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W. D. CORNELL ET AL

AUTOMATIC BOWLING SCORER

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AUTOMATIC BOWLING SCORER

William D. Cornell, Grand Haven, Morton F. Disney, Jr., Spring Lake, and Paul R. Hoffman, Grand Haven, Mich., assignors to Brunswick Corporation, a corporation of Delaware

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The present invention relates to apparatus useful in the scoring of bowling games. Further, this invention relates to automatic bowling scorers and more particularly to scoring systems capable of producing, coordinating, transmitting, and reading out information required for a bowling score sheet.

Bowling score devices of mechanical and electrical-mechanical construction had been devised to permit the automatic calculation and display of only a portion of the bowling score information which is normally manually placed upon a score sheet during the progress of a bowling game. Such devices have provided the score of a game at a particular point as opposed to the game for a frame filled, rather than providing information for a complete score sheet. Many such devices have not calculated and displayed the special marks associated with the bowling game such as strikes, spares, balls, and team mark totals.

For the purpose of official league bowling contests, it is particularly desirable that a complete and relatively permanent bowling score be produced as a record of the game and be in a form giving information regarding the progression of the game with score information entered as would normally be done manually during a game. Thus, it is desirable to have an automatic scoring system to compute and provide all the necessary scoring information that is required to print a complete bowling score sheet.

In previous automatic systems for keeping score, it has generally been necessary to provide a separate score computer for each bowling lane or pair of lanes with score totaling means in each such computer for each bowler participating in a game. From the standpoint of reducing duplication of equipment and of servicing such equipment, it is desirable to provide scorer apparatus which is capable of computing the bowling scores of a plurality of bowling games which are generally concurrently occurring on a plurality of bowling lanes.

In the prior art devices, it has been customary to provide a mechanical or an electrical-mechanical register for totaling pinfall to arrive at a total score for each individual bowler at any point in a bowling game and to provide additional registers which indicate the point to which each bowler had progressed in the game. Thus, in the prior devices, it was necessary to have a totaling register for each player and to provide a register or similar device for each bowler to keep track of his individual progress in the game; at least two register-type devices thereby being required for each and every bowler. Such duplication is also undesirable.

In accordance with one embodiment of the present invention, there is provided new and useful scoring apparatus which may be used in or as a system for scoring bowling games which eliminates much of such duplication while still being capable of servicing a plurality of bowlers on a plurality of lanes during a plurality of generally concurrent games and which is further capable of containing and/or giving readout of all information normally included in a bowling score sheet during ball-by-ball bowling, as will be described.

It is a general object of this invention to provide new and useful apparatus of the type described.

It is also the object of this invention to provide new apparatus which is useful in the automatic scoring of bowling games and to provide a new and useful complete system of such apparatus for reading out scores responsive to pinfall for each bowler using the system where the readout includes individual and team scores.

Another object of this invention is to provide new and useful means for computing scores during a bowling game and capable of serving a plurality of bowlers bowling in concurrent games on the same lane or on a plurality of lanes.

Yet another object is to provide for adaptation in an automatic pinsetter for detection of pinfall for use in scoring.

And another object is to provide for control of an automatic pinsetter responsive to signals in the scoring system to correlate pinsetter action with game requirements.

A more specific object is to provide for correlation of a bowler's identity with the pinfall from each of his balls bowled and with his previous history, e.g., previous score and stage of progression through the game, and to predetermine the mode of scoring of the next subsequent ball to be bowled by each bowler.

A further object is to provide a new and useful mechanized computer for a bowling scorer capable of ball-by-ball score computation.

Another object is to provide a mechanical computer with a plurality of separate mechanical bowler score memories for retaining bowler score histories of individual bowlers.

An additional object is to provide a new and useful bowling scorer that utilizes mechanical means storing the state of a player's game and mechanical means for changing the stored state responsive to changes in the state during the game, and wherein the stored state is useful in controlling computer readout, e.g., for printing purposes.

Another object is to provide means actuated by a bowler for informing the scorer system which bowler is bowling and on which lane he is bowling.

It is also an object to provide new and useful sequencing of the computation means to lanes and bowlers, including means for correlating pinfall data with bowler identity and for feeding the pin fall data to the proper bowler memory channel.

It is a further object of this invention to provide for electrical transmission of information from the bowling lane pit to be counted by a mechanical computer and added to memory scores by a mechanical computer.

Another object is to provide for electrical transmission of data from the mechanical computer to a mechanical printer for causing printing operation of the printer.

A still further object of this invention is to provide new and useful readout of computer data.

Yet another object is to provide scoring apparatus in accordance with the foregoing wherein player-by-player subtotals are printed as each bowler on a team finishes the game in addition to printing a team total upon completion of the game by the last team bowler.

An additional object is to provide new and useful bowling scoring apparatus including pin detection means, means for transmitting pin detection information to a pinfall adding means, means for transmitting added pinfall to a mechanical computer, mechanical memory means in the mechanical computer for separately remembering bowler's and team's past histories and means for introducing counted pinfall and other data into the memory means to change the past histories, mechanical means in the computer responsive to the past history of each bowler's memory means for controlling computation and/or disposition of the next subsequent pinfall count for the bowler, mechanical printer means for printing data as required by the mechanical computer and/or means for electrically transmitting data from the mechanical computer to the printer.
Still other objects include the adaptation of a scoring system with new and useful provision for handling fouls, errors, out-of-range pins, entry of handicaps and/or clearing of the computer and automatic pinsetter responsive to the end of a last team bowler’s game.

Other objects will be apparent to those in the art from the following descriptions and the drawings in which:

FIG. 1 is a view of a bowling installation including an embodiment of the scoring system of this invention in the installation;

FIG. 2 illustrates a score sheet for recording scores for two teams of players by the scoring system;

FIG. 19 is an enlarged view of a bowler's panel or console shown in the system of FIG. 1;

FIG. 4 is a diagrammatic illustration of flow of information and control between components of the installation including the scoring system;

FIG. 5 is a schematic and wiring diagram of a foul detection system useable in combination with the scoring system;

FIG. 6 is a plan view of a pin deck structure of a pinsetter showing a pin detection system useful in determining a foul in a game, for use by the scoring system;

FIG. 7 is a view of the deck structure of FIG. 6;

FIG. 8 is a vertical section through a portion of the deck of FIGS. 6 and 7 taken along the line 8–8 of FIG. 6 to better illustrate the detection switch mechanism;

FIG. 9 is a vertical section taken along line 9–9 of FIG. 8;

FIG. 10 is a side view of a portion of a pinsetter structure showing modifications for better adapting the structure for use with the scoring system;

FIG. 11 is a view of the structure shown in FIG. 10 from the top thereof;

FIG. 12 is a section through another portion of the pinsetter showing modifications thereof;

FIG. 13 is a section through still another portion of the pinsetter showing modifications thereof;

FIG. 14 is a perspective view of a computation system portion of the scoring system;

FIG. 15 is another perspective view of the computation, system portion of the scoring system;

FIG. 16 (Sheet 10) is an enlarged view of a portion of the side of the computation system structure seen in FIG. 14;

FIG. 17 is a view from the right end of FIG. 16 with parts removed;

FIG. 18 is a perspective view of a portion of a rack drive system included within the housing of FIG. 16 at the right end thereof;

FIG. 19 is another perspective view of the portion of the rack drive system shown in FIG. 18;

FIG. 20 is a perspective view of another portion of the rack drive system;

FIG. 21 is a section through the structure shown in FIG. 14 along lines 21–21 of FIG. 22;

FIG. 22 is a top view of and partial section through the structure of FIGS. 14 and 16 along lines 22–22 of FIG. 21 with parts removed for clarity of illustration of other parts;

FIG. 23 is an enlargement of a portion of FIG. 16 with parts removed and portions cut away for clearer illustration;

FIG. 24 is a view as in FIG. 16 with the housing side wall and other parts removed;

FIG. 25 is a top view of the mechanism of FIG. 24;

FIG. 26 is an end view showing the mechanism of FIG. 24;

FIGS. 27 and 28 are timing charts for operation of cam clusters within the structure of FIGS. 14–16;

FIG. 29 is a side view of a frame rack and frame control slide contained in the structure illustrated in FIGS. 14 and 15 for adjustment of the frame rack position;

FIG. 30 is a side view of another control slide in the structure of FIGS. 14 and 15 showing readout switches actuated thereby;

FIG. 31 is a side view of a composite slide configuration by which still another control slides within the structure of FIGS. 14 and 15 are illustrated;

FIG. 32 is a view of a control slide end showing a position of a pin;

FIG. 33 is a view of another control slide end;

FIG. 34 is an end view of the control slides showing their disposition relative to cams which drive the slides;

FIG. 35 is an enlargement of a portion of FIG. 16 showing the right end of a control slide as viewed in FIG. 31 and modification thereof for actuating readout switches;

FIG. 36 is an end view from the right end of FIG. 35 with parts removed for illustration of the control slides and readout switches;

FIG. 37 is a section along line 37–37 of FIG. 35 with parts removed as in FIG. 36;

FIG. 38 (Sheet 14) is an enlarged portion of FIG. 16 with parts removed for clearer illustration of the mechanism shown;

FIGS. 39 and 40 (Sheet 10) are top views of portions of FIG. 16 as seen approximately from line 40–40;

FIG. 41 (Sheet 10) is an illustration of an arrangement of mechanisms of the structure of FIG. 16;

FIG. 42 (Sheet 10) is an illustration of an arrangement of still other mechanisms in the structure of FIG. 16;

FIG. 43 (Sheet 11) is a section along line 43–43 of FIG. 16;

FIG. 44 (Sheet 11) is a view of a shaft and memory wheels in a team marks memory in the system of FIGS. 14 and 15;

FIG. 45 is a plan view of a pinfall totalizing device which is shown in FIGS. 14 and 15 secured to and forming a part of the computation system;

FIG. 46 is a side view of the device of FIG. 45;

FIG. 47 is a section along line 47–47 of FIG. 45;

FIG. 48 is a view of a portion of the right end of FIG. 43;

FIG. 49 is a view from the left end of FIG. 45 with parts removed for clearer illustration;

FIG. 50 is a side view of another portion of the structure of FIGS. 14 and 15 from the side of the housing seen in FIG. 14;

FIG. 51 is an end view and partial section from the left end of FIG. 50;

FIG. 52 is an end view from the right end of FIG. 50 with parts removed;

FIG. 53 is a side view of a mechanism within the structure of FIG. 50 for adjusting a rack (shown in phantom) under bowl-out condition;

FIG. 54 is a top view of the mechanism of FIG. 53;

FIG. 55 is a side view of still another portion of FIG. 14 which is also partially shown in FIG. 50;

FIG. 56 is a top view and partial section of the structure of FIG. 55;

FIG. 57 is a section end view along line 57–57 of FIG. 56;

FIG. 58 is a section through FIG. 55 along line 58–58 of FIG. 57;

FIG. 59 is a section through FIG. 55 along line 59–59 of FIG. 57;

FIG. 60 is a section through FIG. 55 along line 60–60 of FIG. 57;

FIG. 61 is a partial section along line 61–61 of FIG. 56 showing another portion of the mechanism within the structure of FIGS. 55 and 56;

FIG. 62 (Sheet 4) is a partial section along line 62–62 of FIG. 56 showing still another portion of the mechanism within the structure of FIGS. 55 and 56;

FIG. 63 (Sheet 4) is a partial section along line 63–63 of FIG. 56 showing yet another portion of the mechanism within the structure of FIGS. 55 and 56;

FIG. 64 is a section through a portion of the structure of FIGS. 55 and 56 along line 64–64 of FIG. 56;

FIG. 65 (Sheet 25) is an end view and partial section from the right end of FIG. 55;
While an illustrative embodiment of the invention is shown in the drawings and will be described in detail herein, the invention is susceptible of embodiment in many different forms and it should be understood that the present disclosure is to be considered as an exemplification of the principles of the invention and is not intended to limit the invention to the embodiment illustrated.

For convenience, the following is an outline of the descriptions given hereinbelow, with pages indicated on which each subject begins:

**SCORING SYSTEM FOR BOWLING GAMES**

(1) Scoring of a Bowling Game
(2) Automatic Scoring System, in general
(3) Automatic Pinsetter
(A) Ball Control
(B) Pin Control
(C) Pin Detection System
(D) Pin Detection Switches
(E) Pin Detection System
(F) Limiting Pinsetter to Computation System
(G) Pinsetter Switches
(H) Pinsetter Switches

(4) Provision for Linking Pinsetter to Computation System
(A) Ball Control
(B) Pin Control
(C) Pin Detection System
(D) Pin Detection Switches
(E) Pin Detection System
(F) Limiting Pinsetter to Computation System
(G) Pinsetter Switches
(H) Pinsetter Switches

(5) Computer Drive

(6) Programming of Scoring
(A) Formula Cams and Control Slides
(B) Transmission of Control Information From the Selected State Cam
(C) Memory Input and Output
(D) Summation of Pinfall Information
(E) Pinfall Calculator

(7) Calculation of Score Information from Pinfall Count
(A) Addition and Entry of Marks Information to Team Marks Memories
(B) Discontinuation of Addition During "Bowling"
(C) Calculator Reset
(D) Adjustment of Frame Information
(E) Change in and Adjustment of State
(F) Team Total Memory and Carry System

(8) Printing System

(9) Readout for Type Setting

(10) Orientation of Printer Relative to Score Sheet

(11) Additional Printer Controls

(12) Control of Printer on X-Axis during Bowl

(13) Projection System

(14) Miscellaneous Inputs for Printer and Computation Unit

(15) Error Correction and Team Handicap Entry

(16) Wiring Diagrams, General

(17) Exemplary Automatic Scoring Operation

(18) League Bowling
(A) Bowlers 1-4, Not End of Game
(B) Bowler 5, Not End of Game
(C) Bowler 6, Not End of Game
(D) Bowler 7, End of Game
(E) Bowler 8, End of Game
(F) Bowler 9, End of Game

(19) Open Bowling

(20) Automatic Scoring of Foul

(21) Error Correction
(V) Handicap Entry

**SCORING OF A BOWLING GAME**

The procedure for scoring in a bowling game is well known in the art, but a brief description may facilitate an understanding of automatic scoring, with which the present invention is concerned. Accordingly, and exemplarily, in a standard bowling game two balls may be bowled in each frame by each bowler. A bowler bowls a first ball at a standard pin configuration of ten pins on a bowling lane. The total number of pins knocked down, if less than ten, is then recorded in a box on a score sheet, e.g., box 201 of a score sheet 200 such as illustrated in FIG. 2 herein. The same bowler then bowls a second ball and the total number of pins knocked down, by both the first and second balls, is recorded in another box, e.g., box 202. If this total is less than ten, it is then recorded in the space below the boxes as in area 203. The other bowlers then follow successively. The first bowler then starts his second turn or frame and the same procedure is followed, adding the total pins knocked down by the two balls of the second frame to the first frame score. The cumulative score is then entered at 203. This method of scoring is followed except where a foul is committed.
If, in a given frame a bowler knocks down all the pins with the first ball, this is called a strike and a strike symbol "X" is placed in box 201. The second ball of the frame is not bowled. No score is recorded in the area 203 of the frame until the bowler has bowled two more balls, e.g., in the subsequent frame or frames. Ultimately, a score of ten plus the number of pins knocked down by the player on his next two balls will be added to the frame score of the previous frame and the sum entered in area 203 of the frame in which the strike occurred.

If the bowler knocks down all the pins during any frame but requires both balls to do so, a spare symbol "/" is placed in box 202 of that frame. The area 203 associated with the spare symbol will be left blank until the bowler delivers one more ball, e.g., in the next frame. Then, a score of ten plus the number of pins knocked down on the next ball will be added to the previous frame score and will be entered into the area 203 of the frame in which the spare occurred.

The bowling game is continued for ten frames, each bowler bowling two balls per frame for the first nine frames unless a "strike" is accomplished, in which case the second ball is omitted. If a "mark" such as a "strike" or "spare" occurs for a bowler during the tenth frame, commonly referred to as the roll-off, the bowler is entitled to bowl two extra balls to complete the scoring of his "strike" or one extra ball to complete the scoring of his "spare." The bowling of such extra balls is sometimes referred to as eleventh frame bowling. Thus in the tenth frame, an extra box 204 is provided for box score entry where three balls may be bowled.

The total score for each bowler at the end of the game is recorded in area 203 of the tenth frame. In team bowling, as each bowler finishes his game, his final score is added to that of any previous finishers and a sub-total entered in space 205 at the right end of each lane. When the last bowler finishes, the final team total is entered in the area 205 at the right end of this bowler's line.

Departures from the normal occur in bowling as in other games. Some such departures should be taken into account in scoring when they occur; these include "foults," end of handlebars, and correction of errors in scoring.

A foul occurs when a bowler's foot slides over a foul line at the approach end of the lane during delivery of his ball. A foul on the first ball is scored by placing an "F" in box 201 (regardless of the number of pins knocked down). If the foul is committed on the second ball an "F" is placed in box 202 and only the number of pins knocked down by the first ball and recorded in box 201 will be counted in computing the frame score.

Further, in view of the widespread use of automatic pinsetters and in view of the adaptation of many such pinsetters to detect and indicate pins left standing after each ball to the bowler, e.g., by lights in triangular pin setup configuration, it should be realized that at times a bowling pin will be moved when hit to a position out-of-range for detection by the pinsetter, in which case the pins left standing must be counted from the bowler's end of the lane prior to entry of the score.

Also, where the game of a particular bowler ends with a first ball in the roll off which is not a strike, the pinsetter, which is usually not suitably programmed for this occurrence, will not know that the bowler is finished and will await a second ball. Under such circumstances it is necessary to recycle the pinsetter via a recycle button provided at the bowler's end of the lane, in order to obtain a fresh setup for the next bowler.

Thus, there are many aspects of scorekeeping which should be provided for an automatic scorer.

AUTOMATIC SCORING SYSTEM, IN GENERAL

The embodiment of an automatic scorer in accordance herewith illustrated in the drawings will be described in more detail hereinafter with respect to its use with an automatic pinsetter installation, modifications of the automatic pinsetter installation, summation of pinfall information, including transmission of generated pinfall information from the automatic pinsetter and summation of pinfall information in a form useable for computation of bowling scores, the actual computation of bowling scores including transmission from the summer or adder as well as control of computation, storage of bowling scores and transmission of scores between the computer and storage system, readout of computed scores by transmission to a printer and/or projector as well as a useable printing and projection system, and operation of the system in performance of its scorekeeping functions.

A scorer of the type illustrated in the drawings and described in detail herein is useful in conjunction with a bowling installation including one or more lanes. In an embodiment more particularly described herein, the automatic scorer is useful in scoring a multiplicity of generally concurrent games played by a multiplicity of players on more than one bowling lane. Further, provision is made for scoring such bowling games on a team basis, i.e., where the players comprise one or more teams. In this embodiment, the scorer is adapted to transmit pinfall information, e.g., from pinfall detection means which may be installed at the pinsetter end of the alley such as in an automatic pinsetter in a bowling installation. The received pinfall information is converted to a pinfall total which is used by a computer in the computation of bowling scores. The identity of the bowler to whom a given score is attributable is coordinated with the pinfall information to assure correct awarding of the score to the player earning the score.

In a preferred system in accordance herewith, the scoring is on a ball-by-ball basis, whereby the scores are computed and attributed to the players after each ball is rolled and displayed in the same general manner as in manual scorekeeping procedures, with a box score for each ball and a frame total computed after each frame. The illustrated system also provides for indication of marks, such as strikes or spares; and for handling of foults, error correction, handicap entry and out-of-range pins.

The system is also adapted for use under both open bowling and league bowling conditions and means are provided for selecting the desired mode of operation. League bowling operation includes the computation of team totals, entry of team handicaps, scoring of team mark totals, identification of teams to the computation system, handling of teams alternating between different bowling lanes, absent bowler's score entry, bowling by a pace bowler or late bowler (who's score is not added to the team's score) and other features as may be apparent. The scoring system is automatically reset at the finish of each game for an individual player or at the end of each set of games for a team in preparation for the starting of a new game. In an advantageous form, provision is made for the production of a permanent record of the game as well as projection of the game progress on a viewing screen with revision of scores on a ball-by-ball basis.

Turning to FIGURE 1, there is illustrated a bowling installation adapted for use in accordance herewith. Two adjacent bowling lanes 210 and 211 are provided in the usual manner with a divider 212 therebetween. Each of bowling lanes 210 and 211 includes, in the installation, an automatic pinsetter, indicated generally at APL and APR at the pinsetter end; said pinsetter is identical in the usual manner and returned through a conventional ball return system having a ball outlet 213 for delivery of balls to a ball storage rack 214 from which the balls may be removed for bowling. A bowler's identification console 215 is provided for use by bowlers bowling on lanes 210 and 211 for manual information input for use by the scoring system.
A structure in the form of housing 218 encloses and supports components of the scoring system, such as components used for computation of scores, printing and projection of the scored game. The game may be printed by a printer on a score sheet and an image of the score sheet may be projected by projection means in housing 218 through port 219 and reflected by mirror 220 to viewing screen 221.

Console 215, better illustrated in FIGURE 3, is accessible to bowlers for manual operation of various switch means as information inputs for the computation and control system which is housed in structure 218 (FIGS. 1 and 4). In the illustrated embodiment, by bowlers on two bowling lanes and accordingly has two similar control surfaces or panels 215L and 215R, panel 215L being for use by bowlers when bowling on lane 210 and panel 215R being for use by bowlers when bowling on the right lane 211. Each of panels 215L and 215R includes a set of bowler identification switch buttons indicated as BL-1 through BL-12 for panel 215L and BR-1 through BR-12 for panel 215R (wiring diagram, FIG. 101). The identity buttons include lights BL-1 through BL-12 and BLR-1 through BLR-12 in a button portion, constituting a switch means, each light being energized upon the depression of the button and closure of the circuit controlled by the button containing the light. A latch mechanism, such as that provided by Rockwood et al. in apparatus No. 293,908, entitled “Console Device,” filed July 9, 1963, may be used to latch all other BL or BR buttons against depression upon depressing one such button; the latch mechanism also latches the depressed button in depressed position. In the illustrated form of the device herein, a solenoid HBL or HBR is energized for driving the latch mechanism. For example, solenoid HBL and HBR may each be a solenoid actuating a button latch mechanism, such as that illustrated by Rockwood et al., for latching the present buttons BR and BL in an open and closed position. An erroneous selection of a button may be erased by pushing button EL or ER to de-energize solenoid HBL or HBR, respectively.

The bowler identity buttons are provided for the purpose of feeding information into the system with respect to the identity of the bowler and the identity of the lane on which the bowler is bowling and also the identity of the bowler’s lane when the button is depressed. For example, when button BL-3 is depressed, the system knows that bowler number 3 was bowling on lane 3.

Toggles switch LO, i.e., LOL or LOR is provided for selecting league or open. Bowling under open bowling conditions, the six buttons listed under team A on one panel may be used by bowlers bowling on one lane, e.g., lane 211. The six buttons listed under team B may be used by bowlers on the other lane, i.e., lane 211. Each player is assigned a button from the set of buttons and the player uses the same buttons throughout the entire game to be scored. Thus, in the example, bowlers on lane 210 would select one of buttons BL-1 through BL-6 for use while bowlers on the right lane 211 would each select one of buttons BR-7 through BR-12 for use. The player merely depresses his button prior to starting each frame to be bowled by him to inform the scoring system as to his identity.

When switch LOL or LOR is moved to select league bowling to the position illustrated in FIGURE 3, each member of a team uses a separate button under the heading of his team, i.e., team A or team B; however, the team members select or are assigned only from the first five buttons, i.e., omitting buttons BL-6 and BR-6 and BL-12 and BR-12. The last player to bowl on each team is assigned the fifth button, i.e., BL-5 and BR-5 or BL-11 and BR-11. In the illustrated system, the sixth button is for use by a pace bowler or another onetime player. Once the team player has been assigned a button, he may use the bowl on either alley at any time, so far as the illustrated system is concerned, by simply depressing his button prior to starting each frame on the appropriate lane. For example, if a member of team A is designated to use button No. 3, when bowling on lane 210 he depresses button BL-3 prior to starting each frame and on lane 211 he depresses button BR-3 prior to each frame. Accordingly, a member of the other team, e.g., the member assigned button No. 4 of team B, depresses button BR-4 prior to starting each frame on the left lane prior to starting each frame on that lane and depresses button BR-10 prior to starting each frame on the right lane.

Letter designations have been used for reference to various elements hereinabove and many more such letter designations will be used hereinafter. Where the letter L appears at the end of a letter designation of an element, that element is used in the scoring of games or scoring of balls rolled on the left lane or lane 210. Wherever the letter R appears at the end of a letter designation of an element, that element is used in the scoring of games or balls rolled on the right lane 211. It should also be understood that each element including the letter L has a corresponding element of the same structure and function designated by the same letters except substituting the letter R for L, and although the corresponding element may not be illustrated in the drawings for purposes of brevity and clearer understanding, it is to be understood that the corresponding element does exist in the illustrative embodiment and is included in the system in the very same manner as its counterpart element. With reference to the above, as an illustration of the designation system herein, we have seen that two automatic pinsetters APL and APR are involved, two sets of bowler identity buttons designated BL buttons and BR buttons, two sets of bowler identity lights designated BLL lights and BLR lights and two league bowling-open bowling switches designated L Lor LOR, respectively.

In the scoring system illustrated in the drawings, there is employed one mechanical computation unit including a mechanical computer for servicing a plurality of bowlers bowling on a plurality of bowling lanes. The computation unit, housed in structure 218, is fed pinfall information, as illustrated in the information flow diagram of FIGURE 4, in the form of pinfall information from either of pinsetters APL or APR. The computation or control system is also fed information from the bowler panels 215-L and 215-R with respect to bowler identity, team identity, particular identity of the last man on the team, i.e., a pace bowler depending upon the button used, and the bowler panels serve to alert the computation and control system. Further, foul information is provided by the bowler panel as will more particularly be discussed hereinbelow. The computation and control system serves as an automatic pinsetter to which it is linked as indicated by the control lines of FIGURE 4 and the computation and control system further serves to control the printing means for printing of scores as directed by the computation means.

AUTOMATIC PINSETTER

The embodiment of the scorer system described herein is especially useful in association with known pinsetter installations, such as the automatic pinsetter described by Huck et al. in U.S. 2,949,300, issued Aug. 16, 1960, and entitled “Automatic Pinsetters.” Such a pinsetter operates generally in association with a bowling lane having a lane bed, a pit area at one end and side walls or kickbacks at opposite sides of the bed. The automatic pinsetter is installed at the pit end of the lane.

In operation, the machine functions to sweep the lane at the pit end and to gather, triangularize and set a component of 10 pins for the first ball of each frame or when otherwise actuated to do so, and to return the bowler’s ball via the ball return track system. Further, between a first and second ball, the machine raises the standing pins while sweeping dead wood and resports only the lifted pins. Where a pin is left standing but is too-far-off spot for lifting (referred to hereafter as "out of
range"), provision is made to stop the automatic pinsetting operation until restarted by an attendant. A further general description of an automatic pinsetter such as described by Huck et al., the automatic pinsetting machine, may include several components. A pit conveyor located in the pit may be used to direct bowling pins and a bowling ball toward the rear of the lane wherein ball elevating mechanism elevates the ball from the rear of the pit to a track which delivers the ball to a ball return track for return to the bowler's end of the lane.

Bowling pins are elevated from the rear of the pit by a pin elevating mechanism which discharges the pins in succession to a cross conveyor which carries the pins forwardly and upwardly to a discharge point where they move in succession into pockets in a turret.

A pinsetting and resetting deck is located beneath the turret. A rake is mounted at the front of the machine and is cycled to function as a guard when in lowered position and to sweep pins into the pit at the desired time during the cycling of the machine.

An upwardly movable pit cushion is disposed above the pit conveyor to receive the impact of a rolled ball and pins to prevent the passage of a ball to the rear thereof when in its lower position and also to initiate operation of the machine upon movement thereof caused by the impact of a ball. A control center is provided to control the operation of the machine.

Reference may be had when desired to the above-identified Huck et al. patent for structure and operation of the pinsetter, which except for the modification therefor exemplified herein, in itself forms no part of this invention. For simplicity in describing the modifications, all reference numerals prefixed with the letter "H" correspond to the element of Huck et al. having the same numerical reference designation.

FOUL DETECTION SYSTEM

The foul detection system 224 generally shown in the block diagram of FIGURE 4 is utilized to notify the scorekeeper when a foul may have been committed. The foul detection system illustrated utilizes a photoelectric cell and light beam arrangement which would be tripped upon commission of a foul. However, during bowling games such foul detection systems may become inadvertently triggered by an article falling from a bowler's pocket or the like, without the commission of a true foul. For this reason, foul detection system 224 indicates the foul to the scorekeeper so that the scorekeeper may confirm the foul by pushing a switch FC or energize a switch IF for confirming or denying the foul by way of buttons FC and FD. The more specific action of the relay TFLK on the foul system will be described hereinafter.

PIN DETECTION SWITCHES

Referring to FIGS. 6 and 7 of the drawings, there is illustrated an automatic pinsetter deck of the general type disclosed in U.S. Patent No. 2,949,300 to Huck et al., and reference may be had thereto for additional discussion of the pinsetter construction and operation. The deck structure is substantially horizontally disposed over the end of a bowling lane adjacent its pit for receiving pins from a suitable distributing mechanism, setting the pins on the bowling lane in preparation for bowling and, after a ball has been rolled, picking up the pins which remain standing to permit resumption of play and then resetting the last mentioned standing pins for continued bowling. After each frame the pinsetter resets pins on the bowling lane for play of the following frame.

