said machines having an electric control circuit, a plurality of totalizing and scoring units for totalizing and registering the individual scores of a plurality of bowlers representing two opposing teams, a totalizing and scoring unit for each team, selective operating mechanism for automatically actuating each of said player and team units, electric circuit means connecting said units and said machine control circuits, mechanism operative in response to the selective energization of said control circuits of said machines and said circuit means for selectively actuating the operating mechanism of selected individual bowler's scoring units on opposing teams after each frame is rolled to totalize and score each individual bowler's frame by frame and final score, said mechanism including a switch device, a plurality of selectively operable contacts on said device, and means for actuating said device after a bowler completes a frame to locate selected contacts for totalizing and scoring the frame rolled by the next bowler, and means for selectively operating each team unit to totalize the team play by frame by frame and final score.

27. The combination with a plurality of bowling pin spotting machines of a bowling scoring and totalizing device operatively connected therewith, said machines having detectors mounted on tables adapted to be moved to and from the beds of bowling alleys to test for the number of pins knocked down in frame to frame play, each of said machines having an electric control circuit, a plurality of totalizing and scoring units for totalizing and registering the individual scores of a plurality of bowlers representing two opposing teams, a totalizing and scoring unit for each team, selective operating mechanism for each of said player and team units, electric circuit means connecting said units and said machine control circuits, mechanism operative in response to the selective energization of said control circuits of said machines and said circuit means in response to the operation of said detectors in detecting the number of pins knocked down on an alley after a ball is rolled for selectively actuating the operating mechanism of selected individual bowler scoring units on opposing teams after each frame is rolled to totalize and score each individual bowler's frame by frame and final score, means for selectively actuating the operating mechanism of each team unit to totalize the team play frame by frame and final score, and means for incapacitating selected player units to conform the operation of said scoring and totalizing device to the number of bowlers on each of said teams.

28. The combination with a plurality of bowling pin spotting machines of a bowling totalizer and scoring device operatively connected to said machines for conjoint operation therewith, a player totalizing and scoring unit, operating means for said unit, means on each of said machines for detecting the pinfall results obtained by each ball of a frame rolled, means connecting said detecting means to said operating means, and means operated alternately by said detecting means of each of said machines in response to the determination of the number of pins knocked down by each ball of a frame rolled for automatically actuating said operating means of said unit after each frame of a game is rolled

against bowling pins spotted first on one alley and then on the other.

29. In combination, two bowling pin spotting machines, mounted on two bowling alleys, a bowling totalizer and scoring device comprising a player totalizing and scoring unit, pinfall detecting means on said machines connected to said unit, mechanism operated by said pinfall detecting means of either machine in response to the determination by said detecting means of the number of pins knocked down on either alley after the rolling of each ball of a frame for actuating said unit to totalize and register the score made by a player on said alley, a foul declaring device, means operatively connecting said device to said unit, means operative by said device in response to the declaration of a foul to prevent the operation of said unit to totalize and register an improper score, and means for restoring said mechanism and unit to continue the proper scoring of play subsequent to a foul.

30. In the device defined in claim 5, means for



incapacitating a selected player unit if a player defaults, means for reactivating said unit when said player joins the game, and means for operating said player's frame signal to indicate the frame in which said player first joins the game.

JACOB MILLMAN.
HOWARD P. STABLER.


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