Generally, the deck structure is vertically moveable toward and away from the playing area over which it is installed in a suitable manner. The pinsetter deck structure includes an upper deck 250 having a suitable generally triangular frame 251 preferably cast integrally with the deck, and a lower deck 252 having a suitably generally trapezium shaped lower frame 254 or plate 254. The upper deck 250 is supported on a lower deck 252 for movement longitudinally of the bowling alley in a manner described by Torresen et al. in application Ser. No. 133,476 (U.S. Patent No. 3,094,325), filed Aug. 23, 1961, and entitled "Pin Detecting and Indicating Apparatus." Upper deck planks 255 have suitable openings 255 for receiving pins from a suitable distributing mechanism above the deck. The deck is movable to a pinsetting position for depositing the pins on a bowling alley and is also movable to a pin detecting position for detecting of pins standing after the bowling of a ball.

For illustration of the pinsetting structure of Torresen et al., cited above, has been modified as described herein. Accordingly, there is provided a plurality of switch assemblies 256 mounted on upper deck plate 251, one of which is associated with each opening 255 in the third plate 251. Each switch assembly 256 is operated in response to a switch actuator detecting the presence of a standing pin on the bowling alley sur-
face. Each switch assembly includes two switches, one of which functions to operate a suitable indicator visible to the players as described more fully in the application of Conklin and Torresen for a "Pin Detecting and Indicating Apparatus," Ser. No. 126,974 (U.S. Patent No. 3,118,671), filed July 26, 1961. The other switch of each assembly is used in accordance herewith as a pin detection switch for generating pinfall information from which bowling scores may be computed.

Referring to FIGS. 8 and 9, it will be seen that the switch actuators are of generally the same form as described by Torresen et al. in the above cited patent, applicable to multiple switch assemblies. Here are used such other switches which are designated herein PDS-1 through PDS-10 (wiring diagram FIGS. 95 and 96), which operate, as will be more fully understood hereinbelow, upon opening of each switch to prevent energization of a solenoid DSS (FIG. 95, for the purpose of providing and counting pinfall information.

The operation of the switch assemblies, being generally like that of Torresen et al. in Ser. No. 133,476, has been modified so that the switches may be positively reset by cables entering the switch assemblies in a direction opposite that of the Torresen et al. assemblies. This modification is for positive reset of the switches by a solenoid rather than by spring return after deck movement as described by Torresen. Accordingly, referring especially to FIGS. 6 through 9, the four cables 261 which extend diagonally across the top of upper deck 250, each cable operating one or more of switch assemblies 256, are gathered by pulleys 262, each journalled on base 264 for rotation about a vertical axis, the cables being directed for pulling from a direction directly opposing that described by Torresen et al. Each cable has been extended and connected to the front face of a solenoid DSS (wiring diagram, FIG. 97) mounted on upper deck 252. The other end of each cable is connected to the switch assembly and more specifically is secured to each of operating arms 265 by a collar 266 in the alignment of switch assemblies through which the cables extend and thence through commensurate spring 268 and anchored to disc 270 at the end of the spring 268 in the last switch assembly in line, spring 268 serving to keep the cable 261 taut. Pulling of cable 261 by solenoid DSS moves operating arm 265 so that lever cam portion 271 is moved from abutment 272 with resetting of the switches resulting thereafter in the same manner as described by Torresen et al. in the above identified application, Ser. No. 133,476.

The pin detection switches PDS-1 through PDS-10 are mechanically linked to an arm 1 and form a part of the switches 274 which are described by Torresen et al. Accordingly, when the switch assemblies are reset, so are those additional switches for use in accordance herewith to give pinfall information for computation of bowling scores. As has been seen, in general, the cables used by Torresen et al. for detections have been reversed for positive reset from the other side of the switch brackets, rather than for spring release reset as described by Torresen. In order to provide the positive reset, the brackets housing the take-up springs were moved to the bracket at the other side by each cable 261 and were reversed on the bracket to accommodate the cable and provide a spring return of the cable in the opposite direction upon release of the cable by solenoid DSS. The cable, having its other end secured to the armature solenoid DSS, is pulled by the solenoid to reset all deck switches upon energization of the solenoid.

 Provision is made to actuate solenoid DSS after 270°, e.g., at about 280° of each cycle wherein pins are set. Accordingly, an actuator 277 is mounted on upper deck 250 in position to trip a normally open microswitch DS (wiring diagram, FIG. 97) secured to lower deck 252 as the upper deck moves rearward with respect to the lower deck to clear bowling pin bellies during the setting operation. The pin detection switches are also reset by solenoid DSS between cycles and the reverse in which pin detection is accomplished during each first ball and each second ball cycle of the pinsetter except when it has been determined that a foul second ball has been delivered as will be seen.

In case of no foul, the solenoid DSS will be actuated during the period preceding standing pin detection, e.g., at 35°-45° of cycle, by a switch 3A45 (wiring diagram, FIG. 97) actuated by the rake arm sleeve H126a (FIG. 13). In each cycle where a foul has been committed a normally closed set of contacts 2FC-11-1 or 2FCR-1 (wiring diagram, FIG. 97) is in circuit with switch 3A45 and solenoid DSS for preventing resetting of switches PDS. Pinsetter cycling is delayed by foul detection actuation until it has been determined whether a foul has been actually committed and the appropriate FD or FCR switch depressed. If FCR is depressed 2FC-11-1 or 2FCR-1 will open to prevent 3A45 from energizing solenoid DS at 45° during the pinsetting cycle.

The detector switches create the pinfall data signal to be transmitted to the summer for conversion to a form usable by the computer system.

**PROVISION FOR PIN DETECTION AFTER 2ND BALL**

The automatic pinsetter is modified to provide two full 360° cycles so that detection is accomplished after each ball, eliminating the over-travel to 90° after the first ball as described by Hucks et al. Accordingly, the wire link identified by Hucks et al. by reference number 276 which extends from arm H275 to latch H267 is removed and a solid link 280 is attached as shown in FIGS. 10 and 11 between link H267 and an arm 281 which is secured to shaft H230. The connection of link 260 to arm 281 and to link H267 are pivotal connections. This permits detection of pins after each ball bowled by providing the detection stroke eliminated by the Hucks et al. overtravel on the second ball.

 Provision is also made to cause an automatic strike signal on the second ball bowled regardless of pinfall, resulting in new pins being set after each second ball detecting cycle. The automatic strike signal is always given at 90° of the second ball cycle after pins are detected for use in the computer.

It is unnecessary to pick up the pins during the detecting cycle and the pins can be swept into the pit after the second ball. Accordingly, as shown in FIG. 10, a link 282 is connected adjacent the frame from a rod or link 284. As viewed in FIG. 10, as shaft H503 rotates in a clockwise direction, link 282 is pivoted clockwise pulling link 285 through the pivotal pin connection 286 therewith, downward and pivoting link 287 clockwise. Link 285 is pivotally connected to link 287 as indicated at 288. Link 287 pivots about pin 290 secured to suitable framework. A roller chain link 291 is pivotally connected at 292 to link 287 and at 294 to link 295 lifting link 295 as link 287 pivots clockwise, link 295 being pivoted in a counterclockwise direction against the action by spring 296 to release the "new set" lever H470 (FIG. 12), and cause the rake to sweep the alley and new pins to be set. Lifting of lever 295 by link 291 causes releasing of the strike cam follower H472 at 270° of
first ball standing pin cycle to ride on cam H449 and give a strike signal at 90° during detecting in the second ball cycle. Lever H470, due to the tracing of cam H409 by follower H472, will move inward on the cam low at 90° of machine cycle so that pins on the sley are raked off, new pins are set and the mechanism returns for a first ball frame. In FIG. 10, the lower spring and tube, indicated by Huck reference numeral 406, on deck holding hook 297 was also removed and replaced with a tension spring 230 since operation of the holding hook is not required for over-travel. A helper spring 300 was added between pins H414 and H418 at the upper spring tube on the deck holding hook to counterbalance spring 298.

PROVISIONS FOR LINKING PINSETTER TO COMPUTATION SYSTEM

Additional modifications have been made to provide cooperation between pinsetter and computation system.

RAKE SWITCHES

A pair of switches (FIG. 13) are mounted for control by cams on the rake lift arm sleeve H126a of the pinsetter, or switch being the arm 3AP45 to energizing PDS switch reset solenoid DSS, the other switch, AP45 (wiring diagram, FIG. 97) being for enabling control of a solenoid APS (wiring diagram, FIG. 97) by the computation unit. The rake arm structure is described by the Huck et al. patent and reference thereto may be made if desired. Sleeve H126a, rotatably mounted on rake lift frame shaft H101, moves during 90° of the pinsetter cycle as described by Huck et al. Sleeve H126a is not moved between 90° and 270° of the pinsetter cycle. The pair of switches 3AP45 and AP45 having switch arms 304 and 305, respectively, for actuation by actuators 306 and 307, respectively, are mounted on suitable framework (not shown) for actuation by movement of sleeve H126a. Of the two switches, microswitch 3AP45 is normally open and is closed momentarily by triggering at about 45° of the pinsetter cycle when actuator 305 is pivoted into position tripping arm 304. The other switch, AP45, is normally closed and is held open during all except the 90° of travel between 315° and 45° of pinsetter cycle. Thus, during this portion of the pinsetter cycle actuator arm 307 is closed on cam actuator 307.

Sequence of operation for actuation of switches 3AP45 and AP45, as the rake is lowered with sleeve H126a pivoting clockwise at the beginning of the pinsetter cycle, i.e., between 0° and 90° of the cycle, at about 45°, switch 3AP45 is momentarily closed. As to switch AP45, at about 45° of cycle, switch arm 306 is tripped by cam 307 and switch AP45 is opened and held open riding to 90° on cam 307, whereupon sleeve H126a ceases rotation. When sleeve H126a reverses and returns during 270° to 360° of the cycle, arm 306 leaves cam 207 at about 315° of the cycle and switch AP45 closes.

Opening of switch AP45 de-energizes the solenoid AFS (FIG. 12). Contacts 2FL2–2 or 2FCRK–2 (wiring diagram, FIG. 97) are always open during the 270° to 360° portion of pinsetter cycle. Therefore, solenoid AFS is actuated during the period of 0° to 45° of each cycle, whenever the computer permits it to be energized by closing contacts 2FCRK–2 or 2FCRK–2 as will be seen hereinafter. The other switch 3AP45, gives a momentary signal at 45° to activate deck solenoid DSS, to reset pin detection switches PDS–1 through PDS–10 during every cycle, except when the computer prohibits on a second ball signal by opening contact 2FCRK–2 or 2FCRK–2. Prohibition of actuation of solenoid DSS by 3AP45 retains the first ball pin count in the deck switches for use in computing the frame score in the event of a second ball foul.

SIGNAL BY THE PINSETTER THAT PINFALL INFORMATION IS AVAILABLE

As a further modification to the pinsetter, when the pinfall is ready for transmission, a "pinfall ready" signal is sent to the computer. This "pinfall ready" signal may be prevented where necessary, e.g., where an out-of-range pin condition occurs, by additional modification as illustrated herein. Accordingly, normally open microswitch AP90 is mounted on suitable framework adjacent cam H336 which is rotated on shaft H176 one revolution per cycle. As shown (FIGS. 10 and 11), switch AP90 is mounted at the same angular disposition as another switch AP270. An actuator 310 is mounted on a face of cam H336 at proper angular disposition to trip switch AP90 (wiring diagram, FIGS. 95 and 96) at about 90° of each cycle.

The 90° switch AP90, upon being tripped by actuator 310 at 90° sends a signal to the computer that pinfall information is available. Another microswitch ORP (FIG. 10 and wiring diagram, FIGS. 95 and 96) actuated by an out-of-range pin condition, is used to prevent the "pinfall ready" signal from going to the computer at the 90° rotation of shaft H176 where such out-of-range pin condition exists.

The "pinfall ready" signal will, therefore, occur at about 90° of each cycle except where an out-of-range pin condition exists and functions to energize a solenoid CS (wiring diagram, FIG. 104) in the computer through a series of relay contacts to start the computation operation.

In the event that any bowler's game should end with the first ball of a two-ball frame, e.g., less than ten pins with the bonus ball after a spare in the tenth frame, the pinsetter will, on receipt of an end-of-game signal from the computer, automatically go through the second ball cycle but will not send the "pinfall ready" signal to start the computer. Suitable circuitry is provided for the blocking of the computer start signal under such end-of-game conditions.

STOPPING PINSETTER TO AVOID USE OF INFORMATION BY COMPUTATION SYSTEM

The pinsetter is also modified to be stopped whenever it reaches 270° of its cycle before the computer has finished computing the result of the ball just rolled; and, in addition, the pinsetter is modified to be restarted by a signal from the computer when the computer has finished the computation. Accordingly, solenoid 270S (FIGS. 10 and 11 and wiring diagram, FIG. 97) is located, having its armature linked to link HS81 to stop the pinsetter at 270° of cycle if energized. Normally closed microswitch AP270 (wiring diagram, FIGS. 95 and 96) is opened by an actuator 14 just before 270° of the cycle to deenergize relay 270SK, causing relay contacts 270SK–1 to close, energizing solenoid 270S and stopping pinsetter unless, or until, relay energy is provided via a parallel circuit from the computer (FIGS. 101 and 102). Solenoid 270S operates when, energized, to shift link HS81 to the right as viewed in FIG. 10 to give a spurious out-of-range pin signal and stop the pinsetter. De-energization of solenoid 270S releases link HS81 to restart the pinsetter in the same manner as manual movement of link HS81 restarts the pinsetter after occurrence of an out-of-range pin condition in the Huck et al. pinsetter.

MODIFICATION FOR HANDLING FOULS

The pinsetter used herein as an example was also modified to permit use of the foul detection system described above. The present control system, as will be seen, interrupts the power supply to the pinsetter motor via opening of contact AMLK–1 or APRMK–1 (wiring diagram, FIG. 98) at 0° of pinsetter cycle upon closure of the TFL or TFR contacts energizing relay TFLK or TFRK (wiring diagram, FIG. A, 101) in the computer. TFLK–2 or TFRK–2 (wiring diagram, FIG. 101) then closes energizing relay AMLK or APRMK until button...
FC or FD is depressed. In the event that a foul is determined on the first ball, closure of switch FCL or FCRK will cause energization of relays FCLK and 2FCLK or FCRK and 2FCRK (wiring diagram, Figs. 95-71 and 102) to rotate arm 327 of the bell crank 330, which is mounted on the shaft H455 and has another arm 326 which engages with arm 327 of a bell crank 330, rotatedly mounted on the shaft H455 and outwardly on the bell crank arms 322 and 326. Another arm 328 of bell crank 330 is positioned to engage an outwardly extending projection on a lever 330 outwardly mounted on the shaft H455 inwardly on the two bell cranks previously referred to. A spring 331 extends between the projections of lever 330 and the pin H449 extending from the plate H532 to urge the interengaging parts in a counterclockwise direction against a pin H570 extending outwardly from the bell crank 330.

The projection of lever 330 extends outwardly a sufficient distance to line up with arm H573 to rotate the arm around a shaft H574 and also to engage an abutment 332 formed on the extension 295 of the "new set" latch H459. The position on the "new set" latch extension 295 is positioned for selective engagement with the two-ball frame latch 337.

In operation, the solenoid AFSL or AFSR is triggered by depressing switch FCL or FCRK after a foul detector actuator energizes relay TFLK or TFRK. Depressing FCL or FCRK energizes relay FCLK (wiring diagram, Fig. 102) or FCRK closing contacts 2FCLK-2 or 2FCRK-2 and energizing AFSL or AFSR. A holding circuit holds relay TFLR or TFRK energized until the foul is determined and button FDL or FDR or FCL or FCR depressed. As the solenoid AFSL or AFSR is energized and the machine started by de-energizing of relay APMLK or APMRK, the initial portion of the partial cam ring 338 on the cam 340 engages the nose on the arm 327 which has been previously positioned in the path of the partial ring by energization of solenoid AFS which moves arms 322 and 326 and arm 327 in a counterclockwise direction. The engagement of the cam ring 338 with arm 327 pivots the arms a further amount in a counterclockwise direction to carry the projection of lever 330 into engagement with the abutment 332 and pivot the latch 295 in a counterclockwise direction on spring 296, allowing the sufficient distance to release "new set" lever H470 and causing new pins to be set as more particularly described by Huck et al. Pin 335 on latch 295 rotates two-ball frame latch 357 counterclockwise disengaging two-ball frame lever H502 which sets up the machine to await bowling of a second ball.

If a foul occurs upon the rolling of a second ball in a frame, there will be no operation of the foul mechanism because the machine is set up for the second ball. The two-ball frame member H502 has been rotated, as described by Huck et al., clockwise with its latch ing lug in position to intercept the counterclockwise rotation of arm 326 if the foul bell crank should be energized. With the arm 326 blocked, the nose of arm 327 cannot move into position to engage the partial cam ring 338 so that no change is made in the normal sequence of the machine and in this instance the spring 324 takes up the motion of the solenoid.

PROVISION FOR OUT-OF-RANGE PIN CONDITION

The out-of-range pin reset lever or rod H545 (Fig. 10), which is operable by manually pulling rod H545 from the rear of the machine as described by Huck et al., has been modified to cause sweeping of the deck on the second ball after an out-of-range pin when rod H545 is pulled to restart the machine. Without the modification, sweeping would be prevented on the second ball by operation of lever H510. During operation of the automatic pinsetter of Fig. 10, the shift 45° turning clockwise as viewed in Fig. 10 after a first ball and turning counterclockwise after a second ball. After the first ball, the shaft H503 moves about 45° clockwise except when a strike occurs on the first ball, in which case shaft H503 does not turn. After the second ball, the shaft H503 returns to its original position; if a strike is obtained on a first ball, of course, shaft H503 is still in its original position.

In accordance with the illustrated modifications, after the second ball, rod 284, which is attached through bracket 344 to shaft H503, urges reset lever H546 upward raising hook 345 from pin 346; after the first ball, notch 345 is not raised from pin 346. When rod H545 is pulled to restart the machine after an out-of-range pin on the first ball, the machine is reset but the sweep is prevented because of the engagement of notch 345 with pin 346 which pivots lever H510 to the left as viewed, thereby eliminating the sweep. After the second ball, the notch 345 is disengaged from pin 346 and pulling of rod H545 causes resetting of the pinsetter, but pivoting of lever H510 is prevented, thereby causing actuation of the rake to sweep.

Upon occurrence of an out-of-range pin condition, link H540 shifts to the right as viewed in Fig. 10. An actuator 347 has been provided on link H540 to trigger switch ORP by such movement, opening switch ORP which in turn interrupts the "pinfall ready" signal. Switch ORP mounted on the pinsetter frame is closed each time link H540 shifts to the right as viewed in Fig. 10, which occurs at 90° of each pinsetter cycle as described by Huck et al. The pinfall to be awarded to the bowler is entered manually by a dial PMD (Fig. 112) by procedures described below relating to error correction.

END-OF-GAME PINSETTER CYCLE

An extra pinsetter cycle is provided to cycle the pinsetter where a bowler's game ends in the middle of a frame, i.e., after a first ball in a "no strike" situation. The pinsetter receives an "end-of-game" signal from the computer and, in response thereto, the pinsetter is triggered by actuating the pinsetter trigger relay. Such a trigger relay is normally provided for the pinsetter for triggering the pinsetter from the bowler's end of the bowling lane in a game ending in a first ball "no strike" situation.

In order to provide for such pinsetter cycling, switches 2AP45, AP120, 2AP270 and 2APC2 (wiring diagram, Figs. 95 and 96) and relays APCK and 2APCK are included. Switch AP2B is mounted (not shown) for actuation by a trip member on shaft H503 (Figs. 10 and 11) and is closed as shaft H503 moves to its 45° clockwise position after each "no strike" first ball and switch AP2B remains closed until shaft H503 moves counterclockwise away from this 45° position.

Switch 2AP270 is mounted with switch AP270 and actuated to close at about 270° of pinsetter cycle in the same manner. If, after relay APCK has been energized by a signal from a rotary switch contact P10-1, to be described below, switch AP2B is closed when switch 2AP270 closes, solenoid 2705 is de-energized and the pinsetter cycles from 270° to 0° instead of stopping at 270°. The pinsetter trigger relay is also triggered and the "pinfall ready" signal from switch AP90 is blocked from going to the computer.

Switch 2AP45 is mounted with AP45 and is opened momentarily at 45° as the pinsetter continues into the next cycle, having been triggered by closure of switch 2AP270 in the preceding cycle. When switch 2AP45 opens, the APCK relay is de-energized and the 2APCK relay circuit causes the extra pinsetter cycle, described above, to be reenabled for de-energization. This circuit
is de-energized at about 120° of the next pinsetter cycle by momentarily opening of a switch AP120 and the pinsetter cycle continues thereafter without control from the extra cycle circuitry. Switch AP120 is a normally closed switch mounted (not shown) with switch AP90 and triggered to momentarily open during the next cycle by current (not shown) on cam H336 (FIGS. 10 and 11) at 120° of pinsetter cycle.

**COMPUTATION AND CONTROL SYSTEM**

In general

After its generation at the pin deck structure, the pinfall information is translated to bowling scores. In the embodiment used to exemplify the present scoring system in a summation section, the electrical pinfall signals from the deck are converted to mechanical signals and added to provide a mechanical pinfall total signal which is transmitted to a computer section. In the computer section, the pinfall total is converted to bowling score information which is in turn mechanically entered into a score storage or memory section for storage until required by the computer section in further computations. The computation and control system also generates output signals which may be used to control printing means, e.g. a printed projector, as readout from the system.

In general operation, upon receipt of pin count of the first ball of the frame bowled by a particular bowler, the computation and control system counts or totalsizes the pins knocked down, selects and interprets the proper bowler memory, and causes the printer to become properly positioned for printing the score in the appropriate box of the score sheet. The printer is then actuated to print the score obtained from the first ball. The printer returns a “done printing” signal to the computation and control system which will then, according to the bowling situation, either compute a frame score in a previous frame, e.g. if the bowler was working on either a spare or two strikes, and send another “print” signal to the printer for printing the frame score, or will adjust the bowler’s “history” or “state.” The computation and control system is then reset or released for receiving subsequent pinfall information from the same or another bowling lane. The pinfall count for the first ball is erased from the input computation system after computation since this pinfall count will be regenerated by the PDS switches during the second ball detection stroke.

When the bowler bowls his second ball of the frame, assuming a second ball is bowled, the pinfall information is received by the computation and control system, transformed to bowling box score information and the printer is then actuated to print the total box score in box 202. The total score thus far obtained by the bowler is then computed in each frame from new information and from information retrieved from the score storage section. The printer is positioned and actuated to print the total score in area 203 of the score sheet. The new total score is sent to the storage section to be stored for use in subsequent computations, and the computation and control system is again reset or readied for receiving information relating to another bowled ball.

Where a strike occurs on a first ball, the computation and control system directs the printer to print the strike sign in box 201 by positioning the printer and sending a print signal as before. Where a spare occurs in a given frame, the spare is entered in box 202 by positioning of the printer and sending of the print signal. For bowling out, an additional box 204 is provided in the tenth frame and this system is adapted to cause printing in all three tenth frame boxes when applicable.

If a foul occurs on any ball during a game and the FC switch on the bowler panel is used to confirm the foul, the computation and control system causes the printer to indicate the foul on the score sheet by printing the letter F in area 201, 202, or 204, as appropriate.

Where a mark occurs on any ball for a given bowler, the computation and control system does not wait until a subsequent ball is bowled, but rather, enters the basic value for the mark in a bowler memory unit for the particular bowler. A separate bowler memory unit is provided for each bowler in the storage or memory section. The bowler memory units retain the total running score for each bowler.

The computation and control system functions to control the cycling of the pinsetter so that the pinsetter does not cycle past 270° until the computation of each ball score is completed.

In the particular system illustrated, the pinsetter has been adapted so that the rakes is down prior to the beginning of each frame to remind the bowler to push his identification button before bowling his first ball. Depresssion of an identification button actuates the computation and control system to trigger the pinsetter to lift the rake so that the first ball may then be rolled.

During the scoring of team bowling matches, the computation and control system also includes the necessary computing means to allow the team bowling matches. The examples for each of the individual bowlers in addition to retaining score and frame data also retain the past histories of the bowler, including the identification of first or second ball and the number of strikes or spares immediately previously attributed to the bowler which may affect the computation of their score on the next subsequent ball to be bowled. The past history or state is considered and adjusted, if necessary, by the computation and control system after the bowling of each ball.

For handling of a foul, the computation and control system de-energizes the pinsetter responsive to receipt of a signal indicating a possible foul occurrence until the foul determination can be made by depressing one of the FC or FD buttons. For handling an out-of-range pin condition, the pinsetter is stopped responsive to such condition after each ball. Provision is made for entry of foul information manually after occurrence of the out-of-range pin condition. Handicap information entry may also be made manually. For error correction, the stored information may be cancelled and correct information re-entered manually or by editing the stored score information up to its correct value and state for the present frame.

**COMPUTER DRIVE**

Referring especially to FIGS. 14–17, the computation system is driven by a motor 361 through a sprocket 362, chain 364 and sprocket 365 to rotate a power shaft 366 counterclockwise, which supplies input to the one-revolution clutch for a rack drive system and also supplies input to a plurality of formula cam clutches 379.

Mounted on one end of shaft 366 is a sprocket 367 for driving a chain 368 and another sprocket 370 on shaft 371 which in turn carries a sprocket 372. A formula drive chain 374 is driven by sprocket 372 which in turn drives another sprocket 375 on shaft 376 and also drives a plurality of formula drive sprockets 377 with chain 374 being held in engagement with formula drive sprocket 377 by means of idler sprockets 378. Sprockets 372, 375 and 377 are of the same configuration in the illustrated form. Each of formula drive sprockets 377 is driven clockwise as viewed in FIG. 15 and counterclockwise, as shown in FIGS. 14 and 16. Mounted on shaft 376 is a second sprocket 380 which drives a chain 381 to drive sprocket 382 and shaft 384.
The programming of the scoring operation is based on a plurality of different states which depend on the bowler’s past history. The states are pre-set in the form of formula cams and are selected responsive to the bowler’s past history and present ball results for control of the device illustrated in the drawings in accordance with a pre-set scoring procedure; the pre-set procedure differs depending on the formula selected. The bowler’s history, either as retained within a bowler memory or as retained and thereafter up-dated responsive to present ball results, indicates the proper state. The pre-set formula corresponding to the indicated proper state is selected or introduced for control of score computation and readout in accordance with usual scoring procedures. After each ball is bowled, the bowler’s state is reviewed and, if change is necessary, the state is changed to reflect any change in past history. The bowler’s state is stored in a memory system along with his score and frame data. Communication between the memory system (including memories BM-1 through BM-12, T7 TM, T7 TM, T7 MM) and the computation system is established by a plurality of racks designated by a prefix R shown generally in FIG. 16 and to be described in greater detail below.

The states may be considered as twelve in number identifiable as follows.

State:  
1a ——— First ball after an open frame or at the beginning of a game, less than ten pins downed.
1b ——— Same as 1a except ten pins downed by ball.
2a ——— First ball after a spare, less than ten pins downed.
2b ——— Same as 2a except ten pins downed by ball.
3a ——— Second ball after a spare or open frame, less than ten pins downed.
3b ——— Same as 3a except ten pins downed by ball.
4a ——— First ball after a strike, less than ten pins downed.
4b ——— Same as 4a except ten pins downed by ball.
5a ——— Second ball after a strike, less than ten pins downed.
5b ——— Same as 5a except ten pins downed by ball.
6a ——— First ball after two strikes, less than ten pins downed.
6b ——— Same as 6a except ten pins downed by ball.

FORMULA CAMS AND CONTROL SLIDES

The bowling game scoring is programmed in the illustrated form by a plurality of cam clusters, each cluster of cams being triggered to rotate on a shaft A through K (FIGS. 21 and 23) responsive to a “done printing” signal after selection of a proper state (after determination of a state suffix a or b) by insertion of a lever 385 in a slot 386 (FIGS. 21 and 23–25) in a lower flange of a slide SS as will be described more particularly hereinbelow. The selection and rotation of the cam cluster will control the computation as necessary for the state selected. The computation system functions, in addition to computing and printing box scores after each ball, to perform or cause the following steps responsive to the cam cluster for the corresponding state selected:

<table>
<thead>
<tr>
<th>State</th>
<th>Shaft</th>
<th>Computation steps</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a.</td>
<td>A</td>
<td>None.</td>
</tr>
<tr>
<td>1b.</td>
<td>B</td>
<td>Add ten pins to bowler’s cumulative score and add one mark.</td>
</tr>
<tr>
<td>2a.</td>
<td>C</td>
<td>Add the number of pins knocked down by present ball and print total one frame back.</td>
</tr>
<tr>
<td>2b.</td>
<td>D</td>
<td>Add ten pins, print total one frame back, and add two more places, up to mark.</td>
</tr>
<tr>
<td>3a.</td>
<td>E</td>
<td>Add pins knocked down by present ball and print total in present frame.</td>
</tr>
<tr>
<td>3b.</td>
<td>F</td>
<td>Same as 1b.</td>
</tr>
<tr>
<td>4a.</td>
<td>G</td>
<td>Add pins knocked down by present ball and print total in present frame.</td>
</tr>
<tr>
<td>4b.</td>
<td>H</td>
<td>Same as 1b, except add two marks instead of one.</td>
</tr>
<tr>
<td>5a.</td>
<td>I</td>
<td>Add pins knocked down by present ball, print total one frame back, again add pins knocked down by present ball and print total in present frame.</td>
</tr>
<tr>
<td>5b.</td>
<td>J</td>
<td>Same as 5a.</td>
</tr>
<tr>
<td>6a.</td>
<td>K</td>
<td>Add ten pins, print total two frames back and add twenty pins. Add two marks.</td>
</tr>
</tbody>
</table>

It is readily seen from the above that the same cam cluster can be used for states 1b and 3b; the same can also be used for 1a and 4a; and the same formula cam cluster will service states 2b and 5b. Thus, only 9 cam clusters need be included for the 9 different formulas.

In the illustrated embodiment, twelve cam shafts are provided labeled A through L in FIGS. 21, 22, 27 and 28. Each shaft is rotated a complete revolution during a computing cycle, although intermediate printing stops may be made. A set of cams is rotated with the shaft, and the cams in turn operate control slides, prefixed CS, for controlling the computation and printing of score information in accordance with the formula manifest in the cams. Shafts A through K are the state formula cam shafts and shaft L is provided to control printing of team marks. Shaft E is used in team total printing in addition to its use as a formula cam. The identity of the shaft with respect to the state and the general computation steps performed responsive to one revolution of the cams mounted on the shaft is indicated in the table above. The cams on the respective shafts are configured in accordance with the timing charts of FIGS. 27 and 28, although other configuration and timing may be used as desired or required.

Formula shaft sprockets 377 are driven in counter-clockwise direction continuously (as viewed in FIG. 16). Each sprocket 377 drives a drive member of a clutch 379, which, upon connection to the driven member by a pawl, causes rotation of the driven member until the driven member is disengaged. Accordingly, a plurality of trip levers 385 are provided for the eleven formula cam clutches. Each trip lever has an arm 387 for engagement with the driven member of the one-revolution clutch, and which is spring urged away from engagement by a tension spring 388 secured between arm 387 and the computer side plate. Each of levers 385 is normally blocked against feeling for a slot 386 by a stop pin 391 on slideably mounted bar 390. A solenoid FS (FIG. 23, wiring diagram FIG. 107) which is energized responsive to a “done printing” signal from the printer, serves to unblock trip lever 385 so that the lever 385 for the formula to be used may pivot counterclockwise in FIG. 21 to release the clutch formula upon energization of solenoid FS. Accordingly, actuation of solenoid FS results in pulling link 392 upward and pivoting lever 394 about pin 395 to slide the bar 390 to the right as viewed in FIG. 23, thereby unblocking all levers 385.

When bar 390 is urged to the right as viewed in FIG. 21, springs 388 urge ends 387 from engagement with the driven portion of the clutches. To restrain the ends 387 of non-selected levers 385 from disengagement, slide SS is provided with a lower flange 396 against which the ends of levers 385 abut. However, flange 396 includes the plurality of arms 386, and the position of slide SS over the plurality of arms 385 responsive to the previously determined and up-dated state, results in one of trip levers 385.
The plurality of slides CS is mounted below racks R and used to transfer control of the computation by the selected formula to the computer. For this purpose the cams 397 mounted on a formula cam shaft, when the shaft is rotated, cause the slides to travel to the right or left as viewed in FIG. 16 and the slides, in turn, function to actuate limit switches, mechanical linkages, or the like, which control the computation and printing operations.

In each cluster of cams 397, there is a cam for operating each control slide CS needed by the particular formula. The timing charts for the cams are illustrated in FIGS. 27 and 28. FIGS. 27 and 28 identify the control slides operated by the cam shaft cam, the numbers of times operated (indicated by the number of rises), and the angular disposition of the peak of the rise or riseless cam. FIGS. 27 and 28 show that the pro cesses of rotation at which stops 404 are provided for the appropriate shafts which are stopped and restarted one or more times during a computing operation. As will be seen in FIG. 21, intermediate stops 404 are provided on shafts C, D, E, H, I, J, K and L for engaging the clutch disengaging arm 387 of a trip lever 385 to stop shaft rotation prior to completion of one revolution. The shaft rotation is restarted by reactivation of solenoid FS while the slide SS is still in position at the proper state. The shaft then rotates to the next stop 404 (shaft H), or completes its revolution if there is no additional stop 404 (shafts C, D, E, I, J and K). The second stop 404 on shaft H functions the same as the first stop. The intermediate stops occur, it will be noted, immediately after operation of slide CSFS which sends a "print" signal to the score printer. The stop is to provide a time interval to permit the printer to reach proper printing position and complete the printing, whereupon a "done printing" signal is sent which actuates solenoid FS and restarts the formula cam shaft.

The control slides CSU, CST, CSB, CSSA, CSEC, and CSCR are each initially moved to the left, and CSFF, CSRM, CSFS, CSTM and CSY are each initially moved to the right by the formula cam arms, and CSF may be moved to right or left depending on whether it is desired to adjust to a prior or subsequent frame. All slides except CSF are spring returned in the direction opposite their direction of initial movement. The functions of these slides will be considered in more detail below.

The control slides have secured thereto pins 407 which are disposed to be engaged by cams on one or more cam shafts A through L to drive the control slides to the right or left, depending on the disposition of pins 407. Control slides CSF and CSTM are illustrated in FIGS. 29 and 30 respectively, showing the positions of pins 407.

Referring to FIG. 31, the following table shows the positions of pins 407 on the remainder of the slide bars by identifying the positions A through Y identified on the slide bar of FIG. 31 and by identifying the surface or side from which the pins project as "back" or "front."

The control slides which are moved only to the left as viewed in FIG. 16 are CSU, CST, CSB, CSSA, CSEC and CSCR, all operate mechanical linkages in the computer for control of computation. Although the operation of the computer responsive to these slides will be described in more detail hereinafter in general, each time the control slide is moved to the left by a formula cam the following functions are performed:

Slide:    Function
CSU...... Triggers computer to add the units input to the bowler's score.
CST...... Triggers computer to add ten to the bowler's score.
CSM...... Triggers computer to add a mark to the total of team marks.
CSSA...... Releases a state adjustment mechanism causing the state to be adjusted if necessary.
CSCR...... Resets the computer at the end of each computation.
Slide: CSEC---- Engages calculator assembly with racks for performing computing operations. It also actuates a limit switch EC to control cutoff of "done printing" signal from printer.

The control slides which are moved only to the right as viewed in FIG. 16 are CSFS, CSFF, CSY and CSRM trip limit switches for performance of various functions as dictated by the formula cams. The slides, switches tripped, and functions are as follows:

Slide Switch Function
CSFS,..... FFSS... Connects frame score data to printer and sends a print signal to the printer to initiate a print cycle for printing frame score.
CSY..... 3Y Y.. Adjusts the printer to print on scoresheet 200 in area 20B below the box score printing area 200 and 202; this is for printing the frame totals in area 20B.
CSRM,..... EM... Engages memory with racks R to introduce score numbers from area 20B in which the current frame is completed.
CSY..... 5Y Y... Adjusts the printer to print on score sheet 400 in area 20B below the box score printing area 200 and 202; this is for printing the frame totals in area 20B.
CSRM,..... EM... Engages memory with racks R to introduce score numbers from area 20B in which the current frame is completed.

The CS control slides CSFS, CSTM, CSFF, and CSRM are provided with notches or actuating surfaces 408 (FIGS. 30, 35, 36 and 37) or projections 413 for tripping switches 2FFS, PTM, FF and EM respectively and the CS control slides CSFS, CSY and CSYR are provided with notches 410 for tripping switches FF, 3Y and EM respectively as the slides are urged by formula cams against the actuation switch arms in accordance with the timing charts of FIGS. 35 and 36. The surface 410 on slide CSRM is sufficiently further from switch 2EM than surface 408 is from switch EM that a larger arm is required to trip 2EM than that required for tripping EM so EM may be closed by the smaller cam without closing 2EM.

Control slides CSTM and CSFS each operate an additional switch, CTF and CFS respectively for connecting the team marks and frame score information to the printer. As each of these slides is urged to the right (see FIGS. 17 and 38), it abuts and pivots a follower arm 411 mounted on a sleeve 412 having a switch lever arm 413 secured thereto. Arm 415 is pivoted counterclockwise about pin 416 to close spring-loaded locking switch CTF or CFS. Thus, movement of slide CSTM to the right by a cam rises closes switch CTF and slide CSFS closes switch CFS. There is another switch CBS similar to CTF and CFS, which is closed by the rack drive in a manner which will be described later. Closure of any of these switches will cause release of a locking bar allowing any previously closed switch to open.

MEMORY INPUT AND OUTPUT

The computation cycle is normally initiated by engaging one of bowler memory units BM-1 through BM-12 with transmission racks R for subsequent association with the computation system. The bowler memory units BM-1 through BM-12 are arranged from the standpoint of logic, as opposed to physical orientation, in a parallel manner. In other words, because each memory unit BM-1 through BM-12 receives information from the associated bowler and only the associated bowler and is connected to the computation unit in a manner whereby the information contained therein does not pass through other memory units in a serial fashion, the bowler memories are truly parallel. Reference is made to FIGS. 15 through 16 and 43 and 44. Each memory is so engageable by actuating a memory solenoid which pulls a link 420 (FIGS. 15, 16 and 43) to pivot a crank 421 about its pivotal mounting 422 to frame 424 against the urging of return spring 426. Pivoting of crank 421 is counterclockwise as viewed in FIG. 16 and causes arm 426, carrying a shaft 427 having memory gears GU, GT, GH, etc. (FIGS. 43 and 44) mounted thereon downward so that the memory gears, all prefixed G, engage racks R there below. The same pivotal motion of crank 421, which is attached at 428 is one of a plurality of slide bars 430, causes sliding of the slide bar 430 to the left as viewed in FIG. 16 against the urging of spring 431 acting through a link 432 pivotally mounted at 434.

As can be seen best in FIGS. 16, 39 and 40, a plurality of slideable bars 430 is provided, each associated with one or two of limit switches TTMU, TTTM, BMU, BMD, or TMM. The five bars 430 are more specifically identified as 435 through 439 in FIG. 40. Bars 435 and 439 each operate switches TTMU and TTTM; bar 436 operates switch TMM and bars 437 and 438 each operate switches BMU and BMD. Switches TTMU, TTTM, BMU and BMD, it will be noted, are duplicated, one set being positioned adjacent each side of the memory and rack transfer system housing. This duplication is merely for simplification of construction, providing actuation of the slide bars by slide bars on either side of the housing. The duplicated switches perform the same function and may be considered as being wired in parallel.

Switches TTMU, TMM and BMD are normally open switches which are closed by sliding their actuating bars to the left in FIG. 16 as the memories attached thereto are engaged with the racks. Switches TTMU and BMD are normally open switches which are closed by sliding their actuating bars to the right upon dispensage of the appropriate memories.

The BM memories are each attached to either bar 437 or 438 for operating the bar as described above and, therefore, operate switches BMU and BMD, housed in the same switch casing. Similarly, the TaMM and TaMMM memories are attached to bar 436 and operate switch TMM and memories TdMM and TdMM are attached to bars 435 and 439 respectively and operate commonly housed switches TTTM and TTTM.

Switch SAD is closed by actuation of a solenoid SGS for purposes of adjusting bowler history. The provision of switches BMD, TMM and SA assures that the bowler memory system, team marks memory system and bowler history adjustment system are each engaged where needed for the scoring procedure.

Closing of limit switches BMD and TMM and switch SAD enables actuation of solenoid CS by other contacts for starting the computation cycle. Energization of solenoid CS triggers a mechanism for driving the racks, with which the memory wheels have become engaged, to the left as viewed in FIG. 16. Accordingly, solenoid CS pulls a link 441 upward against return spring 442 (see FIGS. 16 and 20) and pivots a pawl 444 counterclockwise as viewed in FIG. 16, mounting pin 446 to withdraw tooth 447 of pawl 444 from a receiver 448 in a one-half revolution clutch driven member 450 (FIGS. 17 and 20) of one-half revolution clutch 451.

A normally closed switch CF (FIG. 16, wiring diagram FIG. old 103) is mounted on frame 424. Switch CF is maintained open by bridge 467 in its home position and is closed by bridge 467 leaving home position. Switch CP is closed as the rack drive starts to drive the racks to the computer. Through appropriate circuitry this causes de-energization of solenoid CS and performs other functions as will be described later. Reference is made to FIGS. 15, 16, and 17 for further details.

Switch CF remains closed until the racks are driven back, whereupon switch CF is opened by bridge 467. Closing of switch CF enables completion of circuitry which, upon interruption by opening of switch CP at the end of the computation cycle, informs the pinsetter that the information has been used and it may proceed to cycle, thereby cancelling switches PDS by normal pin.
setter cycle, switches PDS being linked to and reset with the pin indicator lamp switches. Shaft 452 (an extension of shaft 366) and gear 454 thereon are continuously driven in a counterclockwise direction as viewed in FIG. 16 by chain 364 and sprocket 365. Gear 454 is in mesh with drive gear 455 of one-half revolution clutch 451. Upon release of pawl tooth 447, driven member 450 rotates in a clockwise direction as viewed in FIGS. 16 and 20 to a position 180° away where pawl tooth 447, being urged downward by spring return 442 because of de-energization of solenoid CS enters a second receiver 456 similar to receiver 448 in the position shown in FIG. 20. Thus, prior to energization of solenoid CS, the linkages are in the position shown in FIG. 16 and after actuation of solenoid CS to initiate the cycle, with resulting release of clutch 451 for one-half revolution, the linkages are as shown in FIG. 20.

As member 450 rotates through one-half revolution, it pivots a sector gear 456 about pin 461 mounted to a suitable framework through a crank arm or link 462 which is pivotally connected at 464 to sector gear 460 and at 465 to member 450. Drive sector 460 is in turn in mesh with a pinion 466 secured to frame or bridge 467 and drives pinion 466 and bridge 467 in a clockwise direction as viewed in FIG. 16 during the half revolution of clutch 451 just described. Bridge 467 is pivotally mounted on shaft 468.

Bridge 467 has secured thereto a plurality of seven plates 474 each pivotal at point 475 and urged by spring 476 in a counterclockwise direction as viewed generally in FIG. 19. Also pivotal at point 475 are a plurality of channel members 477, each carrying a pinion wheel 478 rotatably mounted at 480 within the channel portion.

Adjusting screws 481 are provided threaded through each plate 474 and abut against each channel 477, providing a means of adjusting the tension of spring 476. Spring 476, acting on plate 474, normally retains pinion 478 in mesh with wheel RD. Thus, each of pinion wheels 478 is spring-loaded by spring 476 against a rack drive wheel and as bridge 467 is rotated by pinion 466 clockwise as viewed in FIG. 19, the pinion wheels 478, which function as detente wheels, are carried by bridge 467 and rotate the respective wheel RD until wheel RD is stopped, at which time pinion wheel 478, being normally spring detented against rotation by spring 476, is rotated because the force of spring 476 is overcome, rotation of pinion wheel 478 being thus lost motion permitting stopping of the respective RD wheel as the pinion 478 races or rotates on wheel RD.

Each rack drive wheel RD has a stop member 482 which is adapted to abut against the end of the channel 477 provided for the respective rack drive wheel.

Each wheel RD is in mesh with a rack identified by a prefix R and having the same suffix as the corresponding rack drive wheel RD with which it is associated or in mesh; for example, wheel RDU is in mesh with rack RU and wheel RDMT is in mesh with rack RMT. The racks R (FIGS. 16, 17 and 21) are eldridally mounted on a plurality of pins 488 secured to suitable framework and passing through slots 489 in the racks. Clockwise rotation of wheels RD as viewed in FIGS. 16 and 19 results in driving of racks R to the left until racks R are stopped, at which time the detenting pinion wheel 478 associated with the respective rack drives wheel RD races, with no further rotation of the RD wheel.

The amount of movement of rack R to the left as viewed in FIG. 16 permitted depends upon the amount of rotation of the memory gear associated with the rack, each memory gear being pitched by the letter G and having the same suffix as the rack and rack drive gear with which it is associated. The gears G are within the memory units, and when the memory unit is engaged the gears G engage with the respective racks R as will be described. The gears G may better be seen with reference to FIG. 16 and FIG. 43.

Each memory having a BM prefix includes five gears G, i.e., GU, GT, GH, GP and GS for engagement with the respective racks RU, RT, RH, RF and RS respectively. Each memory identified as T,TM or TMM includes three gears GU, GT and GH engageable with RU, RT and RH. Each of memories TMM and TMM includes only two wheels or gears GMU and GMT which are meshed with racks RMU and RMT respectively upon engagement of the TMM memory units.

Engagement of a memory unit or units is accomplished, more specifically, by energization of the respective memory solenoid. For example, with reference to FIG. 43 wherein two bowler memories BM9 and BM10 are shown in more detail, each memory includes a solenoid with an armature 484. The memory solenoids herein are given the same reference designation as the corresponding memory. Actuation of solenoid BM pulls armature 484 upward which in turn pulls link 420 and pivots crank 421 to urge shaft 427 downward in slot 485, the teeth of gears G engaging the teeth of the respective racks R.

Each of gears G is independently pivotally mounted on its shaft 427 and includes a zero stop 486. Mounted above each line of memory wheels is a stop bar 487. With gears G up as shown in FIG. 43, stop bar 487 is between gear teeth engaging rack R and gear G rests against rotation. Upon movement of gears G to the down position for engagement with the corresponding racks, the teeth of gears G become disengaged from stop 487 but become at the same time engaged with the teeth of racks R, thereby eliminating movement of the gears rotationally while being engaged and disengaged with respect to the racks. With gears G in the down position engaged with the racks, zero stops 486 function to limit the rotation of the gears by engagement with bar 487 upon rotation of the respective gear to its "zero" position. Prior to entry of scores into the memory system and at the beginning of each game, the gears G are all in zero stop position and cannot be further rotated by the racks R as the racks are driven to the left as viewed in FIG. 16. Thus, with all gears in zero position, as racks R are driven to the left, all of detent wheels 478 take up the drive supplied by sector 460 because racks R are all secured against movement to the left. Movement of racks R to the left functions to remove stored bowling score information from gears G, racks R extending into the computation section of the computation system for delivery of the score information to the computer system or scoring device to permit engagement of the computer to record the score.

Once the racks R have been driven away from home position for transmission of stored information to the computer, it may be necessary to adjust the racks by entry of additional information by the computer, e.g., by adding new score information, adjusting the bowler's state, or changing the frame designation. Turning to FIGS. 15, 16, 41 and 42, as bridge 477 is pivoted to the extent of its clockwise direction, it engages an arm 490 pivotally mounted to the housing 424 at 492, pivoting arm 490 counterclockwise against the urging of tension spring 494 to close microswitch 495 and energize solenoid DDS. Solenoid DDS pulls in, pivoting a link 495 and a shaft 496 secured thereto and journaled through housing 424. Secured to shaft 496 is a plurality of hook members 497 disposed to engage each of plates 474 mounted on the rack drive bridge 477 and pivot plates 474 clockwise to raise detent wheels 478 from engagement with wheels RD against the urging of springs 496. Such disassociation of detent wheels 478 breaks the drive train to racks R and permits free movement of racks R, only wheels RD of the drive train turning during such movement of the racks. Upon de-energization of solenoid DDS, spring 498 return link 495, shaft 496 and hook members 497 to their normal position and detent pins 478 are re-engaged with wheels RD.

Switch C is mounted on solenoid DDS by bracket 500 and disposed to be closed by link 495 each time solenoid DDS pulls in, i.e., each time the racks are driven all the way.
way out to computing position. This switch closure completes circuitry which function will be described later.

SUMMARY OF PINFALL INFORMATION

The pinfall information derived from detection of standing pins, is relayed to a summer unit for summation of pinfall to provide a pinfall total which may in turn be used for computation of bowling scores for entry as input into the memory units. The pinfall signal from each of the pinfall detection switches PDSL or UDSR is transmitted by electrical wires to a summation section of the computation and control system of the scorer, the summation section being indicated generally by the reference numeral S in FIG. 1.

The summation unit or summer S (FIGS. 14, 15 and 45-49) includes a frame 504 mounted by suitable brackets to frame 424 and including a plurality of crossframe or pin members 505 secured to opposite sides of the frame 504 at their ends. A plurality of slide bars SB-1 through SB-10 are mounted on pin members 505 extending through elongate slots 506 in the SB slide bars. Slots 506 permit longitudinal sliding of the SB slide bars to the left and right while retaining the slide bars against vertical movement as viewed in FIG. 8.

A pin count magnet M-1 through M-10 are mounted by brackets 507 to frame 504 disposed above slide bars SB-1 through SB-10 as viewed in FIG. 45. A plate 508 is pivotally mounted on a pin 511 for association with the core of each of magnets M-1 through M-10. Pin 511 is secured between opposing walls of frame 504. Each of plates 508 is positioned to be attracted upward by the core of the pinfall magnet beneath it which is pivotally mounted and carries a latch portion 512. Thus, as each of magnets M-1 through M-10 is energized, the plate 508 therebeneath is moved to an attracted position as shown for the magnets in FIG. 45. Upon de-energization of each magnet M-1 through M-10, the plate 508 is released and is moved by the urging of spring 514 to the position shown in dotted lines for the plate 508 beneath magnet M-5 in FIG. 45.

Each of plates 508 when in attracted position raises its latch end 512. When in lowered position plate 508 carries latch end 512 into lockable engagement with a receiver or notch 515 in one of the SB slide bars as seen in dotted lines by magnet M-5, FIG. 45. The latch 512 of each plate 508 is disposed laterally as best seen in FIGS. 46 and 47 for lockable engagement with the SB slide bar bearing the same numerical designation as the M magnet operating the given plate 508. Thus, for example, upon release of plate 508 by magnet M-7, the latch 512 of the plate is free from the notch 515 of slide bar 516. Each of the other magnets and slide bars of identical numeral suffix are in the same manner associated through a plate 508 and latch 512, so that when the magnet is de-energized the latch 512 is free to be urged by spring 514 into the notch 515 of the slide bar to latch the slide bar against longitudinal sliding. Upon energization of any one or more of the magnets, the corresponding slide bar is unlatched and free for longitudinal movement on pins 505.

A plurality of pulleys P-1 through P-10 are also provided in the summer mechanism, each pulley being mounted in the pulley channels 516 and 517 through a bearing 518 on a pin 520; the pins 520 are each in turn supported by a bracket 521 secured to a sleeve 522 disposed for pivotal movement on a shaft 524 which is in turn secured to frame 504. Thus, each 1 pulley P-1 through P-10 is free to rotate on bearing 518 and is adapted for pivotal movement through link 521 with the pulley center traveling through an arc.

Each of slide bars SB-1 through SB-10 includes a lower projection 525 disposed to engage the pin 520 supporting the pulley having the same numerical suffix as the slide bar. Thus, the slide bars SB-1 through SB-10 are disposed at a distance from each other by the following order: P-7, P-3, P-6, P-4, P-8, P-5, P-9, P-2, P-10 and P-1. Disposed around the assembly of pulleys in inverse block and tackle fashion is a flexible nonstretching tape 526. One end of tape 526 is secured to the smallest pulley P-7 and thence the tape is thence forth to the largest pulley P-10 in a clockwise direction around each pulley in order of increasing diameter to engage the pulley for approximately 180°. Thus, the first complete loop of tape 526 closes both of these pulleys P-7 and P-3 and thence the loop enlarges to include pulleys P-6 and P-4 and further enlargement of the loop of tape 526 includes pairs of pulleys in order 8 and 9, P-2 and P-10 and P-1 with the tape thereafter being disposed along the tops of the array of pulleys within channel guide 516 to pulley 527 which is provided to permit a change in direction of tape 526 as it exits from summer S. A tensioner and driven by tape the end of tape 526 exiting from summer as will be apparent hereinafter.

The signals from the PDSL and PDSR pin detection switches in APL and APR are fed through blocking diodes to the magnets M-1 through M-10 respectively in summer S so that closure of a PDSL or PDSR switch will cause actuation of the M-magnet having the same numerical suffix when switch CPS in the common of all M-magnets is closed. Thus, energization of each magnet represents a pinfall count of one. For each magnet energized, a latch 512 is withdrawn from the slide bar SB. The tension on tape 526 pulling through the inverse block and tackle arrangement will therupon cause pivoting of the corresponding pulley about shaft 524 toward the center of the block and tackle arrangement carrying the projection 525 on the corresponding SB slide bar therewith. Any unlatched slide bar will permit sliding motion and consequent pivoting of the corresponding pulley while any latched slide bar, i.e., where the M-magnet is de-energized, will stop such pivotal movement of the corresponding pulley. Slide bars SB-1 through SB-5 slide to the left under urging of the pulleys and slide bars SB-6 through SB-10 slide to the right when the corresponding magnet is energized, tension being constantly maintained on tape 526. The SB slide bars are adjusted, as will be seen, so that each slide bar permits almost the same exact length of tape to be pulled for each magnet energized. Thus, the amount of movement of tape 526 from the device can be taken as a mechanical measure of pinfall count, the tape moving one unit for each pin downed.

The longitudinal sliding of each SB slide bar is limited by means of adjusting bolts 528 at the end of the slide bar toward which the slide bar moves. Thus, the adjustments 528 for slide bars SB-1 through SB-5 are on the left and the adjustments for slide bars SB-6 through SB-10 are on the right as viewed in FIGS. 45 and 46. The adjustments 528 and 529 are conventional, comprising a threaded shaft threaded through a nut secured to frame 504 and aligned at the end of the respective slide bar as seen more clearly in FIG. 48, a view from the right end of FIG. 45. The bolt portion of adjustment 528 acts as a stop in the usual manner to limit the travel of the corresponding SB slide bar by abutment of the end of slide bar against the bolt portion. The threads of the adjustments 528 are sufficiently fine to permit adjustment of the amount of travel of each slide bar within 1/1000 inch of each other. Thus, essentially the same distance is traveled by the center of rotation of each pulley in travel of tape 526, the limit permitted by the corresponding slide bar. Each unit of measure added to tape 526 will be for practical purposes the same and will be equal approximately to twice the distance of travel of the center of rotation of each pulley.

After the summer has converted the electrical impulses from the pinfall switches into the mechanical units of measure in tape 526 and after the information represented by elongation of tape 526 has been utilized or accepted for computation of bowling scores, the pinfall information and count must be ely in the system. New data can be accepted.

In the illustrated embodiment, the summing device is triggered by a momentary signal to be discussed further.
hereinbelow. This signal actuates magnet SPS of a magnet actuated one-revolution clutch 530. Thereupon, a motor 531, which may be a constantly driven motor, driving shaft 532, engages shaft 534 through clutch 530 for one revolution to rotate shaft 534 one revolution.

Shaft 534 carries a cam 535 which protrudes through aperture frame and slide bar SB. During revolution of shaft 534 and at the initiation of rotation, movement of slide bars SB–1 through SB–10 is uninhibited by the cam 537 in that apertures 538 are of sufficient size and configuration to permit the required sliding of the slide bars during rotation. The rest position of cam 537 is as shown in Fig. 45. As cam 537 rotates clockwise the first 135° of cam 537 rotation resets the summer by erasing previous data as viewed in Fig. 45. Accordingly, the M-magnets are de-energized and latches 512 of each de-energized magnet fall to the top edge of the respective slide bar and reset thereon. After cam 537 passes 45° of rotation, it begins to pick up any slide bars which were unlatched in the previous cycle, by engagement within aperture 536, and as cam 537 reaches 135° of rotation, the slide bars have been carried back to their reset positions. Latches 512 ride on the top edges of the slide bars during their reset motion, and, upon alignment with the notch 515, each latch 512 drops into the notch, and at 135° of rotation of cam 537, all slide bars are reset. Cam 537 continues to rotate for the complete revolution and continues in the position shown in full lines in Fig. 45. Follower 536 is a spring leaf cam follower normally urged toward cam 535, is actuated by cam 535 at 135° to close switch CPS which is in the common ground of all magnets M, so that the pinfall magnets M–1 through M–10 can be energized by the respective pinfall switches in the pinsetter. Switch CPS is held closed by cam 535 until latches 512 have engaged notches 515 in slide bars to be prevented from following cam 537. Switch CPS then opens and remains open until 135° of the next pin summing cycle. The pinfall switches in the pinsetter have by now been released and have been reset; a subsequent energization of the magnets by the pinfall switches will be attributed to a subsequent ball. If the pinfall switches in another pinsetter serviced by the summer are ready to give information to the summer, this information will at this time be picked up with the summer again acting in the manner described above.

The readout from the summer device is carried by tape 526 in the form of tape feedout from the summer device. The other end of tape 526 is linked to and under tension from the mechanical computer as will be described hereinbelow for transmission of punchout information from the summer to the computer.

ENGAGE CALCULATOR

Referring to FIGS. 55 to 60 for engaging the computer with the racks R, an engage calculator control slide CSEC engages notch 541 of lever 542 via pin 544. Lever 542 is pivotally mounted on shaft 547. As slide CSEC is moved to the left by a formula cam on a cam shaft, arm 542 pivots clockwise and closes the normal open contacts of switch EC which energizes solenoid ECS. The armature 548 (FIGS. 14 and 15) of solenoid ECS abuts an adjustable screw 549 mounted in frame member 550 and pivots housing frame 551 and 551a counterclockwise about pin 547 as viewed in Fig. 15 against the urging of a spring (not shown) normally biased housing frame 551 and 551a counterclockwise about pin 547. Pinions 584 engage the racks RU, RT, etc., upon actuation of solenoid ECS. When it is time for the stoppage of the calculation, the cam releases the control slide CSEL which spring returns to the right, pivoting arm 542 and opening switch EC to de-energize solenoid ECS. The spring return action against solenoid ECS returns Calculator Assembly 551 clockwise to disengage the pinions 584 from the racks R.

The normally closed contacts of switch EC, when the control slide is not actuated to the left, provide circuitry for control of the "done printing" signal as will be described later.

CALCULATION OF SCORE INFORMATION FROM PINFALL COUNT

Referring to FIG. 50, tape 526 from summer S is directed by a slide bar ERB which is slidable mounted and extends from pin 537 to the left as viewed in FIG. 50. A switch PF10 is mounted on frame ERB which is slidable mounted upon movement of pin 536 to the left in slot 555 ten units by tape 526, i.e., upon receipt of a pinfall count of "ten" from the summer. Switch PF10 in turn actuates a "MARK" solenoid PF10S to update the state data taken from the bowler from the a suffix to the b suffix as previously described.

In order to enter less than 10 pins to a frame score, stepped cam 561 is provided. Each of steps 1–9 inclusive of the stepped cam has the same approximate angular length. As tape 526 is released by the summer, stepped cam is rotated clockwise by its torsion spring 564 one step for each unit of measure representing a pin down in tape 526. As tape 526 allows pulley 558 and stepped cam 561 to rotate in a clockwise direction as viewed in FIG. 55, the rotation is caused by the urging of a torsion spring 564 so that when tape 526 is pulled back by the summer, stepped cam 561 would return to the position shown in FIG. 55. As cam 561 is rotated clockwise by releasing of the tape, for each unit the tape is released, the cam rotates an additional step relative to pin 567 which protrudes outward through slot 566. Pin 567 is secured to Add Units SLA SAU which is slidable mounted on shaft 690 by means of slot 568 for sliding movement of slide SAU to the left and right as viewed in FIG. 57. Slide SAU is spring-loaded by tension spring 571 normally urging slide SAU to the left as viewed in FIG. 57.

If a particular scoring situation calls for pinfall to be added to a bowler's total score memory, slide CSU is urged to the left by a formula cam and through its pin connection with lost motion link 572, urges link 572 and arm 575 secured to pivotal movement thereto about pin 547 in a clockwise direction thereby pulling link 576 to the right as viewed in FIG. 57 and pivoting crank 577 about shaft 680 to lift latch end 580 of crank 577 from latching abutment with slide SAU at 582. Slide SAU is then permitted to slide to the left under the urging of spring 571, the amount permitted by stop pin 567. Slide SAU, at its left end as viewed in FIG. 57, carries a pivotally mounted differential gear 584 which is meshed with the upwardly disposed teeth of slide rack RU (provided the calculator assembly is engaged as previously described) and the downwardly disposed teeth of SUor, the formula cam has been engaged through slots 585 and 586 on guide shafts 587 and 588 respectively and is normally spring-urged to the left by tension spring 590. Shaft 587 is secured at each end to calculator housing plates 551 and 551a and reset shaft 588 is slidable mounted at each end through slots in housing plates 551 and 551a. Slide SNU carries a stop pin 591, which as shown in FIG. 57 abuts against the
end of an arm of rack trip crank RTU which is pivotally mounted on shaft 592 and carries a pin 594 on one arm. A stop projection 595 abuts against pin 596 and trip RTU is spring-urged by spring 597 in a counterclockwise direction about pin 592 to abut projection 595 against pin 596.

When, for example, moves to the left as permitted by the stepped cam 561, slide SNU is held against movement to the left by rack trip RTU and differential gear 584 rotates to urge rack RU to the left the number of units corresponding to the step upon which pin 567 rests.

At such times when rack RU is urged to the left a distance corresponding to a full ten pins into unit rack RU, e.g., when a pin total of six pins is discharged from a memory into the rack and another four or more pins are added to the rack as the result of the setting of step cam 561, upon entry of the tenth pin into rack RU, rack RU is in disposition to the left as shown in phantom in FIG. 57, a distance sufficient to engage pin 594 and trip rack RTU in a clockwise direction against the urging of spring 597, thereby releasing the abutment of trip RTU against pin 591 and permitting sliding of slide SNU under the urging of spring 590 to the left a distance regulated by the length of slots 585 and 586 (a distance corresponding to ten units of measure on rack RU). Such movement of slide SNU to the left, slide SAW being as far to the left as it is permitted to travel by pin 567, rotates differential wheel 584 which urges rack RU to the right ten units.

For example, if six units are in rack RU before the additional pinfall is added by release of latch 580 and eight more are to be added to the setting of step cam 561, i.e., pin 567 is opposite step No. 8 when four units of pinfall count have been added to rack RU, the rack is returned to zero and the additional four units are added, e.g., while the rack is returning to zero. Provision is then made for addition or carry of the ten pins into the rack RT.

Carrying of ten units into the tens rack is accomplished by operation of a cam linkage between the units system and the tens system to actuate a linear escapement mechanism in the tens system to add one unit for each ten units subcontracted from the units rack through the operation of slide SNU. It will be recalled that during the subtraction of ten units from the units of the rack, slide SNU was displaced to the left by spring 590. It will be noticed that during such urging to the left, slide SNU carries ten slide CT to the left against the urging of spring 599 by engagement of a flange on an upstanding projection of slide SNU with a hook arrangement on the left end of slide CT, CT being shaft 598. As slide CT proceeds to the left, a cam follower on cam CTC rides up a rise on the upper edge of slide CT, resulting in pivoting cam CTC clockwise about pin 598 as illustrated in FIGS. 57 and 61. After the cam follower on CTC has ridden up the rise on slide CT, the nose of slide CT rides up on bar 551 thereby unlatching CT from SNU and allowing CT to return to its original position under the urging of spring 599. One arm of cam CTC carries a pin 600 having a tooth member 606 pivotally mounted thereon and urged generally in a counterclockwise direction by a spring 601. Also in association with cam CTC is another detachable tooth member 602 pivotally mounted on shaft 680 and biased in a counterclockwise direction through linking tension spring 605 which links member 602 with an arm of cam CTC. As cam CTC pivots, with member 602 being held generally against pivoting by its detent engagement with Add Ten Slide SAT, tooth 606 dips into a ratchet on slide SAT and then pushes upward and out to the left as viewed in FIG. 61 to move slide SAT one unit to the left, thereby adding a unit of movement to the Add Ten Slide due to subtraction of ten units from the units rack. In the meantime, member 602 is permitted to pivot in the mechanism, pivoting of cam CTC in a counterclockwise direction under the urging of spring 605 will permit detent member 602 to pivot about shaft 680 and detent in the next notch on slide SAT in usual escapement fashion. It will also be noted with reference to FIG. 61 that slide bar CST may be used to enter pins through the same escapement mechanism. Accordingly, there is provided a link 607 between an arm of cam CTC, which is pivotally connected to the top of arm 608 connected for pivotal movement about shaft 547 along with lost motion link 610 by a pin 544 at the end of bar CST so that movement of control slide CST to the left will pivot arm 608 counterclockwise resulting in pivoting of cam CTC clockwise through link 607, the same relative angular distance as travel of the cam follower of the surface of slide CT, to add ten pins to the ten slide. Guide member 611 serves as a reference point in considering the figures illustrating the computer. Note that link 607 is slotted at its left end to accommodate actuation of CTC by external means.

As the ten pins have been added to the slide, SAT, such addition will result in adding the pins to rack RT through differential gear 584 in the same manner that pins are added from slide SAU to rack RU.

For carrying from the tens rack RT, upon a total count of ten pins in the tens rack to the hundreds rack, the same general mechanism is provided (see FIG. 63), the movement of rack RT to the left tripping rack RTT to release slide SNT and thereby subtract ten pins from the tens rack and actuate a carrying system employing elements which are generally duplicates of those previously described with respect to carrying to the tens, to place one unit of movement into the hundreds rack RH as described for placing a unit of movement into the tens rack RT. However, there is no provision for direct entry of hundreds from an arm of a control slide CS.

ADDITION AND ENTRY OF MARKS INFORMATION TO TEAM MARKS MEMORIES

As to adding marks, the marks are determined by the formula cams and are entered by control slide CSM sliding to the left once for each mark to be added. The slide bar pivots arms 614 through lost motion linkage 615 to pull link 616 to the right as shown in FIG. 62, resulting in pivoting of lever 617 clockwise about pin 598 to enter one mark into slide SAM through the Geneva escapement in the same manner described above with reference to carry mechanisms. Slide SAM functions with respect to rack RM and slide SNS and rack RMT in the same manner as described above with respect to other calculations and a carry mechanism as described above by carrying pins from the units rack to the tens rack is also provided utilizing a carry marks slide CM and a carry marks cam CMC to carry the marks into slide SMT and thence into rack RMT. However, no direct link corresponding to link 614 in the tens carry system is provided for direct entry of mark because no such entry is required.

In the mark tens calculation system, as well as in the hundreds pin count calculation system, there is no carry over to a next higher order and therefore, there is no carry slide corresponding to slide CT, CH and CMT for higher orders. Marks are not counted to one hundred because a team mark total of 100 or more is not possible. So far as the numerical team score totals are concerned, a "yes-no" operation is provided through a "yes-no" switch T1=1000 or T1=1000, which is closed upon reaching a count of one thousand, the count in ordinary operation of two thousand or more also being impossible.

It will be seen from the wiring diagram of FIGS. 101 and 102 that movement of the open bowling-league bowling switch LO to OB position prevents the team marks memory and team totals memories of CTC from being energized so that team mark totals are not maintained in open bowling. Further, use of bowler switches BLS-6, BR-6-6, BLS-12 or BR-12 also prevents energization of the team marks memory and team total memory during league bowling (positive LB) so that the team score earned by an extra bowler, e.g., pace bowler, bowling in position 6 are not added to the team totals.
DISCONTINUATION OF ADDITION DURING "BOWLOUT"

It has been noted that the formula cams control the computation of scores and the printing thereof. However, after the tenth frame where "bowlout" occurs, i.e., where a mark is received in the tenth frame, the scoring procedure changes since a bowler is not credited with marks or bonus pins for any ball bowled after a complete tenth frame; bonus pins for marks in frames 1–10 having already been added. The input of such credit is, therefore, blocked or discontinued.

To this end, lost motion linkages 572, 610 and 615 are provided between engagement of the slide bars SU, ST and SM, respectively, with arms 575, 608 and 614, respectively. These arms are the ones moved by control slides to add units, tens and marks to the calculator slides through the linear escapement mechanisms. The lost motion linkages permit disconnection of the calculation section from the control slides to prevent excess addition to bowling scores during bowlout. Accordingly, each of the lost motion linkages is provided with a notch 621 which receives a bar 622 on the end of a link 624, normally urged in a clockwise direction about pin 625 by spring 626 (FIG. 50). An arm of lever 624 is pivotally connected to a link 627 by a bowler motor through a solenoid 628. Enerogization of solenoid 628 pivots lever 624 about pin 625 carrying bar 622 counterclockwise about point 625 resulting in raising linkages 610, 615 and 615 which are vertically slidable secured to their respective arms through slot and pin arrangements as shown. The lifting of the lost motion link raises notches 541 from engagement of pins 544 to disable addition of units, tens, or marks by the control slides CSU, CST and CSM.

CALCULATOR RESET

The above description has been with respect to adding of numerical scores and marks to the racks for entry of correct information into the bowler memory system. Of course, after the SN slides have been urged to the left during carry operations, such slides and associated mechanism must be reset before the next cycle.

In Figs. 56, 57, 64 and 61, after the calculator assembly 551 has been disengaged from the racks prior to return of rack data to bowlers memories, the calculator is reset by reset lever 634 which is pivotally mounted on shaft 635. The reset operation is initiated by the formula cams moving control slide 53C to the left (FIG. 21) and when latch end 636 of slide 53C releases one revolution clutch 638 to rotate with shaft 637 with the one-revolution clutch turning crank 637 in a clockwise direction whereby crank 637, projecting through slot 638 of reset lever 634, slides in slot 638 and pivots lever 634 clockwise and then again counterclockwise. After rotation for one revolution, the clutch is released by latch 636 in that slide bar 53C has been spring returned to the right.

During the clockwise pivoting of lever 634, lever 634 carries shaft 588 to the right in slot 641 as viewed in Figs. 56, 57, 64 and 61. Shaft 588 projects through link 644. Because of the release of subtractions slides SN, some of the slides are to the left, and these released slides are returned to the right against the urging of their springs until rack trips RT clear pins 591 and return with projections 595 abutting shaft 596 to hold the slides against movement to the left by abutment against pins 591. All parts are returned by the reset action to their positions at the beginning of the calculation cycle.

ADJUSTMENT OF FRAME INFORMATION

The frame printing position of the printer and the frame data returned to the bowler memory are controlled by the positioning of rack RF. The rack RF position is detected and transmitted to the printer by electric cir-
been pivoted clockwise by pin 666 during movement of slide CSF to the right. Thus, after each movement of slide CSF, slide CSF is centered.

**CHANGE IN AND ADJUSTMENT OF STATE**

Turning now especially to FIGS. 56 and 64, there is illustrated a form of mechanism for adjusting the bowler's state as the game progresses. The structure of the mechanism is in many aspects similar to structure already discussed with respect to the unit's calculation channel, etc. The difference in structure will be evident from the operation of the mechanism.

Accordingly, the state resulting from the previous ball, if any, is fed into a State cam which is configured to permit measurement of the amount of change in state necessary for proceeding to the next subsequent state in accordance with regulation bowling procedures. The state fed to the state adjustment channel is accordingly adjusted or changed the determined amount and the state is then back to the memory system for storage.

More specifically, at the initiation of each computation cycle and before racks R are driven to the left by the rack drive cam for emptying the memory system, solenoid SGS is energized. Armature 674 of solenoid SGS pulls to the right as viewed in FIG. 64 pulling link 675 connected thereto by pin 682, thereby pivoting crank 677, which is pivotally connected by pin 678 to lever 679. Lever 679 is pivotal to shaft 680 raising link 681 which is connected to an arm of crank 677. Crank link 681 is pivotally connected by pin 682 to pinion carrier sector 684 which is pivotally mounted on shaft 690. The counterclockwise movement of carrier 684 engages gear 686 with rack RS and also causes pin 685 in sector 694 and extending through slot 685a in frame 651a, to close switch SAD (FIG. 56). Gear 686 meshes with gear 687 which in turn meshes with gear 688 on shaft 690. Gears 686 and 687 are pivotally mounted on carrier 684. Gear 688 is secured to ratchet wheel 637 and State cam 691.

Prior to movement of rack RS to the left by the rack drive system, gear 686 is engaged therewith by actuation of solenoid SGS so that as rack RS is driven to the left, gear 686 is rotated counterclockwise, rotating gears 687 and 688 resulting in turning of State cam 691 in a clockwise direction from its home position in accordance with any state programmed in the memory system to the adjustment cycle. Gear 695 normally urging cam 691 in a counterclockwise direction, initially as the state rack is driven to the left, cam 691 is rotated to position pin 694 in radial alignment with one of the twelve surfaces numbered 1 through 6 and sufficient with the letter a or b, depending upon whether or not all ten pins are recorded as down by the summer mechanism as will be more fully described below.

If all ten pins are recorded as knocked down by summer S, the state memory stop SMS is readjusted to change the state entered in cam 691 to the corresponding b position. Referring especially to FIGS. 16, 17, 23, and 42, if a pinfall count of "10" was obtained for the ball, solenoid PF105 is energized by switch PF10. The solenoid armature link 720 pivots lever 721 against its mounting pin 722 against the urging of spring 724 to left a lateral latch extension 725 of lever 721 from a recess 722 in adjustable state memory stop slide SMS. Slide SMS is mounted on cross brace members 488 through short oval slots in slide SMS to permit limited movement to the left, the longitudinal movement of slide SMS permitted being the length necessary to allow rack RS to move to the left to rotate cam 691 from its a state to the corresponding b state. Slide SMS is urged to the left by the zero stop on the state gear of the bowler memory which engages a notch in the top edge of slide SMS. Since state memory gear GS is engaged with rack RS, when SMS stops GS, then GS stops RS. During the rack return drive cycle, the adjustable stop slide SMS is carried back by rack RS by means of flanged end 718 hooked around end of RS and, solenoid PF105 being de-energized, latch 725 is re-energized in notch 726 of SMS.

Thus, each time ten pins are knocked down on a ball, the State cam 691 will be rotated sufficient to present the next counterclockwise step face, i.e., having the b suffix between the pin 694 and shaft 690.

In FIGS. 24 and 26, when state rack RS is driven out by drive gear RDS, it carries drive selector slide SS to proper position for alignment of a slot 386 and lever 385 to start the appropriate formula cam shaft. Accordingly, a pawl 696 is carried by the state rack RS and is latched to the butt end of selector slide SS during driving of the rack, thereby carrying slide SS with rack RS. Spring 697 normally urges slide SS to return to home position but rack 698 and pawl 700, pivotally mounted to suitable framework, prevent such return. Pawl 700 is urged into rack 698 by leaf spring 701.

However, it is necessary to readjust state rack RS as a part of the sequence of operations dictated by the formula cam. Thus, as gear RDS reaches the end of its drive, a crank 702 mounted on gear RDF strikes and depresses lever 704 pivotally mounted on rack RS at 705. Lever 704 in turn pivots pawl 696 counterclockwise about its pivotal mounting on rack RS at 706, thereby releasing pawl 696 from slide SS and holding pawl 696 against the normally clockwise urging thereof by spring 707. Rack RS may now be moved for adjusting the state without respect to slide SS. Solenoid DD has been energized to disconnect the drive sector and racks. Slide SS is retained against return by ratchet 698 and pawl 700 for the complete revolution of the formula cam shaft.

When drive sector RDS is returned during return of the racks, rack RS will feed an adjusted new state into the memory. Upon or near completion of the return of sector RDS, a pin 708 mounted thereon strikes a lever 710 pivotally mounted by pin 711 to suitable framework.

Lever 710 pivots clockwise as viewed in FIG. 24 and an arm thereof, resting on lug 712, depresses pawl 700 to release it from ratchet 698, permitting tension spring 697 to return slide SS to home position.

As soon as the rack drive reaches the "out" position, switch c is closed as previously described. This completes circuitry which turns off solenoid SGS, disengaging gear 686 from state rack RS. The position of cam 691 is then retained by pawl of latch 736 engaging ratchet wheel 737 and urging cam 691 in a counterclockwise direction. In FIG. 64, the distance from pin 694 to the surface disposed thereto is proportional to the amount of change required in rack RS to change the information in the rack from a designation of the old state to a designation of the new state. In order to adjust rack RS to reflect the new state, slide SRS is urged to the left with its pin 544 in engagement with notch 621 or a lever 730; the urging of the slide to the left is by means of the formula cams. Lever 730 is pivoted clockwise about shaft 547 pulling lever 732 (FIGS. 56 and 64) to pivot latch member 741 clockwise about shaft 680 thereby lifting latch end 735 (against the urging of spring 734) from latching engagement with slide SAS permitting slide SAS to be urged to the left as viewed in FIG. 64 by spring 731. Pin 694 is mounted on slide SAS and limits travel of slide SAS by abutment against the surface of cam 691 facially disposed thereto. Differential gear 584 moves rack RS to the left with stop arm RTS abutting pin 591 of slide SNS. If rack RS is driven to the left sufficient to abut pin 594 and pivot arm RTS away from stopping slide SNS, slide SNS is spring urged to the left as in the unit subtraction system described and functions to subtract from rack RS, i.e., drive rack RS to the right, a distance sufficient to subtract twelve units (teeth) of rack motion from RS.
As previously described pawl 736 pivotally mounted on pin 587 retains cam 691 against rotation under the urging of torsion spring 695. The new state is now in rack RS and will be entered into the memories upon return of rack RS to the right.

Upon reset, shaft 588 is moved to the right carrying slide SNS therewith until lever RTS is again returned by spring 597 with stop 595 against shaft 596 and with arm RTS aligned for abutment with pin 591 for holding slide SNS to the right. Movement of reset pin 588 to the right also lifts pawl 736 from ratchet wheel 737, and cam 691, under the urging of spring 695, is returned to its home position. Pawl 736 is normally urged clockwise about pin 587 by spring 739 anchored to suitable framework.

Thus, in the over-all operation, the state rack feeds the stored transitory state from the bowler memory into the state cam. The transitory state is up-dated, if necessary to the b position and then becomes the actual state for the ball just bowled. The selector slide SS is carried out by rack RS. The lever for the clutch of the appropriate formula cam shaft corresponding to the state finds its slot 396 in the lower flange of selector slide SS and the clutch is tripped when solenoid FS is energized, causing rotation of the formula cam.

It will be noted that there are eleven clusters of formula cams on 11 separate shafts, only one of which is selected by adjustment of the selector slide SS to one of 12 positions corresponding to the 12 surfaces 1a through 6b on the state cam 691. Thus, the alignment of the state selector slide SS to one of its 12 positions effects selection of the proper formula for controlling the computation in accordance with normal bowling score computation, based on the past history or state of the game.

The formula cam shaft rotates and control slides CS are urged to the left or right as required by the particular formula cam stack for carrying out the computation, and controlling printing.

One of the control slides is the state adjustment control slide CSSA which is always triggered during rotation of any formula cam shaft, regardless of which cam shaft has been selected. The state adjust slide CSSA is urged to the left and, having its pin 544 engaged with notch 541 of lever 736, trips lever 730 clockwise pulling link 732, pivotally connected thereto by pin 733 to the right as viewed in FIG. 64. Link 732 is pivotally connected at 740 to a latch member 741 and pivots latch member 741 clockwise against the urging of latch return spring 734. Latch member 741 pivots about shaft 680 and withdraws its latch engaged with slide SAS, permitting slide SAS to be urged by spring 731 to the left within the limits of pin 694 abutting a surface of cam 691. As explained above, the sliding of slide SAS to the left results in changing the state to the new transitory state for the next ball to be bowled by the bowler and the new transitory state is put back in the bowler memory when rack RS is driven again to the right. This new transitory state for the next ball will be recalled from the bowler memory, up-dated as necessary, and handled in the same way as described above.

More particular reference should now be made to the twelve states identified hereinabove. The a and b suffixes for the states and different cam 691 surfaces for states suffixed with a and b respectively are provided because in the game of bowling a score of ten pins on a single ball will change the progression of the bowling game; thus, the amount of change from the old state to the new transitory state must be adjusted to compensate for such change. If the distance between pin 564 when slide SAS is in its home position to the right and latched, and each surface disposed thereto by rotation of the state cam 691 is measured, it will be seen that a common unit of measurement exists. For example, with surface 1a disposed to pin 564, there are two units of distance between the surface and pin while if surface 1b is disposed to pin 564, the distance is three units. Each unit corresponds to a unit of travel of slide SAS to the left necessary to effect a two tooth, or one full state (a+b), adjustment of the state rack RS to the left. The number of units between pin 564 in home position and each surface is directly disposed thereto is summarized as follows for convenience.

<table>
<thead>
<tr>
<th>Distance rack RS carried to the left in units</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>2</td>
</tr>
<tr>
<td>1b</td>
<td>3</td>
</tr>
<tr>
<td>2a</td>
<td>1</td>
</tr>
<tr>
<td>2b</td>
<td>2</td>
</tr>
<tr>
<td>3a</td>
<td>5</td>
</tr>
<tr>
<td>3b</td>
<td>6</td>
</tr>
<tr>
<td>4a</td>
<td>1</td>
</tr>
<tr>
<td>4b</td>
<td>2</td>
</tr>
<tr>
<td>5a</td>
<td>3</td>
</tr>
<tr>
<td>5b</td>
<td>5</td>
</tr>
<tr>
<td>6a</td>
<td>0</td>
</tr>
<tr>
<td>6b</td>
<td>0</td>
</tr>
</tbody>
</table>

Because, as rack RS travels back to the right, the difference between its a and b disposition with respect to any one particular state is erased, i.e., rack RS carries state memory stop SNS back to latched position by engagement with flanged end 728 thereof, the state for the next succeeding ball will again be a transitory state with one of the a suffixed surfaces disposed opposite pin 564 and the advance from the present state to the new state will be in effect in terms of whole units, i.e., from state 1 to state 2 or 3 or 4 or the like. Because of the number of units of advancement listed above, permitted by the respective state surfaces, the respective surfaces will cause eventual alignment of the cam for the next subsequent ball in the transitory state with the following respective surfaces disposed opposing pin 564.

<table>
<thead>
<tr>
<th>Present state surface</th>
<th>Next succeeding transitory state surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>2a</td>
</tr>
<tr>
<td>1b</td>
<td>2a</td>
</tr>
<tr>
<td>2a</td>
<td>3a</td>
</tr>
<tr>
<td>2b</td>
<td>3a</td>
</tr>
<tr>
<td>3a</td>
<td>4a</td>
</tr>
<tr>
<td>3b</td>
<td>4a</td>
</tr>
<tr>
<td>4a</td>
<td>5a</td>
</tr>
<tr>
<td>4b</td>
<td>5a</td>
</tr>
<tr>
<td>5a</td>
<td>6a</td>
</tr>
<tr>
<td>5b</td>
<td>6a</td>
</tr>
</tbody>
</table>

The state mechanism is also used to identify a second ball condition to the computer. Second to, spaced from and carried by rack RS is a first ball-second ball detector plate 750 which is carried by rack RS with cam follower 751 riding on the lowered cam surface of plate 750. Cam follower 751 is pivotally mounted at 625 and pivots slightly counterclockwise when the cam roller comes to positions 3a, 3b, 5a and 5b. Plate 750 and cam follower 751 are configured and disposed so that the cam follower is riding at the point of letter designation corresponding to the state which has been fed into rack RS and up-dated if necessary responsive to current input.

Switch 2B (wiring diagram, FIG. 105) is mounted on suitable framework and is included in the control circuitry so as to actuate relay 2BK when closed. follower 751 has an arm 752 secured thereto with a flanged tip 754 disposed to trip second ball microswitch 2B when pivoted counterclockwise depending upon the disposition of arm 752. When cam follower 751 is riding along the portions of plate 750 corresponding to the first ball states, i.e., 1a through 2b, 4a, 6a and 6b, switch 2B remains open and while cam 751 is riding in the dwells at point 3a, 3b, 5a or 5b, all second ball states, the second ball switch...
2B is closed. Second ball switch 2B gives a second ball signal to be used as input to the computation system that the ball is a second ball to cause proper printing of the second ball score as a frame score and to perform other functions peculiar to second balls as are described elsewhere, i.e., control of foul scoring.

TEAM TOTAL MEMORY AND CARRY SYSTEM

The team total member unit is used at the end of league bowling to total the scores of the individual team players, thereby obtaining a total for the team. At the end of the game when an individual bowler's final score is represented by the position of racks RU, RT and RH, the team total memory is engaged with these racks instead of the bowler memory and the racks are then returned to home position to enter the bowler's total score into the team total. The team total memory is then disengaged from the racks and any necessary carry operations performed. Then the team total memory is re-engaged with the racks, the racks are driven to the left, the team total memory is disengaged and the team total is printed. Then the team total memory is re-engaged with the racks and the racks are driven to the right. The second player's total is also entered into the team total on top of the first player's total. At this point the second player's total is determined. Such operation is continued until all players have completed their game and their totals have been entered into the team total.

Because the carrying function is not performed with the racks driven to the left by the calculator, provision is made in the team total memory for such carry. Referring to FIGS. 66-71, the team total memories T1TM and T2TM are both shown as mounted in the same housing, although, as indicated above, the team total memories operate separately and may advantageously be included in separate housings. The pinsions of the team total memories are engaged and disengaged by a mechanism in the same manner as the bowler memories described above.

The team total memory elements for each team are separately mounted between parallel housing sides 760 spaced from each other by spacers 761 and secured by bolts 762. Mounted between sides 760 and secured thereto are a plurality of shafts 764, 765, 766, 767 and 768. Plate members 770 and 771 are provided slidably mounted by slots 772 on shafts 765, 766 and 767. Plates 770 and 771 are respectively secured to shafts 774 and 775, which shafts carry the team total memories T1TM and T2TM and from engagement with racks RU, RT and RH. Shafts 774 and 775 extend through slots 776 in sides 760 for connection to the armature of the appropriate T1TM or T2TM solenoid.

Each shaft 774 and 775 includes a plurality of separate sleeve members 777 through 781 thereon. Pinions GU, GT and GH are secured respectively to the sleeve members 777, 779 and 781, as are cam members CAM-U, CAM-T and CAM-H. Stationary sleeves 778 and 780 each have a cam member 784 and a link 785 secured thereto.

Link 785 extends upward from shaft 774 or 775 and a shaft 765 or 766 passes through a guide slot 786 in the link. A frame member 787 is secured to each shaft 765 and 766 and shaft 764 or 767. A link 788 having a latch end 790 is pivoted on pin 791 secured to frame 787 and is pivotally connected to an arm of link 785 through a lost motion slot 792 and pin 794, pin 791 extending through opening 795 in frame 787 between links 788 and 785. Spring 796 normally urges link 788 in a counterclockwise direction as viewed in FIG. 66. A pair of drive sectors 797 are rotatably mounted via sleeves 798 on each shaft 765 and 766. Rotatably mounted on each shaft 767 and 768 are a plurality of pivotal sleeves 800, each carrying a cam follower and latch member 801. Each cam follower 801 is normally urged by a spring 802 in a counterclockwise direction toward a cam CAM-U, CAM-T or CAM-H, but with shafts 774 and 775 in down position, follower 801 is stopped by latching engagement of its latch portion 804 with latch receiver 805 on drive sector 797.

A crank 806 is pivotally mounted by pin 807 to each frame member 787 and has a flange 808 on one arm for abutting drive sector 797 and blocking pivotal movement of the drive sector in a clockwise direction. Crank 806, under urging of spring 811, latches between a pin 811 and drive sector 797, is normally urged clockwise about pin 807. Another arm of crank 806 is urged against sleeve 778 or 780 and the third arm of crank 806 carries a pivotally dependent latch link 812 by pin 811, link 812 having a latch notch 814 and a stop pin 813 engaging biased counterclockwise about pin 811 by a tension spring 816 anchored at its other end to pin 817. Notch 814 is adapted to latch flanged end 822 of frame member 787.

Pin 815 abuts a cam surface 818 on the end of arm 784.

It has been seen that team total memory has a set of three pinions GU, GT and GH on shaft 774 or 775, the pinions engaging respectively the units rack RU, tens rack RT, and 100's rack RH, when in down position. Shaft 774 or 775 is linked to solenoid T1TM or T2TM for engaging and disengaging the pinions G with the racks. Cam members CAM are rotatable with each pinion G and are in the position shown in the team A total memory in the left portion of FIG. 66, when the pinion has been rotated a total of 10. No stops are provided as were provided in the case of the bowler memory pinions.

Provision is made to carry from units to hundreds and hundreds to thousands in the memory system since the computer is not provided with a team total carry system. Accordingly, when any pinion G has rotated a full 10 count from its 0 position, the corresponding cam CAM trips cam follower 801 to pivot follower 801 clockwise in FIG. 66. Upon disengaging the pinions from the racks, pinion G and cam CAM are carried upward by shaft 774 or 775. Latching flange 804 of follower 801 projects laterally and engages latch receiver 805 on drive sector 797. Prior to tripping follower 801, latch member 804 holds drive member 797 against clockwise movement by its position latching in receiver 805. As follower 801 is pivoted clockwise, latch 804 is removed from receiver 805 permitting spring 810 to urge drive member 797 clockwise. However, flange 808 blocks sector 797 from substantial pivotal movement until pinions 812 are disengaged from the racks so that the team total memory 797 will not jam any of pinions 812 while score information is being introduced to the memory.

Upon lifting of shaft 774 or 775 to disengage the pinions G from the racks, shaft 774 or 775 carries link 785 upward guided by slot 786 on cam 806. Arm 784 of link 785 also moves upward. Crank 806 is pivoted counterclockwise on pin 807 by shaft 774 or 775 through an arm of crank 806, removing flange 808 from blocking sector 797 which pivots clockwise a distance permitted by flange 808.

Link 785 is connected through a lost motion pin and slot arrangement to reset latch 788 and latch 785 is spring-urged in a clockwise direction with respect to link 785. Lifting of shaft 774 or 775 and link 785 results in pivoting reset latch 788 counterclockwise about pin 821 to a raised position.

Crank 806 is pivotally connected at 811 to latch 812 and urges latch 812 downward to latch flange 822 of mounting plate 787 in the position shown with respect to team 806 in FIG. 66. With spring 816 holding the latch in latched position, stop pin 815 is moved to the inclined on the edge of arm 784 and up to the cam surface. The illustration of the mechanism of the team B memory is shown at this phase of operation with the parts moved as described hereinabove.

The teeth 820 on drive member 797 are disposed to engage the next adjacent pinion G of the next higher order, e.g., pinion GT adjacent to pinion GU where pinion GU has tripped follower 801. Drive member 797 is
limited in its clockwise pivotal movement to advance the next adjacent pinion 812 via teeth 820 counterclockwise one unit, i.e., one tooth or 36° of rotation. Thus, the carry is effected during the disengagement of the memory subsequent to rotation of a pinion 36° to carry 36° of rotation into the pinion of the next higher magnitude digit.

The carry mechanism is reset upon re-engaging the pinion wheels 812 with the racks R for subsequent entry of the team total scores into the racks for printing. Shaft 774 or 775, moved downward by solenoid T6, TM or T6, TM carries pinion G and cam CAM downward and also carries link 778 and arm 784. As link 778 is moved downward, latch 788 pivots clockwise and engages surface 824 of drive member 797 and pivots drive member 797 counterclockwise until latch receiver 805 is re-engaged by latch projection 804 on cam member 801. Cam or stop member 815 rides on and follows the inclined end of arm 784 pivoting latch 812 clockwise about pin 811 against the urging of spring 816, resulting in unlatching of latch 812 from flange 822. Spring 810 urges crank 806 in clockwise direction about pin 807 carrying pin 811 and latch 812 therewith. Flange 808 abuts sector 797. All elements shown in the position shown with respect to team A in FIG. 66.

Turning now to FIG. 71, a different provision is made to retain a count of one thousand in the team total memory because no provision therefor has been made in the above team total mechanism. Thus, the carry from pinion GH which is aligned to engage rack RH carries a cam member CAM-II as before for actuating the cam follower 801. However, the heel portion 804 of follower 801, upon pivoting of follower 801 clockwise, acts to close switch T6—1900 or T6—1000 which indicates that the team total is at least 1000.

Turning now especially to FIG. 68, each time the team total memory is engaged for entry into the racks, it is desired to print the team total so far accumulated and, upon the entry of the score for the last player of the team, it is desired to print complete team total. Accordingly, in the illustrated form, provision has been made to stop the state rack in position indicating state 3a, this state being selected rather than providing an additional state since state 3a will cause printing and return the state rack to state 1a, a convenient position from which to start after the printing of the complete team total, state 1a being the position for beginning the next game. In order to stop the rack at state 3a, a stop member 825 is mounted at 826 on plate 770 or 771 for each team total memory. At each time the pinion is moved, stop member 825 projects downward in the position shown in FIG. 68 with respect to team A. As state rack RS is driven to the left, a square lug 827 thereon abuts stop member 825 whenever stop member 825 is down. Lug 827 is disposed linearly on rack RS in correct disposition for stopping rack RS at state 3a when lug 827 abuts projection 825. Stop 825 is pivoted at 826 and spring-urged in a counterclockwise direction so that when the rack RS is moving from left to right in FIG. 68, the stop 825 will pass over lug 827 if necessary and will not stop rack RS.

PRINTING SYSTEM

The printing mechanism (FIG. 72) is mounted on a frame 830 and includes a carriage 831 movable in X and Y directions and carrying a printing head 832, a driven differential gear mechanism 834 for moving the carriage a predetermined number of units in each direction and a printer head operating mechanism generally indicated at 835. This setting type in head 832 responsive to readout signals from the computation unit. Frame 830 may be supported on suitable legs or the like, and in the illustrated form, is mounted within cabinet 218 (FIG. 1). Mounted on frame 830 by brackets 836 are a pair of parallel bars 837. A carriage member 831, having sleeves 840 secured thereto, is slidable mounted on bars 837, slidable along an X-axis as viewed in FIG. 72. Considering FIGS. 72—74, a second pair of parallel bars 841 is mounted on carriage member 831 at each end of each bar as indicated at 842. A printing head 832 is slidable mounted by sleeves 844 on bars 841, slidable along a Y-axis.

A carriage positioning tape T—X is secured at one end by bracket 845 to carriage 831 for pulling carriage 831 to the left as viewed in FIG. 72 with sleeves 840 sliding on bars 837. A cable 846 extends to the opposite side of carriage 831 by bracket 847. Cable 846 is extendable from and retractable by a spring rewind reel 848 having sufficient spring power to move carriage 831 the extent of its travel to the right in FIG. 72 to approximately the position shown, i.e., carriage home position, upon release of pull on tape T—X.

A print head positioning tape T—Y is secured at one end to frame 830 by bracket 850 and passes thence in order through pulley 851 rotatably mounted on carriage 831, pulley 852 rotatably mounted on print head 832, and pulley 853 rotatably mounted on carriage 831. The other ends of both tapes T—X and T—Y pass to windup spools driven by differential mechanism 834 as will be more fully described below. Another cable 855 is secured to print head 832 by bracket 856. Cable 855 is extensible from and retractable by a spring rewind reel 857 having sufficient power to move print head 832 along the Y-axis to its limit of movement in one direction, i.e., to a home position in which the carriage is illustrated in FIG. 72, upon release of pull on tape T—X.

The printer head 832 is normally maintained in home position and is moved from home position for positioning the head correctly for each desired printing operation via tapes T—X and T—Y. Upon release of tapes T—X and T—Y, the head again returns to home position, the distance permitted by playout of tapes T—X and T—Y. However, in order to take tension off tapes T—X and T—Y while the head is in home position, abutments (not shown) are provided against which each carriage 831 and print head 832 rest while in home positions.

Each of the tapes T—X and T—Y for positioning the printer head is windable at its other end in one direction by a spool 905 or 927 and is extended from the spool 905 or 927 by spring means 857 and 848 urging the printing head in the opposite direction. The amount of winding of the tape on the spool determines the position of the printing head along the X and Y coordinates. The spools are each 770 or 771, carry separate differential system, as a part of mechanism 834, each driven by a plurality of sun planetary and ring gear mechanisms, each for moving a shaft for driving one of the tape spools a predetermined amount from a home position, the home position corresponding to the position of the printer head with both tapes fully extended from the spools.

More particularly, a shaft 860 rotatably mounted on frame 830 is driven by a motor 861 through a sprocket drive 862. Shaft 860 has a plurality of one-half revolution clutches 864 through 872, (FIGS. 75 and 77) mounted thereon.

Each clutch (FIG. 77) has a drive sprocket wheel 875 including notches 876 at 90° intervals and mounted on shaft 860 by means of pin 877. Also, in each clutch is a wheel 878 rotatably mounted on shaft 860 for rotation relative thereto and carrying a notch member 880 pivotally mounted at 881 on disc 878 and having latching surfaces 882 and 883. Surface 882 is adapted to engage notch 876 and is normally urged toward engagement with notch 876 by means of spring 884 having one end secured to latch member 880 and the other end on disc 878. Shaft 887 is mounted between points of frame 830. A pawl 886 is pivotally mounted on shaft 887 for pivoting from a latched position shown in FIG. 77 to a clockwise direction to an unlatched half revolution hold posi-
tion as will be described hereinafter. Pawl 886 is secured to an armature of a solenoid ½YS, 1YS, 2YS, 4YS, 5YS, 6XS, 7XS, 8XS, or 9XS by means of link 888 pivotally connected at one end to pawl 886 and at the other end to the armature. The actuation of the solenoid pulls the armature into the solenoid pivoting pawl 886 in a clockwise direction about shaft 887, whereby pawl 886 releases surface 883 of latch 880 and latch 880 is urged by spring 884 so that surface 882 is swung into the path of the rotating clutch wheel 875 rotating on shaft 860. Notch 876 engages surface 882 and pawl carrier 878 is thereby latched to clutch disc 875 for rotation. Pawl carrier 878 rotates one-half revolution whereupon end 890 of pawl 886, which has been pivoted, engages surface 883 of latch 880 and causes latch 880 to pivot clockwise to the position shown in dotted lines to release clutch disc 875. Pawl carrier 878 is thereby stopped while clutch disc 875 continues to rotate so long as the solenoid remains energized. Upon de-energization of the solenoid, pawl 886 is pivoted back to the position shown in FIG. 77 releasing latch 880 which pivots counterclockwise to engage notch 876 whereby pawl carrier 878 again rotates with the one revolution, i.e., until surface 892 of pawl 886 engages surface 883 of latch 880 and causes pawl carrier 878 to pivot latch 880 out of engagement with notch 876 and to stop pawl carrier 878 again in the position shown in FIG. 77.

The manometer at 887 is a backstop latch member 895 which is normally urged in a counterclockwise direction by spring 896. A pair of receivers 900 is configured to receive the end of latch member 895 each time rotation of pawl carrier 878 is stopped, i.e., at the one-half revolution hold position and at the normal position before or after completion of the one revolution. Thus, whenever pawl carrier 878 is in an stopped position, the end of latch member 895 abuts the surface 900 in pawl carrier 878 to prevent reverse rotation which may be caused from impact.

Secured to each of pawl carriers 878 is an eccentrical circular cam 901 which rotates about shaft 860 one revolution with pawl carrier 878 so that cam follower arm 902 having cam follower roller 904 riding on the surface of cam 901 travels from a low portion of the cam surface over a single rise and back to the low portion during each revolution. When pawl carrier 878 is in un-latched one-half cycle stop position as stopped by pawl end 890, roller 904 is resting on the rise of 901. Thus, during the revolution of cam 901, the follower 902, which pivots about the axis of shaft 926, is pivoted in a counter-clockwise direction through the instance of one revolution of cam 901. All cam followers 902 are of the same configuration but disposed 180° with respect to the cam of one revolution clutches 864, 866, 868, 869 and 871, and at the half revolution point, the cam follower is on the rise of the cam. In the instances of the other one revolution clutches, i.e., 865, 867, 870 and 872, the cams 901 are of the same configuration but disposed 180° with respect to the cam 901 of one revolution clutches 864, 866, 868, 869 and 870, and thus the cam follower 902 is pivoted clockwise while on the rise of cam 901.

Each cam follower arm 902 is provided with an adjustable stop 906 which rests against frame member 907 when roller 904 is at its lowest travel. The stops 906 are provided for adjustment with 905 for adjusting to provide a gap 910 between roller 904 and cam 901 while roller 904 is on the low portion of cam 901. Thus, the position of planet gears 911 and the amount of movement of planet gears 911 during each revolution of the clutch mechanism is adjustable by means of adjustment 908.

A plurality of differential gears 914 through 920 is provided, each differential gear including a sun gear 921, a pair of planet gears 911 and a differential carrier 912. The two differential units are provided, first including gears 914 through 917 and the second including gears 918 through 920. The first differential is used in adjusting the Y direction tape T–Y for movement of carriage 838 in the Y direction, i.e., from printing position to printing position along a particular bowler's line, as directed by selection of the BL or BR switch identifying that bowler. The second differential unit for adjustment for movement of spool 825 through gears 924 and 925, spool 905 being pivotally mounted at 912 to frame 998. Each of gears 914 through 917 has its ring gear connected to the sun gear of the gear unit of next higher number with the exception of gear unit 917 where the ring gear is secured to the follower arm 902 of one revolution clutch and the cam assembly 868, as best shown in FIGS. 75, 78 and 79. The planet gears 911 of units 914 through 917 are mounted on follower arms 901 of clutch and cam units 864 through 867 inclusive.

Movement of planet gears 911 about shaft 926 in each gear unit causes output rotation of shaft 922 and corresponding rotation of spool 905 to wind a portion of tape T–Y thereon. The gear assemblies 914 through 917 are coordinated with each other in such manner that for each pivoting of the respective cam follower 902 by the hammer actuating portion to strike a row of type aligned by the typesetting portion to effect the printing of the corresponding Y solenoid, ½YS, 1YS, 2YS, or 9XS, remains energized. Each unit of measure corresponds to the distance from one bowler's line to the next on the score sheet upon which the printing is to be conducted.

The second differential unit including gear assemblies 918 through 920 operates on the same principle, with the exception that one of the intermediate units is eliminated. The gear assemblies are coordinated so that movement of follower arms 902 by means of clutch and cam assemblies 869 through 872, respectively, (as actuated by X solenoids 1XS, 2XS, 4XS and 8XS) cause windings of 1, 4 and 8 units of tape on spool 927 by the output from the sun gear of gear assembly 918. The operation of gear assembly 920 responsive to clutch and cam assemblies 871 and 872 is the same as the operation of gear assembly 917 responsive to clutch and cam assemblies 867 and 868, while the operation of gear assembly 919 responsive to clutch and cam assemblies 869 and 870 is the same as the operation of gear assemblies 914 and 915 responsive to clutch and cam assemblies 864 and 865.

It will be apparent from the above that the array solenoids ½YS through 8XS may be selectively actuated in order to position the print carriage for printing in any scorekeeping print position on the score sheet.

The Y solenoids are selected by the bowler identity switches BL and BR and suitable circuitry (FIGS. 99 and 101) links these switches for energizing the Y solenoids singly or in combination to correctly position the printing head on the X-axis to the selected bowler's score line. The X solenoids are selected by the contacts attached to the frame rack RF completing circuits through matrix MAT–2 and suitable circuitry (see especially FIG. 107) is provided for energizing the X solenoids singly or in combination to correctly position the printing head on the Y-axis of the corresponding Y solenoid.

Print head 832, referring to FIGS. 80 through 87, includes a lower typesetting portion with the type disposed over a prism surface 928, an upper hammer actuating portion and an intermediate hammer 930 which is actuated by the hammer actuating portion to strike a row of type aligned by the typesetting portion to effect the printing
operation upon a printable surface, such as a score sheet 700, backed by surface 728. In the typesetting portion, there are provided four parallel slides 931, each mounted on a pair of pins 932 through slots 934 and 935, pins 932 being secured at the ends to frame 936. The slides 931 are normally urged to the left as viewed in FIGS. 80 and 81. Slides 937 grounded to frame 936 by suitable bracket means shown at 938 and attached at their other ends to upstanding flange portions 940, of slides 931. Each slide 931 is retained against sliding to the left by a separate tape 941 secured to flange 940, which tape is under tension from a typesetting control system to be described hereinbelow. In general, the typesetting control system plays out the tapes 941 permitting each of slides 931 to slide to the left a given number of units up to a maximum number of units corresponding to the number of type slugs carried by each slide 931. Slides 931 (except the slide for printing the thousands digit) each carry a set of 13 type slugs 942, as illustrated, each having on its bottom or printing surface 944 the indicia shown immediately above the type slug. Printing surface 944 on each type slug is disposed for alignment of printed indicia by the distance between slugs 942 and prism surface 938. As each slide is permitted to move a given number of units to the left, it carries a given type slug under the impact portion 945 of hammer 930 so that if hammer 930 strikes the type slug, as projected and positioned, the hammer may impress its corresponding mark on the paper.

As best seen in FIGS. 81 and 84, type slugs 942 are mounted between the slide 931 and a plate 946 mounted on slide 931 and spaced therefrom. Slugs 942 are vertically slidable between the plate 946 and slide 931 and each slug 942 has a projection 947 which projects into a recess 948. Recess 948 extends the length of plate 946 and is of sufficient height to accommodate a leaf spring 950 which normally urges projections 947, and type slugs 942 upward. It will be noted that a striking force on the upper end of any of the type slugs will force the type slug, printing end downward, to impress a surface therefore, and spring 950, held in place by pin 949, will urge against projection 947 to return the type slug to its normal position as shown in FIGS. 81 and 84.

In order to precisely align and type slugs for exact alignment and appear identical digits in a score number to be printed on a score sheet, a plurality of aligning notches 951 are provided on an upper surface of each slide 931. The aligning notches are generally V-shaped and one such notch is included for each type slug mounted on each slide 931. When tape 947 plays out and permits a slide 931 to move to the left as viewed in FIG. 81, a notch 951 will become generally aligned under a pointed plunger 952 having a pointed end 954. After alignment of the desired type slugs in a row beneath the striking portions 945 of hammers 930, as will be seen, lever 955 is actuated by leftward motion of pin 938 and pivoted counterclockwise about pin 956, mounted to frame 936, pivoting flange 957 out from beneath arm 958. Spring 960, biasing between arm 958 and lever 955 pulls arm 958 counterclockwise urging pin 961, secured to plunger 952, downward carrying plunger 952 therewith. Plunger 952 is vertically slidable by its mounting on pins 962 and 964 through slots 965. Point 954 engages the notch 951 disposed therebelow and the configuration of point 954, being such as to tightly fit in the notch 951, cams the notch 951 to a central position thereby precisely aligning the type slug impinging against the hammer portion 947. The points 954 will remain in notch 951 until the printing operation is complete, maintaining the proper alignment of type slugs with respect to each other in the parallel slides 931.

The hammer mechanism includes a hammer for each set of type carried by a slide 931. Thus there are four hammer members 930, best seen with respect to FIGS. 81 and 84. Hammers 930 are pivotally mounted on pin 966 which is secured at each end through frame 936. A pin 967 is provided on each hammer for lifting the hammer to operate the hammer by letting it fall with impact portion 945 striking the top of the aligned type slug, hammer 930 pivoting on pin 966.

Adjacent each hammer, a stop member 968 is also provided mounted on pin 966. Stop member 968 has a flange 970 projecting beneath the hammer to limit its downward travel and to lift it off the type slug after each impact. A pin 971, secured at each end to frame 936, projects through a limit slot 972 in each stop member 968 slightly elongate with respect to pin 971 so that when hammer 930 is lifted and dropped and strikes flange 970, stop member 968 will pivot slightly clockwise as viewed in FIG. 81 as permitted by the size of slot 972 on pin 971, thereby permitting hammer 930 to fall to a position slightly below that shown in FIG. 76 for striking the type and driving the type downward, sufficient to effect printing on a paper surface therefore, but insufficient to transfer significant force of the printing hammer 930 to the glass surface 928.

Spring 974 is a tension spring connection between arms of stop member 966 and paper or the like for the purpose of providing a resilient connection between the hammer and stop member. Further, the stop member 968 is grounded through spring 975 to pin 976 secured at each end to frame 936 so that when hammer 930 is lifted and dropped on flange 970, stop member 968 pivots clockwise the amount permitted and tension in spring 975 is introduced. After the momentum of hammer 930 is stopped by the stop member, the shock being absorbed by resistance of the type slug and by pin 971, spring 975 returns stop member 968 counterclockwise to the position of FIG. 81 with flange 970 lifting hammer 930 from the type slug. Spring 974 assists in positive driving of the hammer downward and adds to the force of gravity when hammer 930 is released from its elevated position.

A spring-loaded mechanism is provided for lifting and dropping hammer 930 to effect the printing operation. Accordingly, a pair of slides 977 is mounted by elongate slots 978 on pins 932, best seen in FIGS. 81 through 86. The two slides 977 are secured parallel to each other in spaced relation to each other by pins 981, 982, 984, 985, 986, 987 and 988. A pair of intermediate carried members 990 of the same general configuration as the midportions of slides 977 are spacedly mounted and carried on pins 984 and 987, thereby secured between and in spaced relation to slides 977. Mounted to each of slides 977 and members 990 on pin 985 is a scoop member 991 having a lateral curved flange 1014 along a lower angular surface thereof and carried on pins 984 and 987. A scoop member 991 having an arcuate elongate slot 992 through which pin 986 projects, slot 992 being slidable over pin 986 to permit pivoting of scoop member 991 about its pivot point 985. A latch 994 for normally latching scoop 991 in its elevated position as shown in FIG. 81 is pivotally mounted to each of slides 977 and 990 by a pin 995. Latch 994 is normally urged in a clockwise direction to engage a latch receiving portion of scoop 991 by tension spring 996 extending between latch 994 and grounded to pin 997. The purpose of latch 994 will be discussed hereinbelow, but for the present, it will be assumed that latch 994 is pivoted counterclockwise, extending spring 996, for normal operation of the hammer. Each scoop 991 is normally urged in a counterclockwise direction by spring 1012 biasing between slides 977 or 990. With slides 977 and 990 held in their position to the right as in FIG. 81 by tape 998, scoops 991 are retained in elevated or clockwise position by a stop pin 1011 grounded at each end to frame 936.

A tension spring 980 is provided secured at one end to pin 981 on slides 977 and secured at the other end to pin 979 grounded on each hammer 930 with their home position, spring 980 is retained under tension by resistance of taut tape 988 secured to slides 977 by pin
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982. Release of tension on tape 998, attached to pin 982, as will occur responsive to a print control mechanism to be described hereinbelow, permits tension spring 980 to drop from zero where zeros are not desired in the printing. As slides 977 and 990 travel to the left under the urging of spring 980, scoops 991 are carried clear of stop pin 1011 and springs 1013 urge scoops 991 downward. The end of the trough-like flange 1014 drops beneath pin 967 and pin 967 engages the interior of the trough 1014 and as all lever 1026 is released in the left pull of pin 967 rides up the trough to the end thereof and drops from the right-hand end of trough 1014 as viewed in FIG. 81. FIG. 84 shows the scoop 1014 in phantom in a section al view through pin 967. When hammer 930 falls from the upper end of scoop 1014, the printing operation as discussed above is effected. However, in the meantime, pin 988 has engaged lever 955 to actuate the aligning device driving member 952 with its pointed camming surface 954 into notches 951 to precisely align the type before being struck by hammer 930.

Only two of the levers 955 project up for engagement by pin 988, the other two levers 1017 are secured thereto by a pin 1016 and are of the same general configuration therebelow as the levers 955, all levers 955 and 1017 pivoting about pin 956 in the above described manner.

The print head is reset by returning slides 977 to the right to the position of FIG. 81 by pulling tape 998 by slide 1021 and pulley 1022, mounted thereon, in an operation which will be described hereinbelow. As slides 977 are pulled to the right, pin 988 disengages lever 955: springs 953 pull levers 955 clockwise about pin 956, flange 997 engages arm 952 which in turn lifts arm 952 from engagement with notches 951. Tapes 941 are also pulled at this time by slides 1018 and pulleys 1019 mounted thereon to return slides 931 to the right to the position shown in FIG. 81. As slide 977 progresses further to the right, the lower arm 1023 of the scoop 991 engages stop pin 1011 and scoops 991 are thereby pivoted clockwise about pin 985 to the position shown. During their return, scoops 991 may ride by flanges 1014 over pin 967 of hammer 930 so that spring 975 is of sufficient strength to retain hammer 930 against pivoting. At home position, scoops 991 will be seen, will also be relatched by latch member 994 in those cases where the latch member has been released.

In the printer head assembly, apparatus is provided for normally suppressing the printing of zeros by the printing head. Such apparatus functions to suppress printing of zeros where zeros are not desired, e.g., in the thousands and hundreds columns where the total to be printed is less than 100 or in all columns other than units column where the total to be printed is less than ten. Accordingly, a pin 1024 is provided on each slide 931 for printing tens, hundreds and thousands, pin 1024 being eliminated from the slide 931 for printing units. With slide 931 in position aligning a zero with the printing hammer, pin 1024 blocks the clockwise pivoting of lever 1026 about pin 1027 under urging of tension spring 1026 grounded to suitable framework. As the slide 931 carrying pin 1024 is moved away from the zero position, pin 1024 no longer blocks the clockwise urging of lever 1026. With pin 1024 moved away from blocking position, lever 1026 is free to pivot clockwise toward the stop pin 1030, as urged by spring 1028, and surface 1029 lifts arm 1031 upward so that flange 1032 engages lever 994, pivoting lever 994 counterclockwise about pin 995 against urging of spring 996 to unlatch lever 994 from holding scoop member 991 against dropping. Scoop 991 is then permitted to drop for printing of the digit. On arm 1031 there is provided a second lifting flange 1033 which extends laterally from each of the three levers 1031 to closely underlie the flange 1033 on the next lower order of arm 1031, i.e. the hundreds and tens arm 1031 respectively. Thus, each time one of the three arms 1031 is lifted, it carries each arm 1031 of a lower order upward with it to unlatch the scoops and cause printing of zeros, printing of zeros being otherwise suppressed by the treatment of pin 1023 of FIG. 81.

For operating the printer head 832, there is provided an operating mechanism which is indicated generally by reference number 835 but which also extends by means of a plurality of operating tapes 998 and 941 to the printing head carried by the above described carryings.

The print head control or operating mechanism (FIGS. 72 and 88 through 92) for setting type in the print head and for actuating the hammer is driven by a shaft 1036 which rotates one revolution per print cycle. Shaft 1036 is driven by shaft 1037 through solenoid actuated one revolution clutch 1038. Shaft 1037 is in turn driven through sprocket 1059 from constantly driven shaft 860. Actuation of the one revolution clutch solenoid causes the one revolution cycle of the shaft 1036, i.e. the print cycle. Solenoid PS is actuated through a time delay by a signal from the computer by closure of a print signal switch PTM, PFS or PBS.

In FIG. 92, one revolution clutch 1038 and its actuation by solenoid PS is shown in more detail. Upon energization, solenoid PS pulls in latch member 1074 to pivot clockwise on pin 1075 against the urging of tension spring 1092 biasing between member 1074 and a bracket 1093 secured to frame 830, disengaging notch 1095 and permitting clutch member 1094 to rotate clockwise, carrying shaft 1036 therewith. During the first portion of the revolution of the clutch member 1094, magnet PS is deenergized and latch 1074 rides on the edge surface of member 1094. At the end of the one revolution, notch 1095 is re-engaged by latch 1074 to stop member 1094 and shaft 1036. The complete clutch is not shown in detail but it will be apparent from the description hereinabove that a conventional clutch mechanism is used.

As shaft 1036 rotates through one revolution, cams 1041, 1042, 1043 and 1044 are rotated through one revolution. Each of cam followers 1046, 1047, 1048 and 1049 is mounted on a slide 1048 or 1049 having elongate slots 1051 slidable over pins 1052. Cam followers 1046 and 1047 are slidably mounted on pins 1052 by elongate slots 1051 for slidable movement toward and away from cams 1041 and 1042. Followers 1046 and 1047 are spring urged normally forward, i.e., toward the cams, for following the cams during rotation of the cams. During cam rotation, followers 1046 and 1047 are urged rearward, with 1046 leading, by rises of cams 1041 and 1042 and toward shaft 1036 on falls in the cams, urged by springs 1053 and 1054.

Cam follower 1047 will control actuation of the printing hammer. To control the hammer actuation system, slide 1049 deviates laterally to a bifurcated portion 1057 having a pin 1058 therethrough. Hooked end 1056 of slide 1018 abuts pin 1058. The other end of slide 1018 is bifurcated and carries the pulley member 1022 pivotally mounted at 1062 having a tape 998 extending therearound. Slide 1018 is slidably mounted on a pair of pins 1063 and 1064 through elongate slots 1066.

Similarly, slide 1048 is slidably on pins 1052 via slots 1051 and carries a pin 1067 on a lateral deviation. Hooked ends 1056 and a plurality of four slides 1018 about pin 1967. The four slides 1021 are each independently slideable on pins 1063 and 1064 via slots 1066 and are of the same general configuration is slide 1018, including the hooked ends 1056 and the pulleys 1019 pivotally mounted within
the bifurcations of ends 1059. Slides 1021 each includes a ratchet edge 1068, each tooth of which represents a unit of movement of slide 1021. A magnet TS-1, TS-10, TS-100 or TS-1000 is mounted on suitable framework adjacent edge 1068 of each slide 1021. Each of magnets TS has its core end 1069 disposed adjacent and facing a flange 1071 on a latch member 1072 pivotally mounted at 1073. Latch member 1072 is disposed to engage and disengage ratchet 1068 upon pivoting clockwise and counterclockwise about pin 1073, respectively.

During the first phase of the print cycle, the type is aligned, and during the second phase, the print hammer is actuated to print the score information reflected in the aligned type.

At the beginning of the print cycle, followers 1046 and 1047 are on rises of cams 1041 and 1042, respectively. As cam follower 1046 falls on cam 1041, pin 1067 is moved forward, magnets TS being de-energized and latches 1072, normally spring-urged in a counterclockwise direction as viewed in FIG. 88, are disengaged from ratchets 1068. During the travel of pin 1067 forward, energization of any of the magnets TS will pivot latch 1072 into ratchet 1068 and hold the slide 1021 against following pin 1073. Meanwhile, follower 1047 continues on a rise holding pin 1058 and slide 1018 against movement in a rearward position.

Each of slides 1021 or 1018 is under tension from the typesetting springs 937 or scoop travel spring 980 in the printing head through a tape 941 or 998 which extends around a pulley 1022 or 1019 pivotally mounted at end 1059 of slide 1021 or 1018.

A circular commutator 1076 is mounted on the printer frame. Commutator 1076 includes a wiper member 1077 which wipes a plurality of contacts, one corresponding to each digit or other indica printable by the printer. Wiper 1077 is mounted on shaft 1036 and wipes these contacts identified by reference numeral 1078. Wiper 1077 also wipes a continuous hot contact 1079 on a wall 1081 of commutator 1076 facing the wall 1082 on which contacts 1078 are mounted. These contacts are diagrammatically illustrated in FIG. 108.

The contacts 1078 are angularly disposed in an arc for wiping by wiper 1077 and are disposed so that the “zero” contact is wiped as follower 1081 begins to ride on the fall of cam 1041. The remainder of the contacts are spaced from each other a distance corresponding to the amount of rotation required by shaft 1036 to rotate cam 1041 an amount sufficient to permit slides 1021 to move forward one unit. Each unit of movement of a slide 1021 corresponds to the amount of movement required to permit the printer hammer to become aligned with the printer hammer for printing by the printer head. Thus, the total movement of slide 1021 is thirteen units, one unit for each indica provided or one unit for each unit of movement of slides 931 in the printer head.

As the four slides 1021 slide on pins 1063 and 1064, each slide will come to a position in which the proper digit is aligned in the printing head to be struck by the printer hammer. This proper position is detected through commutator 1076 and the circuitry in FIG. 93. Accordingly, the commutator completes a circuit with the matrix MAT-1 (FIG. 108) through the contacts riding on the matrix and positioned by racks RMU, RMT, RU, RT and RH or slide ERB. Completion of this circuit energizes the appropriate magnet TS-1, TS-10, TS-100 or TS-1000 to pivot latch 1072 into ratchet 1068 and hold slide 1021 against the slide through pin 1067 continues forward. Thus, the proper digits are positioned in the printer head for printing.

Follower 1047 proceeds off its high on cam 1042, while follower 1046 is riding on the low dwell of cam 1041 and cam 1042 is configured to cause a sufficiently abrupt fall to cause the print hammer to strike the type, while follower 1047 is on the low dwell. This causes printing of a score by the type as set. Followers 1046 and 1047 proceed up the rises near the end of the print cycle. Pins 1058 and 1067 engage hooks 1056 on slides 1021 and 1018 and return slides 1021 and 1018 at the top of the rise and end of the cycle slides 1021 and 1018 are in their rearward position shown in FIG. 88.

When the print signal is received from the computer, it is desired to print the score on the score sheet. The print signal, after a delay to assure arrival of print head to proper X-Y position, energizes magnet PS, releasing clutch 1038 for one revolution of shaft 1036, permitting alignment of the type by slides 1021 and permitting the slide 1018 to slide forward under the urging of spring 1078 in the printer head, causing the printer scoop to slide across the printer head and effect the printing operation.

Latches 1072 remain in ratchet 1068 even after de-energization of magnet TS until slide 1021 is returned against the urging of the printer head springs. As the slides 1021 return after the printing operation, and at the initiation of the next printing cycle, latches 1072 are spring-urged out of engagement with the ratchet 1068.

A pulse generator switch PG is mounted for actuation by plunger 1083 which rides on a cam 1084. Cam 1084 includes a keyway point where the commutator wiper is aligned with a contact and the slide bar 1021 is precisely aligned with a tooth of ratchet 1068 in exact alignment for engagement by latch 1072. At this point, plunger 1083, under urging of spring 1086, falls into a fall on cam 1084 and immediately rises to a rise. While plunger 1083 is in the fall, contacts 1087 and 1088, which contacts are ignition points and comprise switch PG, send a momentary pulse to the appropriate magnet TS to latch the appropriate slide 1021. The pulse generator system assures that the slide 1021 will be latched in the desired correct position and prevent arcing between commutator contacts.

Switch DP is a normally open switch which closes once during each revolution of cam 1043, i.e., at the termination of a complete print cycle. Switch DP is actuated by a cam follower 1099 which follows cam 1043, cam 1043 having a fall at the end of the cycle. Switch DP is the source of the done printing signal sent to the computer to inform the computer the operation is complete.

A time delay circuit is provided for preventing the print signal from causing printing before the print head carriage has been positioned to correct alignment for the desired printing operation. Accordingly, when any of the print signal switches PTM, PFS or PBS are closed, the signal is not immediately sent to print hammer solenoid PD.

Switch SP, operated by cam follower 1091, following cam 1044 on shaft 1036, is closed at the beginning of the print cycle and opens soon after the cycle is initiated and is reclosed immediately prior to completion of the print cycle as cam 1044 rotates. Referring especially to FIG. 94, with switch SP closed prior to and at the beginning of the cycle, relay SPK is energized and contact SPK-1 is closed, energizing relay PK which is latched closed through one of the print signal switches. Energization of relay PK closes contact PK-1 to hold relay PK through switch SP while contacts PK-3 and PK-4 are broken cutting out the print signal switch and the 25 ohm resistor paralleling relay 2PK. Contact PK-2 is closed actuating relay 2PK through time relay comprising a resistor in series with relay 2PK and a condenser paralleling relay 2PK.

Contact 2PK-1 closes to energize solenoid PDS for starting rotation of shaft 1036 and cam 1044 opens switch, SP, de-energizing relays SPK, PK and 2PK and breaking the circuit to solenoid PDS. At the end of the cycle, the print signal from switch PTM, PFS or PBS will have been discontinued keeping solenoid PDS de-energized until a new print signal is received. Thus, the printing action is delayed until actuation of relay 2PK to give the printer head and type sufficient time for proper printing address.
53 READOUT FOR TYPE SETTING

Data for transmission to the printer for directing the printing position and the identity of indicia printed is generated by electrical means, including contacts completing portions of circuitry in a matrix on a circuit board, in accordance with the disposition of racks RU, RT, RH, RM, RMT, and RF and slide ERB.

It has been seen that upon completion of a computation to a point where it is desired to print the computed score information, each of racks RU, RT, RH, RM and RMT is in a position to the left as viewed in FIG. 50 one unit for each unit of the digit desired to be printed in the corresponding position on the score sheet. For example, where a total frame score of 126 has been computed and is ready for printing, rack RU will be six units to the left, rack RT two units to the left and rack RH one unit to the left. In like manner, where 16 team marks have been computed and is desired to print the number of marks, racks RM and RMT are six and one units to the left, respectively. It will also be recalled that slide ERB has been moved to the left one unit for each pin count received after bowling a ball. Since it is necessary to print box scores after each ball of a frame, the disposition of slide ERB is taken as the box score count.

By each of racks RU, RT, RH, RM and RMT and on slide ERB adjacent the left end thereof there is carried a contact 1096 slidable over a surface 1097 thereabove and a surface 1098 therebelow as the respective rack or slide is moved longitudinally. Racks RU, RT, RH, RM and RMT are connected to slides ERU, ERT, ERH, ERM and ERMT respectively which, in turn, have contacts 1096 secured thereto. Surface 1097 includes a printed circuit represented by the electrically conductive horizontal strips HS in the matrix MAT-1 illustrated in the left portion of FIG. 108 and surface 1098 includes a printed circuit configured as the electrically conductive vertical strips HS of matrix MAT-1.

In MAT-1, as in MAT-2 described below, surface 1097 may form a lower level on which contacts 1096 ride, while surface 1098 is spaced above and parallel to surface 1097 with contacts 1096 in contact with both surfaces. Proper alignment of the surfaces will be apparent and, in the illustrated matrices, may be accomplished by pivoting surface 1098 facially against surface 1097 from the position shown generally along the phantom line between surfaces 1097 and 1098 and then raising surface 1098 for securing at a proper spaced distance above surface 1097 depending on the height of contact 1096, with the reference corner lines, a, b, c and d, respectively, in vertical spaced registry.

The contacts 1096 carried by slide ERB and slides ERM, ERT, ERU, ERH, and ERT, respectively, are carried along strips HS-BS, HS-M, HS-MT, HS-U, HS-T and HS-H from left to right as viewed in FIG. 108 and from right to left as viewed in FIG. 50. Each unit of rack or slide movement carries the contact a distance from the center of one strip VS to another. For readout of information, a circuit is completed between the strips HS and one of the strips VS by each contact determining the digit to be printed in units, tens and/or hundreds positions.

54 READOUT FOR PRINTER POSITION

Turning to FIGS. 50 and 107, the rack RF also completes a printed circuit between upper surface 1097 and lower surface 1098 constituting matrix MAT-2. Contacts 1096 are carried by slide ERF which is positioned by rack RF in accordance with the frame in which the bowler is bowling, i.e. by formula cams and based on the bowler's state. The disposition of contacts 1096 on circuit boards or surface 1097 and 1098 translates the frame information in rack RF to electrical control for aligning the printer to print in the proper frame.
latch 1111 re-engages ratchet 1114 under urging of spring 1116 to latch slides 1103 and ERF against movement with rack RF.

OTHER ELECTRICAL CRUCIAL S LATCHES

Other electrical circuitry and switches are provided in addition to the printed circuit boards and controls for orienting the X-axis position of the printer head and for setting type in the printer head and in addition to the bowler identification switches BL–1 through BL–12 and BR–1 through BR–12 for orienting the printer head along the Y-axis. For example, switch PBS (FIG. 16, wiring diagram FIG. 107) is mounted to suitable framework in the rack drive portion of the data transmission system for transmitting data between the computer and memory system. Each time the rack drive drives the racks to the computer portion, switch PBS is closed momentarily during the last part of this motion, by eccentric 462 of the rack drive mechanism. Momentary closing of switch PBS sends a "print" signal to the printer for purposes of printing the box score reflected by disposition of slide ERB with respect to strips VS and HS–BS of matrix MAT–L.

Also included in the gang is a locking bar and release mechanism identified generally by reference number 1136. The gang of switches is of a type wherein each of the three switches CBS, CFS or CTM, upon closure, latches closed. The latch holding any of these three switches closed is released any time another of the three switches is closed or each time the latch release 1156 is actuated. For closing, switch CBS is tripped by spring loaded cam 1137 pivotal on member 1138 secured to shaft 468 of the rack drive system upon driving the racks all the way out to the computer and is repositioned by either CFS or CTM is closed. Cam 1137 pivots follower 1139 (pivots at 1140) counterclockwise in FIG. 38 to push the plunger of switch CBS. Switch CBS is tripped by one of arms 415 which is pivoted counterclockwise by engagement of slide CSFS each time slide CSFS is moved to the right in FIG. 39. Switch CTM is tripped by another arm 415 which is pivoted counterclockwise by slide CSTM each time slide CSTM is moved to the right as viewed in FIG. 38. Switches CBS, CFS and CTM, respectively, connect box score, frame score and team marks information channels from the computer to the printer. Release 1136 is actuated by cam 1135, secured to shaft 468, via another follower 1139 to release any of the switches CBS, CFS or CTM each time the racks R are driven back to their home positions.

A switch DDP (FIG. 50, wiring diagram FIG. 107) is provided for permitting energization of relay DPTMK without energizing relay DPK and solenoid FS for printing team marks information while the computer is engaged, i.e. solenoid ECS energized through two position switch EC so that the data generation and printing cycle control is effected by cams on the team marks shaft L, solenoid FS controlling initiation of all other formula shafts A through K. The switch DDP is operated by a cam on shaft L and remains open until formula shaft L completes its one revolution and returns to home position.

Switches TMS and TMT are also tripped by cams and shaft L. The printer selects formula shaft L begins to rotate and causes de-energization of solenoid TMMS so shaft L will stop after one revolution, switch TMS remaining open during nearly the entire revolution. Switch TMT closes as shaft L begins to rotate and remains closed to hold in relay TMTK and control circuitry during use of shaft L at the last bowler of a team, circuitry having been closed at that time by a circuit parallel to switch TMT, which parallel circuit energizes relay TMTK. Opening of switch TMT at the end of the revolution of shaft L de-energizes relay TMTK and the control circuitry. The control circuitry is controlled for energization by relay TMTK and in turn directs the printing of total team marks for the team.

CONTROL OF PRINTER ON X-AXIS DURING BOWLOUT

During bowlout scoring in the tenth and subsequent frames, only box scores are printed until after the last ball of the game. During this period, the change to the printer is provided through switch CBS which is closed each time the information is to be printed. However, because of the possibility of three balls being bowled and the possibility of up to three frames being completed during bowlout and because the score for all such balls and frames is printed in the column for frame 10 on score sheet 200, an additional box 204 is included. Box 204 has the same printing position as boxes 202 of preceding frames and box 202 of frame 10 has the same printing position as box 201 in previous frames. Box 201 of frame 10 represents a new printing position and as is apparent from the wiring diagram of FIG. 108, the 100's printing type and hammer can be used for printing in this box.

Certain adaptations are in the printing control after the ninth frame for overriding the printing described above. Considering FIGS. 50 and 52 through 54, a frame cam member 1121 is secured to frame rack RF for movement therewith. Rack RF, it will be recalled, is moved to the left a number of units corresponding to the frame being bowled. A cam follower 1122 having an arm 1123 follows the lower cam surface of cam 1119 through the first nine frames without pivotal movement. A second cam 1124 is pivotally mounted at 1124 to cam 1121 and has a cam surface end 1127. Spring 1128 normally urges cam 1124 in a clockwise position but follower 1132 extends over to and follows the top edge of detector plate 750 maintaining cam member 1124 in the position illustrated in FIG. 53 at all times throughout the first nine frames.

It will be seen from the wiring diagram FIG. 105 that a switch F10, when closed, assuming other appropriate contacts to be closed, by causing energization of relay F10K and resulting reversal of contacts F10K–2 and F10K–3 will channel box score information from matrix MAT–1 to be printed by the 100's type and hammer, i.e. in box 201 of the tenth frame. Referring to FIG. 108, switch F12 in the position indicated, cause printing of box score in box 202 of the tenth frame by the 10th's type and hammer and reversal of contacts of a switch F12, illustrated diagrammatically as a SPDT switch, will cause printing of box score information in box 204 of the tenth frame by the units type and hammer.

Switches F10 and F12 are mounted with switch 2B to suitable framework. Switch F10 comprises a normally closed microswitch and switch F12, a SPDT switch, as illustrated in FIGS. 50 and 52. While follower 1122 rides along the first nine frame designated portions of cam 1121, switch F10 is open, one contact of F12 is open and the other contact of F12 is closed. While follower 1122 is on the level corresponding to following from frame 1 to frame 9, arm 1123 holds switch F10 open and allows the normally closed contacts of F12 to remain closed, thereby preventing printing of box scores in boxes 201 and 202 in frames 1 through 9 in the normal manner.

When rack RF proceeds to the tenth frame, cam follower 1122 pivots counterclockwise closing switch F10 to signal the printing mechanism to print the box score in box 201 or 202 of the tenth frame for first or second ball respectively.
If the first ball in the tenth frame is a strike, the next
ball bowled is the first ball in the eleventh frame. In
the eleventh frame, the cam level of cam 1321
is the same as for frames 1 through 9, and this will
result in printing in the box 202 of the tenth frame which
cares in its position on the score sheet of FIG. 2
to box 201 of frames 1 through 9.

If the first ball in the tenth frame and the first
ball in the eleventh frame are strikes, then the next or
tire ball becomes the first ball in the twelfth frame.
The cam level of cam 1211 for frame 12 is below that of
frames 1 through 9 and 11 and will depress follower
1125 more than for frames 1 through 11 and 11 thereby
casting the normally closed contacts of switch F12 to
open and the normally open contacts of switch F12
to close. The leaf spring actuator of switch F10 over-
travels during this motion. This causes the box score to
be printed in box 204 of frame 10 on score sheet 200.

If the first ball in the tenth frame is a strike, but the
first ball in the eleventh is not a strike, the second ball box
score in the eleventh will be printed in box 204 of the
tenth frame which corresponds to box 202 of frames
1 through 9 because the cam level of cam 1211 is the same
for the eleventh frame as for frames 1 through 9 and the
second ball switch 25 is closed, as previously
described.

The first ball in the eleventh frame, following a spare
in the tenth frame should result in the box score being
printed in box 204 of frame 10. To accomplish this, plate
1128 is pivotally mounted to plate 1121 at 1126, spring-
urged clockwise by spring 1128 and having pin 1132 rid-
ing on surface 1311 of plate 750. When frame rack RF
is in the eleventh frame position and state rack RS is in
the 2a or 2b position corresponding to first ball after a
spare, pin 1132 will rest upon the plate 1219 of cam surface
1311 on plate 750 as shown in phantom in FIG. 53. This
rotates plate 1124 counterclockwise so that the lower sur-
face of plate 1124 in the area of the eleventh frame posi-
tion of plate 1211 will be level with the twelfth frame level
of plate 1121. This will depress follower 1122, causing
contacts of switch F12 to switch, causing the box score
printing to occur in box 204 of frame 10.

ORIENTATION OF PRINTER RELATIVE
TO SCORE SHEET

During operation of the scoring system, a score sheet
200 (FIG. 2) is disposed on surface 928 (FIGS. 81 and
91) for printing thereon by the printing type 942 there-
above. The printer head assembly may be provided on
hinges, e.g. as shown at 839, to open out of the way
giving better access to the surface 928. Score sheet 200 is
a two-team score sheet, the upper grid being for scoring
bowlers on Team A, and the lower grid for scoring bowl-
ers on Team B. The printer head, as described above,
as moved along X-axis for positioning the type over the
appropriate frame box or score sheet 200. It will be ap-
parent that the score sheet 200 bears a relation to the
amount of movement permitted by tapes X and Y in that
winding of tape T-X on spool 907 permits travel of the
head to the next scoring frame, from left to right, as
viewed in FIG. 2.

Likewise, reeling of one Y unit of tape T-Y onto spool
905 causes movement of the printer head from one bowler's
core line to the next bowler's core line. Such move-
ment is effected by the X and Y solenoids at the printer
head positioning mechanism. The movement of one unit
Y will move the printer head in alignment with the next
bowler's score line, and multiple units of winding or un-
winding of tape T-Y will move the multiple lines upward
or downward for positioning a new score sheet line
beneath the printing head. The Y movement mechanism
is also provided with means for moving one-half line, i.e.
one-half unit in the form of solenoid ½YS. Thus, al-
though the printer head is positioned by a whole
number of units on the Y tape in alignment with boxes 201,

202 and/or 204, the solenoid ½YS, when actuated, re-
positions the head one-half the distance between lines of
such boxes, i.e., in some form for, printing running game
total. Team total marks are printed in line 206 on the whole
integer of an Y movement. The space between the lower grid
line of the Team A portion of score sheet 200 is a whole
number of Y directional movement units from the top
grid line above the name and frame indication of the
Team B portion therebelow. If the printer is posi-
tionable over both score sheet portions using the same
units of movement of tapes T-X and T-Y. In Y direc-
tion, the control of the printer is arranged to move the
printer an extra Y unit each time it is to move between the
two team portions of the score sheet.

Although fractional movement of the carriage could be
effected by simple expansion of the system for differenti-
ating in printing between boxes 201, 202 and 204, no
such fractional movement in the X direction is necessary
since other provision has been made for differentiating
between these boxes during printing. Accordingly, in the
first nine frames, the idea is printed in the first ball box
201 by the 10's hammer and type line and in the second
ball box 202 by the unit's hammer and type. In the tenth
frame, printing in box 201 is by the 100's hammer and
type, printing in box 202 by the 10's and printing in box
204 by the unit's. In printing frame scores and game totals.
where a plurality of digits may be needed for the score
number, the unit's, 10's and 100's hammer and type
mechanisms are used for printing in their respective digit
positions simultaneously. The game totals for each player
are printed in box or column 205a. Each game total of a
preceding player is added to that of succeeding players
on the same team as the players finish their game and the
subtotals are printed in boxes or column 205b, giving a
complete total in column 205b opposing the name of the
last player of the team. Team marks totals are, as
indicated above, printed in line 206. No provision is made in
the printing system by printing bowlers' names in the
presently illustrated form; however, such a feature may
readily be added, if desired. It is intended that the players'
names be hand-printed upon the score sheet after place-
ment of the score sheet on surface 928, e.g. with the
printing carriages moved out of the way.

PROJECTION SYSTEM

The projection system employs an internally reflective
platen surface 928 as a source of the image to be pro-
jected. In the form of such system is described in an internal-
ly reflective platen surface is a face 928 of a prism 1141. The
system is such as that described by Jack A. Russell
in application Ser. No. 365,956 filed May 8, 1964, and
now Patent No. 3,269,259. The projection system is best
illustrated by reference to its operation. As has been
shown, printing slugs 942 will print by means of the in-
dica on the printing ends 944 on a surface disposed on
surface 928. As shown in FIG. 93, a score sheet 200 is
placed upon the surface 928 underlying printing ends 944
over slugs 942. The printer positions the slugs and the
head for registry with the score sheet and for printing in
the appropriate place on the score sheet. For this pur-
pose, the score sheet is of such size that when its edges
are within registry with a frame (not shown) over surface
928, the score sheet being the same size as the internal
opening in the frame, the score sheet is properly posi-
tioned with respect to the printing positions of the prin-
ter for printing in the appropriate boxes thereon.

Paper or score sheet 200 has a carbon backing which,
when impressed from the printing side, causes deposition
of carbon on the surface 928 of prism 1141 thereby inter-
rupting the internal reflectivity of the surface and creating
an image thereon. A projection lamp 1142 is mounted from the frame
1143 for projecting light to curved mirror 1144. Curved
mirror 1144 reflects the light through face 1146 of prism
1141 and the light travels through the prism to face 928
where it is internally reflected through face 1147 of prism 1141. The angle at which light from mirror 1144 impinges surface 928 is at or below the angle of total internal reflectivity of the prism surface. Blower 1143 cools the projection lamp and adjacent optical elements.

Light passing through surface 1147 has picked up the image from surface 928 and is reflected by an adjustable planar mirror 1149 to a right angle mirror assembly. The right angle mirror assembly includes planar mirrors 1149 and 1151 which are mounted at right angles to each other for proper reversal of the image for projection to the screen. The image is first selected from the generally upwardly disposed surface of mirror 1149 and thence from the generally upwardly disposed surface of mirror 1151 and is thereby directed through projection lens 1152 mounted across the light path from mirror 1151. The image, being projected upward, leaves casing 218 by way of port 219 (FIG. 1) and is thereby reflected by mirror 220 to viewing screen 221. Mirror 220 and viewing screen 221 are suitably mounted from a ceiling or other overhead structure. The prism 1141, blower 1143 (carrying projection lamp 1142) curved or elliptical mirrors 1144, mirror 1148, the right angle mirror assembly 1149 and 1151 and the projection lens 1152 are all suitably mounted by bracket means not described herein in detail.

As to the electrical circuitry for projection lamp 1142 and motor of blower 1143, such circuitry is conventional in projection devices and is not described herein.

**MISCELLANEOUS INPUTS FOR PRINTER AND COMPUTER UNIT**

A switch panel PNL is provided in unit 218 (FIG. 1), accessible by lifting a hinged cover member 1156. The switch panel mounts a plurality of switches CM, SM, BS, F, TH-CE, CESW, FD, FSD-100, FSD-10, FSD-1, and PMD, each illustrated schematically in FIGS. 109 through 112. Switches CM, SM, BS and F are of the push button type and are normally spring-urged to their open position shown in FIG. 109. Switch TH-CE is a three pole selector switch having a central "off" position, a "correction error on" position and a "team handicap on" position. Each switch FD, FSD and PMD is a rotary selector switch having a plurality of contacts, any one of which contacts may be selected.

Switch CM is provided for clearing a selected memory. For operation, the memory is selected by the appropriate bowler identity switch BL or BR (FIG. 101) which results in driving of stored information from the selected memory, disengagement of the memory and return of the racks with the memory disengaged so that the memory has no stored information, i.e. is "cleared."

Switch SM is for setting a memory, i.e. after being cleared. Closing switch SM actuates circuitry enabling the introduction of manually selected score information into the computer and a selected memory. Such information may be selected as to the frame to which a score applies by frame dial FD, as to the total score applicable to such frame by frame score dial FSD (including FSD-1, FSD-100 and FSD-100) and/or as to the pointcount applicable for a given frame and pinfall dial PMD. Pinfall for a single next ball may be entered manually by setting pinfall dial PMD and closing switch BS. Where it is desired to manually enter a score of "zero," e.g. because of a foul ball, PMD may also be used.

Switch CE-TH is for selection of either circuitry for error correction (CE) or circuitry for entry of team handicaps (TH) or neither. With error correction or entry of team handicaps, selected switches CM, SM, FD, FSD, PMD and/or BS may be used, as will be apparent from the description below relating to correction of errors and entry of handicaps. Switch CESW is closed during correction of errors and reads the computer circuitry for receiving the error correction.

**ERROR CORRECTION AND TEAM HANDICAP ENTRY**

In general, the error correction and team handicap entry procedures result in disconnecting the matrices MAT-1 and MAT-2 for their readout purposes described above and using the matrices as commutators for stopping the racks RU, RT, RH and RF in positions selected by dials FD and FSD. For stopping these racks, there are provided in the computer rack assembly five magnets CEUS, CETS, CEHS and CEF5 and CESS, shown only in the wiring diagram of FIGS. 110-112. Each magnet, when actuated, operates a pivotal mounted latch member (not shown) to drive a latching lead of the latching member into the ratchet edge of the corresponding rack RU, RT, RH, RF or RS to hold the rack against movement. The magnets and latch members may be mounted for operation in much the same manner as the latches 1071 and magnets TS described above with reference to the type setting control mechanism in the printer.

During error correction, the memory to be corrected is first cleared depressing switch CM after switch CE-TH has been thrown to CE position. This initiates a clearing cycle as described. The error correction frame selected and frame score are then selected on dials FD and FSD. Then switch S is depressed. The racks are driven out with the memories disengaged and contacts on the racks trace matrices MAT-1 and MAT-2, a contact 1096 on the frame rack RF tracing between the top two contact surfaces shown in MAT-2 in FIG. 107 and a contact 1096 on each of racks RU, RT and RH tracing across the vertical printed circuit strips of MAT-1 of FIG. 108 and respectively along the units, tens and hundreds horizontal strips HS to complete a circuit between the strips HS and any energized ones of the strips VS in commutator manner as the racks drive out. The frame dial FD selectively energizes the corresponding contact segment of surface 1098-1 in MAT-2 and the dials FSD-1, FSD-10 and FSD-100 energize the appropriate vertical strip VS of MAT-1 corresponding to the digit selected. Upon completion of a circuit with an energized surface in either matrix, suitable additional circuitry is provided to actuate the corresponding magnets CEUS, CETS, CEHS or CEF5 and latch the respective rack RU, RT, RH or RF against further movement; the detent system in the drive sector thereof begins to race. The state rack RS does not have ratchet teeth at each state position relative to the latch, but only one tooth at the 30 position. Magnet CESS is energized continuously during each rack drive cycle. The printer is oriented and type is set in accordance with the opening of the racks and the type overprints, i.e. prints over the formerly printed score. When the racks are driven back to home position, the appropriate memory is engaged and the correct score and frame information are entered.

After entry of a prior known correct frame, each succeeding ball bowled is manually entered by setting dial PDM to the number of pins knocked down and closing switch BS. This sends the pinfall information to summer S where it is added and sent to the computer in the same manner as if the information were derived from the pinfall detection switches PDS-1 through PDS-10. Thus, PDM provides manual ball-by-ball input of pinfall information to bring the corrected score up to date, i.e. up to the present frame, overprinting the former erroneous score entries.

It will be apparent that the panel switches can also be used for entry of team handicaps, in the last frame, i.e. corresponding to the "frame 11" circuitry of MAT-2. Thus, dial FD is set at "11" and the dials FSD are set at the handicap of error to be added. Switch CE-TH is set to TH and button SM is depressed. The racks are driven away from home position with the corresponding team memory disengaged and are stopped in the
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dialed positions by magnets CEFS, CEUS, CETS and CEHS as described above. The team total memory TATM or TBTM for the team to receive the handicap is engaged and the racks driven back to add the selected handicaps to the proper team total memory. Printing, etc. is thereafter obtained by normal operation of the system.

**WIRING DIAGRAMS, GENERAL**

In considering the circuitry of FIGS. 94 through 112, it will be noted that there is a similarity between nomenclature for various components. The switches including limit switches, cam operated switches and rotary switches are generally given letter designations. The relays worked by such switches are usually designated by the same letters with the suffix K; similarly, the solenoids actuated by the switches or solenoids which operate the switches usually bear the switch letters suffixed with S. The normally open contacts for the relays are illustrated by a pair of parallel lines normal to and breaking the circuit line; the normally closed relay contacts include an additional diagonal line crossing both parallel lines. The relay contacts bear the appropriate relay designation followed by a hyphen and contact identity number. The hyphen and contact identity numbers are also used for the contacts of two rotary switches P10L and P10R. The terminals in the drawings designated by C-followed by a numeral show the circuit linkage between figures; each terminal of the same designation is to be considered to be connected.

As discussed above, wherever a component is suffixed by the letter L as a component associated with the left lane, another component is understood to be present for the right lane linked in the same manner whether shown or not. This applies to the wiring diagrams also where switches, lamps and other components suffixed L indicate that a corresponding R component is present. In the case of relays, the suffixes are K and RK, while the duplicated solenoids will be indicated with suffixes LS and RS and wherever an element is designated for association with one lane, e.g., left, it is to be understood that a similar element exists for the other lane, even though it may not be shown in the figures.

**EXEMPLARY AUTOMATIC SCORING OPERATION**

Referring to the drawings in general and especially to the wiring diagrams of FIGS. 94 through 112, the step-by-step sequence of operations performed by the automatic scorer described hereinabove will now be traced and discussed generally. Such discussion will include operation of the system under the variety of conditions of open or league bowling, including the handling of fouls, errors, entry of handicaps, team marks and team totals, and automatic computer and pinsetter clearing at the end of the game.

In general, the bowler must identify himself to the scorer by pushing his BL or BR button prior to rolling the first ball of the frame. The pinsetter rake remains down at the beginning of each frame until such identification is made to remind the bowler to give such identification.

(1) LEAGUE BOWLING

(A) Bowlers 1-4, not end of game

During league bowling for each ball bowled by bowlers using either of ID buttons BL1 through BL4, BL7 through BL10, BR1 through BR4, or BR7 through BR10, where the ball bowled is not the last ball of a game, the sequence below applies, with notation of differences in operation depending on whether the ball bowled completes a frame. The sequence is outlined assuming that the bowler is using button BL3 and is bowling on the left-hand lane of the pair of lanes in which the scorer is installed. Of course, other bowlers bowling in predetermined sequence on the left lane under similar circumstances using, for example, button BL1, BL2, BL4 or any of BL7 through BL10, would cause similar sequencing, with the resulting score being attributed to the proper bowler as a result of the depressed identification button which identifies the bowler to the system. The sequence of control is as follows:

1.0 Bowler 3 pushes button BL3.

(1) Contacts BL3-1 through BL3-3 close.
(2) Light BL3 lights.
(3) Solenoid HBL is energized, locking all left lane buttons.
(4) Relay 270SLSK at pinsetter APL is energized, de-energizing solenoid 270SLS and raising the pinsetter rake and deck to allow bowling.
(5) If a bowler should accidentally push the wrong button, he can release the locked buttons by pressing a "Release" button in panel PAN, opening switch REL. He may then press the proper button.

2.0 Bowler 3 bowls on left lane and pinsetter APL cycles.

(1) At approximately 45° of the pinsetter cycle, the pin detection switches PDSL are reset by actuation of solenoid PDSL.
(2) Switch AP90L at pinsetter APL closes momentarily at 90° of the cycle, energizing relays PCLK and PSLK at the same time that the pin detection switches are actuated by standing pins during the pin detecting stroke of the pinsetter deck.
(3) PCLK-1 closes, holding relay PCLK.
(4) PCLK-2 closes, energizing relays CALK and 2CALK and the pin detection switches PDS-1 through PDS-10 on the left lane (unless CARK-2 is open indicating use of the computer to process information from the right lane and blocking use by the left lane.)
(5) PCLK-3 closes, energizing solenoid SAS.
(6) PCLK-4 and PCLK-5 close.
(7) PSLK-1 closes holding in PSLK through normally closed CK-9.
(8) PSLK-2 closes.
(9) 2CALK-1, 2CALK-2, and 2CALK-3 close, energizing solenoids BM3 and TMM.
(10) Pin detection switches PDS-1 through PDS-10 on appropriate, e.g., left, lane, energize a pincount magnet M-1 through M-10 for each pin not standing.

(11) CALK-1 opens, unparallelling CK-1.
(12) CALK-2 opens, preventing energizing of relay CARK.
(13) CALK-3 closes.
(14) CALK-4, BMD, SA and TMMD close, energizing solenoid CS.
(15) CALK-5 opens.
(16) CALK-6 closes.
(17) CALK-7 closes.
(18) CALK-8 closes, enabling energizing of relay CFLK later.
(19) CALK-9 closes, enabling energizing of relay EMFLK later.
(20) CALK-10 closes, enabling energizing of relay FFFLK later.
(21) CALK-11 closes.
(22) CALK-12 closes energizing magnet SPS to reset summer S.

3.0 Computer rack drive starts, closing switch CF and energizing relay CKF.

(1) CKF-1 opens, de-energizing solenoid CS.
(2) CKF-2, 4 and 6 close. CKF-2 will hold in relay TMSK when PCLK-5 opens later.
(3) CKF-3 closes, paralleling switches P10L-6 and P10R-6.
(4) CKF-5 closes, energizing relay CFLK.
(5) CKF-7 closes, enabling EMK-4 to hold relay EMK later.
(6) CFLK-1 opens.
(7) CFLK-2 closes, paralleling FFLK-2.
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(8) CFLK-3 closes to hold CALK when PCLK-2 opens later.

(9) CFLK-4 closes, paralleling switch EL.

4.0 The computer rack drive reaches computing position, closing switch C, energizing relay CK, also closing switch PBS momentarily and closing switch CBS which latches in the closed position. Solenoid DDS is also energized by closing of switch DD.

(1) CK-1 opens, de-energizing relay PCLK.

(2) CK-2 closes, enabling EMK-1 to energize solenoid CS later.

(3) CK-4 opens, de-energizing solenoids BM3 and TMM.

(4) CK-3 and 5 open.

(5) CK-7 closes, connecting the X-position printed circuit MAT-2 to the printer.

(6) CK-8 and 9 open de-energizing relay PSLK and, through opening of PSLK-2, magnet SPS (Fig. 106); follower 536 is now on the rise of cam 535.

(7) PCLK-1 and 2 open.

(8) PCLK-3 retains, de-energizing solenoid SAS.

(9) PCLK-4 and PCLK-5 open.

(10) Closing of switch CBS connects the box score information to the printer.

(11) Closing of switch PBS starts a variable time delay described above, to allow the printer to arrive at proper X and Y axis printing positions before a printing cycle begins.

5.0 The printer sends the “done printing” signal at the end of the print cycle by closure of switch DP.

(1) The relays DPK and DPTMK are energized.

(2) DPK-1 closes holding relay DPK.

(3) DPK-2 closes energizing solenoid FS and starting the proper formula shaft turning.

6.0 A formula cam 397 actuates slide bar CSEC for reversing switch EC and de-energizing relay DPK.

(1) DPK-1 opens.

(2) DPK-2 opens de-energizing solenoid FS.

7.0 The formula cam 397 generates data for and initiates zero, one, or two frame score printing cycles, connecting the proper data channels to the printer by closing switches PFS and CFS. After each print cycle, switch SC is returned to original position and steps 5.0 and 6.0 are repeated.

8.0 Switch EM is momentarily closed by a formula cam through slide CSRN energizing relays EMK and EMLK.

(1) EMK-3 closes, energizing solenoids BM3 and TMM.

(2) EMK-2 closes, paralleling the open switch SA.

(3) EMK-1 closes, energizing solenoid CS.

(4) EMK-4 closes, holding relays EMK and EMLK.

If the formula cycle does not finish the current frame, switch 2EM is closed by a formula cam energizing relay 2EMK.

9.0 If the cycle completes the current frame, switch FF is closed by a formula cam, energizing relay FFFK, closing FFFK-1 and energizing relay 2FFFFK.

(1) 2FFFFK-3 closes, holding relays FFFK and 2FFFFK.

(2) 2FFFFK-1 opens de-energizing relay 270 SLK.

(a) 270SLK-1 closes, energizing solenoid 270SL and stopping pinsetter APL at 270° of its cycle with the deck and rake down.

(3) 2FFFFK-2 opens, unparalleling CFLK-2.

(4) 2FFFFK-4 closes.

(5) FFFK-2 opens.

10.0 The computer rack drive leaves computing position, opening switch C and de-energizing relay CK and solenoid DDS.

(1) CK opens.

(2) CK-2 opens, de-energizing solenoid CS.

(3) CK-1, 3 and 5 close.

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11.0 Computer rack drive returns to computation finished position, with the racks to the right as viewed in Fig. 16, opening switch CF and de-energizing relays CFK and CFLK.

(1) CFLK-1 closes.

(a) If 2FFFFK-1 is closed, relay 270SLK will be energized.

(1) 270SLK-1 opens de-energizing solenoid 270SL and allowing the pinsetter rake to rise.

(b) If 2FFFFK-1 is open, relay 270SLK will not be energized until the next bowler presses his bowler identification button.

(2) CFLK-2 opens.

(a) If relay FFK was energized at step 9.0, 2FFFFK-2 will be open de-energizing solenoid HBL and relay FFK, and releasing all left lane push buttons for next bowler.

(b) If FFK was not energized at step 9.0, 2FFFFK-2 will be closed and solenoid HBL will continue to hold BL3 button down and BL3 light on for second ball.

(3) FFFK-1 opens after delay period (if it was previously closed) de-energizing relay 2FFFFK.

(a) 2FFFFK-1 closes, but not until HBL has allowed BL-2 to open.

(b) Other 2FFFFK contacts return to cycle start positions.

(4) CFLK-3 and CFLK-4 open, de-energizing relays CALK and 2CALK and pinfall magnets M1-M10.

(5) 2CALK-1 opens, de-energizing lock magnet HBL and solenoids.

(6) All CALK, 2CALK, FFK, CFLK and CFK contacts return to cycle starting position.

As a result of the sequence outlined, the information normally printed during scorekeeping procedures is caused to be printed by the printing mechanism after each ball. The memory units retain the information necessary for computation of scores to be entered on the score sheet during subsequent frames and as totals at the end of the game.

(B) Bowler 5, not end of game

In team bowling, the teams normally alternate between alleys, and buttons at positions 1 to 6 are used by one team on one alley while buttons 7 to 12 are used by the other team on the adjacent alley, one team (Team A) thereby using buttons from the set BL1 to BL6 and BR1 to BR6 and the other team (Team B) using buttons from the set BR7 to BR12 and BL7 to BL12. Buttons BL5 and BR5 are used by the last bowler on Team A and BL11 and BR11 by the last bowler on Team B. Where the control system illustrated is employed, if there are one or more absent bowlers, buttons at positions 1 to 4, i.e. BL1 to BL4 and BR1 to BR4 and/or BL7 to BL10 and BR7 to BR10, are omitted as necessary.

The sequence of steps for bowler 5 using button BL5, BR5, BL11 or BR11, all 5 position buttons, is the same as for bowlers 1–4 as described above with the exceptions noted hereinafter.

For example, assuming bowler 5 is bowling on the left lane, bowler 5 pushes button switch BL5 which closes contacts BL5–1 through BL5–4 and opens contact BL5–5. Lamp BL5 lights. Steps 1.0(3) through 1.0(5) of A, above, are completed as before. Bowler 5 bowls; the pinsetter cycles and steps 2.0(1) through 2.0(5) are completed. PCLK-5 closes energizing relay TMSK and closing TMSK–1. Steps 2.0(9) through 2.0(22) are completed as above except that BMS is energized in lieu of BM3, Steps 3.0 through 7.0 are the same except that during step 4.0(3), BMS is de-energized.

In step 8.0, when EMK-3 closes, solenoids BM3 and TMM are prevented from being energized by CALK-5 and BL5–5 being open; also, when EMK-1 closes, the open switches BMD and TMM prevent energizing of
solenoild CS. In addition, another step occurs between steps 8.0 and 9.0. The additional step is:

B8.1 If the current frame is not finished, switch 2EM is also closed by formula cam energizing 2EMK relay held in by 2EMK-1. BM-5 and T2MM are re-engaged and solenoid CS is energized. Step 9.0 is the same as outlined in A above and the following additional steps are then completed:

B9.1 The team marks printing formula shaft L rotates.

(1) The switch TMS opens, de-energizing relay TMSK, opening TMSK-1 and de-energizing solenoid TMS.

(2) The switch DDP opens preventing energizing of relay DPK until formula shaft L returns home.

(3) The switch CTKM closes, energizing relay CTKM and connecting team marks data to the printer.

(a) CTKM-1 closes to position the printer via the printer position diode matrix for printing running team total score and contacts CTKM-2 reverse but produce no effect because switch BL11 is open. When the last team member of the other team, i.e. team B, bowls, switch BL11 will be closed, resulting in positioning of the printer for printing team total in the space provided for Team B on score sheet 200.

(4) The switch PTM closes momentarily starting the print time cycle delay.

B9.2 The printer sends "done printing" signal at the end of the printing cycle.

(1) Relay DPTMK is energized.

(2) DPTMK-1 and DPTMK-2 close, energizing relay TMSK and solenoid TMS.

(a) TMSK-1 closes holding relay TMSK.

B9.3 Team marks formula shaft rotates.

(1) Switch TMS opens, de-energizing TMSK and solenoid TMS opening TMSK-1.

B9.4 Switch 2EM closes (also switch EM, relay EMK and all EMK contacts).

(1) Solenoids BM5 and T2MM are energized.

(2) Solenoid CS is energized.

Steps 9.1 through 9.4 are provided to cause printing of a running total of marks for each team after bowler 5 of that team bowls the last team ball in each frame.

Steps 10.0 and 11.0 are the same as set out in A above except that BL5 and BM5 should be substituted for BL3 and BM3.

C) Bowler 6, not end of game

Buttons BL6, BL12, BR6 and BR12 are provided for use by a sixth bowler, such as a bowler bowling in lieu of one of the team members. When one of these buttons, e.g. BL6 is depressed and bowler 6 bowls his ball, the sequence is the same as in A, above, with the exceptions noted hereinbelow. Of course, in all steps, BL6 and BM6 should be substituted for BL3 and BM3, respectively.

During step 2.0(9), relay OBK is energized, opening OBK-2 and preventing energizer of solenoid T2MM; OBK-1 closes paralleling switch TMM; OBK-3 closes; and OBK-4 transfers circuits.

In step 8.0(1), EMK-3 closes to energize solenoid BM6 but solenoid T2MM is not energized.

With reference to step 11.0, when CFKL-3 opens, OBK is de-energized and the OBK contacts also return to cycle starting position.

The difference in operation of the system for bowler 6 results generally in open bowling sequencing for the bowler and eliminates introduction of his marks into the team marks memory.

D) Bowlers 1-4, end of game

On the last ball of the game for each of bowlers using buttons for bowlers 1-4, the operation is sequenced differently for purposes of obtaining and printing the individual bowler's total score. Accordingly, the sequence is similar to A, above, with the exceptions noted.

After step 7.0, the following step is added:

D7.1 Switch PFS closing while relay P10K is energized by positioning of rack RF, energizes a rotary solenoid switch P10L, causing solenoid switch P10L to step from position 1 to position 2. Switch P10L is ganged stepping switch having four stepping positions and including a solenoid P10LS for stepping the four positions sequentially. The contacts to the ganged switch and its actuation are generally best shown in FIGS. 104 and 105, and as is seen, the stepping switch comprises twelve ganged four position rotary switches.

(1) P10LK-1 closes, energizing relay P10LK.

(a) P10LK-1 closes paralleling CFLK-2 and FFLK-2.

(b) P10LK-2 closes paralleling CFLK-3 and PCLK-2.

(c) P10LK-3 closes paralleling CFLK-4.

(d) P10LK-4 opens.

(2) P10L-4 opens, unparalleling CFLK-3.

(3) P10L-5 transfers from solenoid BM3 to solenoid T2TM.

(4) P10L-6 closes, connecting solenoid P10LS to switch TTMU.

(5) P10L-8 closes, energizing solenoid DAS to prevent entering of additional score or marks into the memories.

(6) P10L-9 opens, disconnecting box score printed circuit HS-BS in MAT-1 (FIG. 108) from the printer.

In step 6.0(1), closing of EMF-3 energizes solenoid T2TM in lieu of solenoid BM3. In step 9.0(2), 2FFLK-1 opens as above and if the automatic pinsetter reaches 270° of its cycle prior to closing of CFLK-1, 2FFLK-1 and P10LK-4, switch AP270L will open, de-energizing 270LSL relay, step 10.0 is the same as in A, above.

In lieu of step 11.0 of A, above, the following steps are provided:

D11.0 The computer rack drive returns to computation finished position, opening switch CF and de-energizing relays CFK and CFLK.

(1) CFLK-2 opens.

(a) If CFLK relay was energized at step 9, 2FFLK-2 will be open but P10LK-1 is closed and solenoid HBL will continue to hold button BL3 down and light BL3 and relay FFLK energized.

(b) If CFLK was not energized at step 9, 2FFLK-2 will be closed and solenoid HBL will continue to hold button BL3 down and light BL3 on for second ball.

(2) CFLK-1 closes but P10LK-4 is open.

(a) If APL reaches 270° of is cycle before CFLK-1, 2FFLK-1 and P10LK-4 close, switch AP270L will open and relay 270LSL will be de-energized, closing 270SLK-1, energizing solenoid 270SL and stopping pinsetter APL with the rake and deck down.

(3) CFLK-3 and 4 open, but P10L-2K and P10L-3K hold relays CALK and 2CALK.

(4) CFLK-3 opens, de-energizing solenoids T2TM and T2MM.

(5) All other CFLK and CFK contacts return to normal positions.

D12.0 T2TM reaches "up" position, closing switch TTMU and energizing rotary switch position 2 P10LS, causing it to step from position 2 to position 3.

(1) P10L-1 closes, energizing relay PCLK and relay APCLK.

(a) APCL-1 closes holding relay APCLK.

(b) APCL-2 closes energizing 2APCLK when switch AP2BL is closed.

(2) PCLK-1 closes, holding relay PCLK.

(3) PCLK-2 closes, paralleling P10LK-2.
(4) PCLK-3 closes, energizing solenoid SAS.
(5) PCLK-5 closes.
(6) P10L-3 opens, preventing energizing of relay TMSK.
(7) P10L-4 closes, energizing solenoids TATM and TAMM.
   (a) Switch TTMU opens de-energizing solenoid P10L.

D12.1 PCLK-4, BMD, SA and TMM close, energizing solenoid CS.

D13.0 The computer rack drive starts, closing switch CF and energizing relay CFK and CFLK.
(1) CFK-1 opens, de-energizing solenoid CS.
(2) CFK-2 and 4 close.
(3) CFK-3 closes, paralleling switches P10L-4 and P10R-4.
(4) CFK-5 closes, energizing CFLK.
(5) CFLK-1 opens.
(6) CFLK-2 closes, paralleling P10LK-1.
(7) CFLK-3 closes to hold CALK when PCLK-2 opens later.
(8) CFLK-4 closes, paralleling switch REL.

D14.0 The computer rack drive reaches computing position, closing switches DD and C and energizing relay CK and solenoid DDS. Switch PBS is also closed.
(1) CK-1 opens, unparallelizing P10L-1.
(2) CK-2 closes, enabling EMK-1 to energize solenoid CS later.
(3) CK-4 opens, de-energizing solenoids TATM and TAMM.
(4) CK-3 and 5 close.

D14.1 De-energizing of solenoid TATM closes switch TTMU energizing solenoid P10LS and cycling switch P10L from position 3 to position 4.
(1) P10L-1 opens, de-energizing PCLK relay.
(2) P10L-2 opens, de-energizing relay P10LK.
   (a) P10LK-1, P10LK-2 and P10LK-3 open and P10LK-4 closes.
(3) P10L-7 closes.
(4) P10L-10 closes energizing relay P10K.
   (a) P10K-1 closes connecting relay contact TATM00K-2 to print function selector switch CFS.
   (b) P10K-2 closes.
   (c) P10K-3 closes, energizing relay FFLK is not already energized.
(5) PSLK-1 and 2 open.
(6) PCLK-3 opens, de-energizing solenoid SGS.
(7) PCLK-4 opens.
(8) PCLK-5 opens.

D14.2 The box score printing cycle of the printer results in blank printing because switch P10L-9 is open. D15.0 Printer sends the “done printing” signal at end of the print cycle.
(1) Relays DPK and DPTMK are energized.
(2) DPK-1 closes holding DPK relay.
(3) DPK-2 closes energizing solenoid FS and starting the 3a formula shaft E turning.

D15.1 A formula cam actuates slide bar CSEC, reversing switch EC and de-energizing relay DPK.
(1) DPK-1 opens.
(2) DPK-2 opens de-energizing solenoid FS.

D15.2 Formula cams 397 will generate data for and initiate a frame score printing cycle, connecting the proper data channels to the printer by closing the switches PFS and CFS. After the print cycles, steps 5 and 6 are repeated.
D16.0 Switch EM is closed by a formula cam acting through slide CSRM energizing relays EMK and EMLK.
(1) EMK-3 closes, energizing solenoids TATM and TAMM.
(2) EMK-2 closes, paralleling the open switch SA.
(3) EMK-1 closes, energizing solenoid CS.

D17.0 FFLK and 2FFLK relays are still energized from steps 9 to 14.1.
(1) FFLK-3 is closed, holding FFLK and 2FFLK relays.
(2) 2FFLK-1 is open preventing energizing of relay 270SLK.
(3) 2FFLK-2 is open, unparalleling CFLK-2.
(4) 2FFLK-4 is closed.
(5) CFLK-2 is open.

D18.0 The computer rack drive leaves computing position, opening switch C and de-energizing relay CK.
(1) CK-4 closes, holding solenoids TATM and TAMM during rack return drive.
(2) CK-2 opens, de-energizing solenoid CS.
(3) CK-1, 3 and 5 close.

D19.0 The computer rack drive returns to computation finished position, opening switch SF and de-energizing relays CFS and CFLK.
(1) CFLK-2 opens, de-energizing solenoid HBL and releasing all left lane push buttons for next bowler.
(2) CFLK-1 opens, but as 2FFLK-1 is open, relay 270SLK will not be energized until next bowler presses his Bowler Identification button.
(3) CFLK-4 closes after BI3-2 opens (relay FFHKL has delayed break).
(4) CFLK-4 opens, de-energizing relays CALK and 2CALK.
(5) 2CALK-1 opens, de-energizing solenoids TATM and TAMM.
(6) All other CALK, 2CALK, CFLK, CK, FFLK, and 2FFLK contacts return to cycle starting positions.

D20.0 De-energizing of solenoid TATM closes switch TTMU, energizing solenoid P10LS and stepping all gangs of switch, P10L from position 4 to position 1.
D21.0 If a bowler’s game ends with the first ball of a two ball frame, 2AP2BL switch, closing while AP2BL switch is closed, will energize relay 2APCLK at pinsetter APL.
(1) 2APCLK-1 closes holding relay 2APCLK.
(2) 2APCLK-3 closes energizing relay 270SLK opening 270SLK-1 and de-energizing solenoid 270SLK to allow pinsetter APL to go from 270° to 0°.
(3) 2APCLK-4 closes energizing the pinsetter trigger relay for triggering the pinsetter to cycle.
(4) 2APCLK-6 opens to prevent the pincount signal from going to the computer.
D22.0 Pinsetter APL cycles through the second ball cycle.
(1) At 45° switch 2AP45L opens de-energizing relay APCLK.
(2) At 120° switch AP120L opens de-energizing relay 2APCLK and returning all 2APCLK contacts to normal position.
D23.0 Opening of switch AP300L will de-energize relay APCLK if there is no extra cycle required.

(E) Bowler 5, end of game

The sequence for the last bowler of a team bowling the last ball of a team results in the printing of team total score in addition to his individual score. The sequence incorporates generally the changes to A as outlined in B and D with some additions to provide for printing of team score totals. Steps 1.0 through 7.0 are the same as in B; step 7.1 is included from D and the following are added to step D7.1:
(7) TMTK-1 closes holding TMTK
(8) TMTK-2 closes.
(9) TMTK-3 opens preventing energizing any memories.
Step 8.0 is changed to the following and step 8.1 is as outlined:

E8.0 Switch EM is momentarily closed by a formula cam through slide CSRM energizing relays EMK and EMLK.

(1) EMK–3 closes, solenoids T₄TM and T₄MM prevented from being energized by CALK–5 and BL₅–5 being open.

(2) EMK–2 closes, paralleling the open switch SA.

(3) EMK–1 closes, but switches BMD and TMMMD, being open, prevent energizing of solenoid CS.

(4) EMK–4 closes, holding relays EMK and EMLK.

(5) EMLK–1 opens.

(6) EMLK–2 closes energizing relay FFLK whether current frame is finished or not.

E8.1 If current frame is not finished, switch 2EM is also closed by a formula cam and slide CSRM energizing relay 2EMK.

(1) 2EMK–1 closes, holding relay 2EMK.

(2) 2EMK–2 closes but solenoids T₄TM and T₄MM are de-energized by TMTK–3 being open.

Switch FF has been closed during step E8(6) and step 9.0 proceeds as outlined in A, above, to stop the pinsetter at 270° of its cycle and to energize solenoid TMS. Steps B9.1 through B9.3 are completed and the following steps are added in lieu of B9.4:

E9.4 Switch TMT opens de-energizing solenoid TMTK.

E9.5 Switch 2EM is closed by the formula cam on slide CSRIM, energizing 2EMK relay if not already energized at step E8.1. Also, switch EM closes energizing relay EMK for operating all EMK contacts.

(1) 2EMK–1 closes holding relay 2EMK.

(2) Solenoids T₄TM and T₄MM are energized by closing of 2EMK–2
   (a) Switch TMTU opens, de-energizing solenoid PIOLS.

(3) Solenoid CS is energized.

Step 10.0 is the same as in A; Step 11.0 is substituted as follows:

E11.0 The computer rack drive returns to computation finished position, opening switch CF and de-energizing relays CFK and CFLK.

(1) CFLK–2 opens.
   (a) As FFLK relay was energized at step (8), 2FFLK–2 is open but PIOLS–1 is closed holding BL₅ button down and light on and relay FFLK energized.

(2) CFLK–1 closes.
   (a) As 2FFLK is open, relay 270SLK will not be energized until next bowler presses his Bowler Identification button.

(3) CFLK–3 opens, but PIOLS–2 is closed holding relays CALK and 2–CALK.

(4) All relays CFK and CFLK contacts return to cycle starting positions.

Steps 12.0 through 15.2 are the same as in D, above, except that during step E14.1(3), when PIOLS–7 closes, relay CCLK is energized with the following results:

(a) CCLK–1 closes, paralleling switches SA, TMMMD AND BMD.

(b) CCLK–2 and CCLK–4 close.

(c) CCLK–3 opens, preventing energizing of any memory solenoids later.

(d) CCLK–5 transfers, de-energizing solenoid PIOLS.

(e) CCLK–6 closes to hold relay CCLK when BL₅–3 opens later.

Thus, in steps 16.0 through 18.0 otherwise the same as D16.0 through D18.0, when EMK–3 closes during step 16.0(1), CCLK–3 remains open to prevent energizing solenoids T₄TM and T₄MM and when CK–4 closes during step 18.0(1), solenoids T₄TM and T₄MM are still not energized. In step E19.0, otherwise the same as D19.0, the stepping of switch PIOLS from position 4 to position 1 is accomplished by closing CCLK–5 to energize solenoid PIOLS; PIOLS–7 opens to de-energize solenoid PIOLS.

Step 20.0, as outlined in D, is now unnecessary and is omitted. Steps 21.0 and 22.0 are completed as set out in D, above.

(F) Bowler 6, end of game

On the last ball of the game for Bowler 6, who is bowling not as a member of the team, the sequence not only serves to omit his marks from the team marks total in C, above, but also omits his score from the team total score. Thus, the sequence is much like C, above, with provision for end of game programming as in D, above. Steps 1.0 through 7.0 are the same as in C. Step 7.1 is added as follows:

F7.1 Switch PFS is closed by a formula cam acting through slide CSFS while switch F–10 is closed by the position of rack RF or racks RF and RS energizing relay CCLK.

(1) CCLK–3 opens preventing energizing of BM6.

(2) CFLK–2 and 4 close.

(3) CCLK–3 closes, paralleling switches SA, TMMMD AND BMD.

(4) CCLK–6 closes energizing relay APCLK at APL.
   (a) APCLK–1 closes holding APCLK.
   (b) APCLK–2 closes energizing relay 2 APCLK if switch AP2BL closes later.

(5) CCLK–7 closes energizing relay FFLK.

Step 8.0 is the same as in C, except that BM6 is prevented from energizing when EMK–3 closes. In step 9.0, FFLK has been energized from step F7.1 closing FFLK–1 and energizing relay 2FFLK giving the same results as in 9.0(1) through 9.0(5), outlined in A, above. Step 10.0 is the same as in A and C. Step 11.0 is generally in accord with the procedure of C11.0, above, and may be outlined as follows:

F11.0 The computer rack drive returns to computation finished position, opening switch CF and de-energizing relays CFK and CFLK.

(1) CFLK–1 closes
   (a) As 2FFLK–1 is open, relay 270SLK will not be energized until the next bowler presses a Bowler Identification button.
   (b) 2FFLK–1 closes after contact BL₅–2 opens.

(2) CFLK–2 opens
   (a) Relay FFLK is energized from step F7.1. 2FFLK–2 will be open and solenoid HBL will be de-energized, releasing all left lane push buttons for next bowler.
   (b) 2FFLK–2 closes after BLC–2 opens (relay FFLK has delayed break).

(3) CFLK–3 opens, de-energizing relays CALK, 2CALK, FFLK, PFLK and 2FFLK.

(4) 2CALK–1 opens, de-energizing solenoid BM6 and relays CCLK and OBK.

(5) All contacts CALK, 2CALK, FFLK, CFLK, CFK, CCLK and OBK return to cycle starting position.

The remainder of the sequence for bowler 6, end of game, has been described as steps 21.0 and 22.0 in D, above, steps 11.0 through 20.0 being omitted.

(II) OPEN BOWLING

Where open bowling is desired resulting solely in totaling of individual scores, i.e. without team totals, the following operation applies for any of bowlers 1 through 6. First, the League Bowling-Open Bowling toggle switch LBOB is set at OB position.

(1) Relay OBK is energized.

(2) OBK–1 closes, paralleling switch TMM.
(3) OBK-2 opens, preventing relay TMSK from energizing.
(4) OBK-3 opens, preventing solenoid T_AMM from energizing.
(5) OBK-4 closes, paralleling buttons B5-6 and B11-6 so that EMK-3 will re-engage bowler memories for all bowlers.
(6) OBK-5 disconnects switches F5 and FR-10 from rotary switch solenoids PIOLS and PIORS and connects to relays CCLK and CCRK.

With relay OBK energized, all bowlers will cause the computer to cycle in the manner shown for bowler 6 in C and F above.

(III) AUTOMATIC SCORING OF FOULS

As described above, the automatic pinsetter has been modified to stop at 270° of cycle with the rake down unless and until two conditions are met, i.e. (1) a bowler identification push button on the particular lane is depressed, and (2) the computer has finished scoring the previous ball. Further, in the automatic pinsetting structure described above, the actuation of the foul detector prevents triggering of the automatic pinsetter by arrival of the ball at the lane pin. Confirmation or denial of a foul, which information may be fed into the system via switches FL and FD as described above, will in turn trigger the automatic pinsetter. Also, as described above, the pin detector system holds the first ball pinsfall until confirmation or denial of the foul and determination of the legality of the second ball.

Assuming a first ball foul on the left lane, the following sequence of operation may be used for scoring:

(1) Foul detection closes switch TFL energizing relay TFLK.
   (a) TFLK-1 closes holding relay TFLK.
   (b) TFLK-2 closes energizing relay APMLK at pinsetter APL.
   (1) APMLK-1 opens shutting off APL motor.
(2) FCLK button is pushed, confirming the foul.
   (a) Relay FCLK and relay 2FCLK are energized.
      (1) FCLK-2 closes holding relay FCLK and 2FCLK.
      (2) FCLK-1 opens preventing energizing pinsfall magnets M-1 through M-10.
      (3) FCLK-3 and FCLK-4 close to transfer from the numerical scoring circuit to a "foul" circuit for printing the designation "F" as the box score.
      (4) 2FCLK-1 closes.
      (5) 2FCLK-2 closes energizing automatic foul sequencing solenoid AFSL, resulting in causing the pinsetter to sweep, set new pins and adjust for receiving a second ball.
(3) Pinsetter APL cycles.
   (a) At 45° of the cycle, switch AP45L opens de-energizing solenoid AFSL.
   (b) At 90° of the cycle, switch AP90L closes sending a "pinfall counted" signal to the computer.
   (4) The computer causes box score printing of "F" and otherwise treats the ball as a gutter ball.
(5) EMLK-1 opens de-energizing relays FCLK and 2FCLK. With contact FCLK-1 reclosing, magnets M9-M10 are energized through any switches PD5L which were not opened by the first ball and the frame score is awarded on the basis of pincount from only its first ball.
(6) Switch FF will be closed by a formula cam and slide CSFF, opening 2FFLK-2. Switch FF does not open to close contact 2FFLK-2 until after solenoid HBL is de-energized, releasing the left lane bowler identification buttons. Therefore, the rake of pinsetter APL will remain down until another bowler button is pressed.

In both first and second ball cycles, if button FDL is pushed, relay TFLK is de-energized, the automatic pinsetter is triggered and a normal scoring cycle is initiated.

(IV) ERROR CORRECTION

Error correction may be handled by the illustrated system by erasing the bowler's score, restoring the bowler's score to the last known correct frame and manually entering pinfall data for frames subsequent to the last correct frame for each ball that has been bowled subsequent to that frame.

The following procedure applies:

(1) The bowler (assume 3) switches "Correcting Error" toggle switch CEL on left side of Bowler Panel to "on," closing the switch.
   (a) Lamp CELK lights.
   (b) Relay CELK is energized.
   (c) CELK-1 opens, preventing energizing of relay 270SLK.
   (d) CELK-2 closes, enabling energizing of relay FCLK later.
   (e) CELK-3 closes, enabling energizing of relay FCLK later.
   (f) CELK-4 closes, to hold solenoid HBL through-out error correction procedure.
   (g) CELK-5 opens, preventing energizing of relay CELK.
   (h) CELK-6 opens, preventing energizing of solenoid SAS.
(2) Bowler presses BL3 button.  
(a) BL3 light lights.  
(b) Solenoid HBL is energized, locking switch BL3 down until toggle switch CEL is returned to "off" position at the end of the error correction procedure.  
(3) Error-Handicap selector switch CE-TH is set for Correcting Error or "CE."  
(4) Bowler presses "Clear" button on error panel or switch "CM."  
(a) Relay PCLK is energized.  
(b) Relay CALK is energized closing CALK-2.  
(c) "Correcting Error" CE light in error panel lights.  
(d) CEK relay is energized.  
(1) CEK-1 closes paralleling switches SA and TMMD.  
(2) CEK-2 opens, preventing energizing of solenoid T2MM.  
(3) CEK-3 closes, enabling energizing of relay CCLK later.  
(4) CEK-4 transfers, enabling "done printing" signal to energize relay EMK later, and preventing energizing of relays DPK and DPTMK.  
(e) BM3 solenoid is energized.  
(f) BMD switch closes, energizing solenoid CS.  
(g) Rack drive starts, closing switch CF and energizing relays CK and CFLK.  
(1) In addition to normal cycle control functions, CKF-4 closes, enabling energizing of CCLK relay later.  
(h) Rack drive reaches computing position, closing switch C and energizing relay CK and de-energizing solenoid BM3.  
(i) Memory BM3, reaching up position, closes BMU switch energizing relay CCLK.  
(1) CCLK-3 opens, preventing energizing any memory solenoids.  
(2) CCLK-1 closes, enabling closing of EMK-1 later to energize solenoid CS.  
(3) Other CCLK relay contacts not effective this cycle.  
(j) The box score printing cycle is started, but because no pinball magnets are energized, the printing cycle results in "blank" printing.  
(k) The "Done Printing" signal from printer energizes EMK relay (formula shaft solenoid FS is prevented from being energized).  
(1) EMK-1 closes, energizing solenoid CS.  
(2) EMK-2 closes.  
(3) EMK-3 closes.  
(4) EMK-4 closes, holding EMK until CKF-7 opens later.  
(5) EMK-5 and EMK-6 open.  
(l) The rack returns to computation finished position with no memories engaged, opening switches C and CF and de-energizing CK, CKF and CFLK relays.  
(1) CFLK-3 opens, de-energizing relay CALK.  
(2) CALK-2 opens, de-energizing relay CEK.  
(3) CEK-3 and CKF-4 open, de-energizing relay CCLK.  
(4) All CCLK contacts return to normal.  
(5) CE light in error panel goes out.  
(6) CKF-4 opens, de-energizing relay EMK.  
(5) The bowler sets frame score dials FSD and frame dial FD to correspond to the last correctly printed frame score.  
(6) The bowler presses the "Set Memory" button SM.  
(a) PCLK relay is energized.  
(b) CALK relay is energized closing CALK-3.  
(c) Correcting Error CE light in error panel lights.  
(d) SK and 2SK relays are energized.  
(1) SK-1 closes, holding SK until EMK-5 opens later.  
(2) 2SK-1, 2, 3, 4, 5 and 6, connect dials FD and FSD to the printed circuit commutators and magnets M1 through M10. 2SK-5 also connects power to the printer commutator.  
(3) 2SK-7 closes, paralleling the open CELK-6 and energizing solenoid SCS.  
(4) SK-2 opens, disconnecting box score printed circuit HS-BS from the printer.  
(5) SK-3 opens, preventing energizing of relay CEK.  
(6) 2SK-8 and 9 open, preventing energizing of any bowler memories, but allowing solenoid T2MM to be energized.  
(7) 2SK-10 closes, paralleling switch BMD, and energizing solenoid CS.  
(e) The computer rack drive goes from computer finished to computing position, closing CF and C and energizing relays CK, CFLK and CCLK.  
(1) Frames rack RF and score racks RU, RT and RH are stopped at positions set on dials FD and FSD.  
(2) State rack RS is stopped at 3e position.  
(3) CK-8 opens, de-energizing relay 2SK and returning all 2SK contacts to normal.  
(f) "Blank" box score is printed and "done printing" signal is received from printer, energizing solenoid FS and starting the 3a formula shaft E.  
(g) The frame score is printed in the proper frame.  
(h) A "done printing" signal energizes solenoid FS again, closing switch EM and energizing relays EMK, 2EMK, FFLLK and 2FFLLK.  
(1) EMK-5 opens, de-energizing relay 5K.  
(2) All SK contacts return to normal.  
(a) SK-3 closes, but FFLLK-8 is open preventing energizing of relay CEK.  
(3) EMK-1, EMK-2 and EMK-3 close initiating a normal rack return drive cycle and putting proper score, frame and state in the bowler memory.  
(j) Correcting Error, CE light in the error panel PAN goes out.  
(7) The bowler sets pinball dial PMD at proper pinfall of next ball.  
(8) The bowler presses "ball score" button BS.  
(a) Relay PCLK is energized.  
(b) Relays CALK and 2CALK are energized.  
(c) Light CE in error panel PAN lights.  
(d) Relays BSK and 2BSK are energized.  
(1) BSK-1 closes, holding BSK relay until 2EMK-2 opens later.  
(2) 2BSK-1 closes, enabling energizing of solenoid SAS.  
(3) 2BSK-2 opens, preventing energizing of relay CEK.  
(e) Pinfall magnets M1 through M10 are energized to indicate number of pins down and a normal scoring cycle is initiated.  
(f) At the end of the scoring cycle, when CALK relay is de-energized, light CE goes out.  
(9) Steps 7 and 8 are repeated until score is caught up to the current ball. If a "foul" score is desired, dial PMD is set at "0" and button F is pushed. This will initiate a normal foul scoring cycle.  
(10) When the incorrect score has been corrected and the CE light in panel PAN has gone out, the bowler throws toggle switch EC-TH in the error panel and toggle switch CEL in the bowler panel to "off" positions.  
(a) Light CELL goes out.  
(b) Relay CELK is de-energized.  
(1) All CELK contacts return to normal.  
(2) Solenoid HBL is de-energized.  
(3) Button BL3 is unlocked and light BL3 goes out.
(V) HANDICAP ENTRY

The system of the present invention may also provide for the entry of handicap information in the following manner:

(1) The bowler (assumed to be on Team A) switches toggle switch CEL in bowler panel 215 to "on."
   (a) Light CELL lights.
   (b) Relay CELK is energized.
   (c) CELK-1 opens, preventing energizing of relay 270SLK.
   (d) CELK-2 closes, enabling energizing of relay PCLK later.
   (e) CELK-3 closes.
   (f) CELK-4 closes to hold solenoid HB1 thrown-out handicap entry procedure.
   (g) CELK-5 opens, preventing energizing of relay CERK.
   (h) CELK-6 opens.

(2) The bowler presses the first bowler identification button BTL of Team A, receiving the handicap.
   (a) Light BLLL lights.
   (b) Solenoid HBL is energized, locking switch BLL down until toggle switch CEL is returned to "off" position at end of handicap entry procedure.

(3) The bowler switches CE-TH toggle switch in error panel PAN to TH or "team handicap" position.

(4) The bowler sets frame score dial FSD to correspond to the handicap being given Team A.

(5) The bowler sets frame dial FD to "II", for entry of the handicap in the 11th frame.

(6) The bowler presses button SM.
   (a) Relay PCLK is energized.
   (b) Relay CALK is energized, closing CALK-2.
   (c) Light TH in error panel PAN lights.
   (d) Team handicap relay THK is energized.
      (1) THK-1 opens, preventing energizing of clutch magnet ½YS in the printer.
      (2) THK-2 closes, paralleling switch TMMD.
      (3) THK-3 opens, preventing energizing of memory TXTM later.
      (4) THK-5 transfers, preventing energizing of solenoid BM1 and enabling energizing of solenoid TXTM later.
   (e) Relays SK and 2SK are energized.
      (1) SK-1 closes, holding SK until EMK-5 opens later.
      (2) 2SK-1, 2, 3, 4, 5 and 6 connect dials FD and FDS to the printed circuit commutators and magnets M1 through M10 and to the CE magnets.
      (3) 2SK-7 closes, paralleling the open CELK-6 and energizing solenoid SGS.
   (4) SK-2 opens disconnecting box score printed circuit HS-BS from the printer.
   (5) SK-3 opens, preventing energizing of relay CERK.
   (6) 2SK-8 and 9 open, preventing energizing of any bowler memories, but allowing solenoid TXTM to be energized.
   (7) 2SK-10 closes, paralleling switch BMD and energizing solenoid CS.
   (f) The computer rack drive goes from computation finished to computing position, closing switches CF and C and energizing relays CK, CFK, and CFLK.
      (1) Frame and score racks RF, RU, RT and RH are stopped at positions set on dials FD and FDS.
      (2) State rack RS is stopped at 3a position.
      (3) CK-8 opens, de-energizing relay 2SK and returning all 2SK contacts to normal.
   (g) A "blank" score is printed and the "done printing" signal is received from the printer, energizing solenoid FS.

(h) The handicap score is printed in the box score portion of 11th frame, bowler 1.
   (i) The "done printing" signal energizes solenoid FS again, closing switch EM and energizing relays EMK, 2EMK, FFLK and 2FFLK.
   (1) EMK-5 opens, de-energizing relay SK.
   (2) All SK contacts return to normal.
      (a) SK-3 closes, but FFLK-5 is open preventing energizing of CEK relay.
   (3) EMK-1, EMK-2 and EMK-3 close, initiating a normal rack return drive cycle and putting the proper handicap in the TXTM memory.
   (j) Light TH in error panel PAN goes out.

(7) The bowler then switches toggle switch CE-TH in the error panel to "off" position.

(8) The bowler also switches toggle switch CEL in the bowler panel 215 to "off" position.
   (a) Light CELL goes out.
   (b) CELK relay is de-energized.
      (1) All CELK contacts return to normal.
      (2) Solenoid HBL is de-energized.
      (3) BLLL button is unlocked and light BLLL goes out.

The above procedure outlined for entry of handicap data may also be used to enter an absent bowler's score in the team total memory for either team. In the illustrated system, provision is made for entry of one number in any memory without resulting in an overprint, and therefore, if the same team is to receive both an absent bowler's score and a team handicap, the two scores should be combined and added as a single number, if done before the game begins. An absent bowler's score may be entered at any other time by putting the proper score in the absent bowler's tenth frame by means of the error correction procedure outlined hereinafter.

As has been described, the system relies on manually operable bowler ID buttons to identify bowlers to the calculator and pinsetter. Thus, it is possible for bowlers, and especially bowlers 1 to 4, to bowl out of turn without adversely affecting the scoring operation. A late bowler may also begin bowling in the middle of the game since there is no required set sequencing of all bowlers, sequencing being generally random by using the ID button.

Although the operation of the scoring system has been exemplified with respect to certain situations, it will be apparent from the above descriptions and from the drawings, including the wiring diagrams, that the system is capable of scoring a complete bowling game while giving visual readout and producing a printed record of the game. No attempt has been made to describe a complete game from start to finish since such complete games vary considerably from each other as to their scoring. Rather, the system has been described and its operability exemplified with respect to occurrences in the game which may affect scoring of the game.

In an advantageous form of the scoring system of the present invention, and in the embodiment described herein, the computer accepts information from each of a plurality of separate lane detector systems responsive to the pinfall ready signal from the corresponding lane automatic pinsetter, if the computer is free at the time the signal is given. If the computer is not free, i.e., is tied up with computation of score from pinfalls information received from another lane, the pinfall ready signal is held and when the computer becomes free the signal is received; the pinfall information is then channeled to the computer and the score for the frame just bowled is computed. Additionally, when the computer receives the pinfall ready signal and when the channels for transmitting pinfall information from either of the lane pin detector systems is set up, channels are also set up to feed the bowler identification information from the correct or corresponding lane to the printer so that, in the event a bowler ID button on each lane is depressed,
both the computer and the printer are controlled to award the score to the bowler who has bowled on the lane from which the pinfall information is being received. Such control permits bowlers on one or two teams to bowl completed frames on the same or on different ones of the two lanes and the computer and printer are properly channeled to award the score to the proper bowler, regardless of his team or lane.

Further, the computer and printer, upon completing the computation on a ball-by-ball basis, are free, after computation and printing of the score for each ball, to receive and process score information from the other lane since the computer and printer are not locked in to a particular lane until completion of a frame on the lane. Generally, the computer takes information in a first-in-first-out basis with respect to “pinfall ready” signals so that, if the computer is free when two “pinfall ready” signals are created, the computer and printer are channeled to process pinfall from the lane giving the first signal, blocking any other “pinfall ready” signal and stopping the pinsetter at which such other signal is generated. In the case of concurrent signals, one will complete a circuit through the computer and the other is blocked by such completion. However, the signal is maintained while the pinsetter gives the other signal is stopped, as described above, until the signal is received after the computer becomes free.

Although the specific form of apparatus described herein is shown attached to a single mechanical and computation unit for serving two lanes, it will be apparent that more than two lanes, preferably a multiple of two lanes such as four lanes or more, can be serviced by a single mechanical computer. Of course, where a greater number of lanes, such as four lanes, is serviced by a single computer, the computer still accepts information and the receipt of a “pinfall ready” signal from one lane blocks and holds any available signals from the other lanes, stopping the pinsetters at the other lanes where the “pinfall ready” signals are available. Assuming that a plurality of signals from such other pinsetters are available at the time the computer finishes processing pinfall information, the other signals are unblocked and a circuit through the computation unit can then be completed from the lane from which the pinfall information is to be next processed. The completion of the channels in the computer will process information from any one given lane and, of course, channels the proper information to the printer for printing the computed score in the proper position for the proper bowler.

Another important advantage provided by the apparatus of the invention resides in the arrangement by virtue of which bowler sequencing is controlled by the bowler identification push buttons, and lane sequencing is controlled in a similar fashion, so that both bowler sequencing and lane sequencing may occur in random order, and the computation and control systems are adapted to handle bowler and lane information in such fashion on a ball-by-ball basis. As a result of such arrangements, it will be understood that where prior scorer systems required each of the bowlers on both teams to complete a frame on their respective lanes before any bowler from either team could switch lanes, the present apparatus is not so limited and if one team should finish a frame early on one lane before the bowlers on the other lane are through, the bowlers from the slow team may proceed on the first lane without waiting for each of their teammates to complete the frame on the other lane. Indeed, as previously bowled, there may be bowlers on more than two lanes bowling in random fashion.

We claim:
1. An apparatus for scoring a bowling game wherein balls are rolled concurrently by a multiplicity of players on a plurality of bowling lanes, said apparatus being associated with each of said lanes for detecting pinfall and for providing pinfall information, a single totalizing and computation means common to said plurality of lanes, including a single counting means, connectable to each of said pinfall detecting means for receiving pinfall information for converting pinfall information from each of said detecting means to bowling score signals for each of the multiplicity of players bowling on each of the multiplicity of lanes, means responsive to the presence of pinfall information in any one of said detecting means for connecting the corresponding detecting means to said single totalizing and computation means, memory means, including a plurality of storage channels, one for each of the multiplicity of players bowling on the plurality of lanes, for receiving from, storing, and providing to said single totalizing and computation means, score information for each of the multiplicity of players, and means for printing bowling scores based on pinfall achieved on each of said plurality of lanes for each of said multiplicity of players responsive to said score signals.
2. The apparatus of claim 1 wherein said totalizing and computation means includes means for generating said score signals as distinguishable signals for each different bowling score, and said printing means includes printer type for printing score indicia, means for moving the type responsive to said moving signals, and means for comparing type alignment with the generated and held score signals for controlling said moving means to move the type into proper alignment for printing score indicia corresponding to score represented by said score signals.
3. The apparatus of claim 1 further including control means for said printing means; said printing means including means for printing hundreds, tens and units digits of a bowler’s cumulative score in hundreds, tens and units locations within a frame score area on a score sheet at a cumulative score position within said frame score area; said control means being operative to cause said means for printing hundreds, tens and units digits to alternately print a first ball box score computed by said computation means in the tens location within said frame score area and at a box score position and to cause said means for printing hundreds, tens and units digits to print a second ball box score computed by said computation means at a units location within said frame score area at said box score position.
4. The apparatus of claim 1 including means for entering corrected score information into said totalizing and computation means and means for controlling said printing means to overprint erroneous score information with the entered corrected score information on the printable surface.
5. The apparatus of claim 1 wherein said printing means is adapted to print responsive to a signal from said computation means.
6. The apparatus of claim 5 wherein said printing means includes means for printing marks and for printing numerical scores up to at least three digits and means responsive to a signal from said computation means for selection of each digit and said computation means is adapted to actuate said printer for printing marks and/or numerical scores attributable for each ball on a ball-by-ball basis.
7. The apparatus of claim 1 including means for indicating a foul occurring on any one of said plurality of lanes during a bowling game, said printing means being adapted to print a foul indication, and selective means for controlling said single computation means responsive to said foul indicating means for signaling said printing means to print a foul indication.
8. In a machine for computing individual player cumulative scores for a bowling game wherein bowling balls are rolled by a plurality of players on each of two teams who bowl alternately on two bowling lanes, one frame on one lane and the next frame on the other lane, to earn cumulative scores based upon pinfall resulting from the rolling of said balls, in combination, a plurality of logi-
cally parallel means, one for each of said plurality of players, for storing cumulative scores for each of the players on both teams based upon pinfall attributable to the players, a single computation means for selectively receiving from said storing means a cumulative score and adding thereto a particular pinfall value, first means for establishing pinfall values attributable to one of said lanes, second means for establishing pinfall values attributable to the other of said lanes, means for signaling to the computing means the particular storage means to which a particular pinfall value is to be added and for identifying the value establishing means from which each pinfall value is to be taken including two sets of manually controllable switches, one set corresponding to each of said lanes, each set including a plurality of switches corresponding respectively to each of the players on both teams, and means for transferring the pinfall value from the identified value establishing means to the computation means.

9. A system for scoring a bowling game wherein balls are rolled during each of a succession of scoring frames on a plurality of bowling lanes at a bowling installation including an automatic pinsetter structure for each of said plurality of lanes movable through a cycle after each ball is bowled for cleaning dead wood from the pin set-up supporting surface and/or depositing a new set-top of pins on the surface, which system comprises a plurality of lanes, one for each of said lanes, for detecting pinfall and storing pinfall information, a single means for receiving and translating pinfall information received from each said detecting and storing means into bowling scores attributable to each ball bowled on each of said plurality of lanes during progression of the bowling game, means associated with each of said pinsetters for cancelling pinfall information from said detecting and storing means at a predetermined time during each pinsetter cycle, means connected to each of said pinsetters for normally stopping the corresponding pinsetter prior to said predetermined time during each cycle and means for overriding said stopping means responsive to a signal from said translating means that the translation of pinfall information into bowling score information has been completed.

10. An apparatus for scoring a bowling game for a multiplicity of players on a plurality of teams bowling alternately on a plurality of bowling lanes comprising:
(a) a plurality of means, one for each of said plurality of lanes for providing pinfall information relative to the presence or absence of a standing pin at each pin location on the respective lanes for a multiplicity of players obtained on said plurality of lanes;
(b) a single totaling and computation means for computing bowling scores for said multiplicity of players and including a single counting means connectable to each said providing means to receive pinfall information therefrom relative to pin condition at each pin location on the respective lane and to convert said pinfall information into a downsed pincount for addition to a bowler's cumulative score;
(c) storage means including a plurality of memory channels, one for each player, for receiving and storing scores earned by each of said multiplicity of players and computed by said single totaling and computation means, and for providing stored scores to said single totaling and computation means, each said memory channel being connectable to said single totaling and computation means;
(d) means for sequencing said single totaling and computation means between said lanes and said players including manual selection means for correlating bowling scores with bowler identity and for connecting a memory channel to said single totaling and computation means, and
(e) means responsive to the presence of pinfall information in any of said providing means obtained on any of said plurality of lanes for connecting the corresponding one of the providing means to said single totaling and computation means to provide the latter with the pinfall information obtained on a particular one of said lanes.

11. The combination defined in claim 10 wherein said manual selection means comprises a plurality of sets of switch means, one set corresponding to each lane, each set being adapted to be placed in a plurality of unique electrical positions, each said position corresponding to a bowler.

12. A system for scoring a bowling game wherein balls are rolled during each of a succession of scoring frames on a plurality of bowling lanes at a bowling installation including a plurality of automatic pinsetter structures, each associated with a corresponding one of said lanes, each pinsetter structure being of the type that is normally cycled responsive to the bowling of each ball for cleaning dead wood from the pin supporting surface of the corresponding lane and/or deposit a new set-up on the surface, which system comprises separate means associated with each of said lanes for providing pinfall information relative to pins knocked down on the associated lane; a single means for receiving said pinfall information from each of said pinfall information providing means and for translating said pinfall information into bowling scores attributable to each ball bowled during the progress of the bowling game, and a program means connectable to each of said pinsetters for determining the end of a bowler's game and providing an end of game signal and means responsive to the end of game signal actuating the pinsetter associated with the lane on which the bowler who completed a game was bowling to cause said pinsetter to cycle in readiness for the next ball bowled by another player and/or the first ball rolled in a new game.

13. A system for scoring bowling games bowled on a plurality of bowling lanes wherein balls are rolled during each of a succession of scoring frames at a bowling installation including a plurality of automatic pinsetter structures, one associated with each lane and adapted to undergo a cycle after each ball rolled on the associated lane to deposit a new set-up of pins on the pin set-up supporting surface and/or clean dead wood from the surface, which system comprises: a plurality of pin detecting means, each associated with one of said pinsetters and operative during the cycle of the corresponding pinsetter to provide pinfall information, a single computation means for receiving said pinfall information from any one of said pin detecting means to compute bowling scores of the bowling games bowled on any of said plurality of lanes, and means associated with each of said pinsetters precluding the cycling of any of said pinsetters when said computation means is not in readiness to receive pinfall information from the corresponding one of said detecting means.

14. The system of claim 13 further including means operatively interposed between each of said pin detecting means and said single computation means for temporarily storing pinfall information; means for cancelling pinfall information in each said storing means at a predetermined point in the cycle of the corresponding pinsetter, said precluding means comprising means connected to said pinsetters for normally stopping any of said pinsetters prior to said predetermined point in their cycles and means for overriding said stopping means when said single computation means is in readiness to receive pinfall information.

15. An apparatus for scoring a bowling game for a multiplicity of players on a plurality of teams bowling alternately on a plurality of bowling lanes comprising:
(a) a plurality of means, one for each lane, for detecting pinfall information for the multiplicity of players,
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(b) a single totaling and computation means for computing bowling scores for said multiplicity of players connectable to said detecting means and including a single totaling and computation means for computing bowling scores for said multiplicity of players connectable to said detecting means and including the pinfall information from any said plurality of detecting means into downed pin count information for inclusion in a bowler's cumulative score,

(c) a multiplicity of storage means for receiving and storing scores earned by said multiplicity of players and for providing stored scores to said single computation and totaling means, said storage means each being connectable to said single computation and totaling means,

(d) manual selection means for connecting said single computation and totaling means with one of said multiplicity of storage means for each of the multiplicity of players to be credited with pinfall from each ball bowled,

(e) means responsive to the presence of pinfall information in any of said detecting means for connecting the same to said single computation and totaling means to provide the same with pinfall information relative to a particular one of said multiplicity of players, and

(f) said pinfall means connectable to said single computation and totaling means for computing bowling scores for the multiplicity of players computed thereby.

16. The invention of claim 15 wherein said means for printing bowling scores prints scores at differing locations on a score sheet, each location corresponding to a different one of said players; said manual selection means further including means for identifying the location on the score sheet at which said printing means should print a bowling score.

17. The invention of claim 16 wherein said manual selection means comprise a plurality of electrical switches having push button actuators.

18. A system for scoring bowling games wherein balls are rolled during each of a succession of scoring frames on a plurality of bowling lanes at a bowling installation including automatic pin detecting means for each lane for determining pinfall after each ball is rolled, said system comprising: a single means for receiving pinfall information from each of said lanes from said pin detecting means and for translating the same into bowling scores attributable to each ball bowled during the progression of the game, each said lane and said single means for receiving and translating means undergoing a cycle to provide said bowling scores; and means for precluding operation of said pin detecting means when said receiving and translating means is cycling in response to pinfall information relative to a ball rolled prior to the rolling of a ball that normally activates said pin detecting means, and further including means for clearing downed pins from a bowling alley surface on each of said plurality of lanes operative in response to the rolling of a ball, said precluding means further being operative to preclude operation of said clearing means.

19. The apparatus of claim 18 wherein said printing means comprises a single printer for printing bowling scores for said multiplicity of players bowling on said plurality of lanes in response to said score signals.

20. A system for scoring a bowling game wherein balls are rolled during each of a succession of scoring frames on a plurality of bowling lanes by a plurality of bowlers, said system comprising: a plurality of automatic pinsetter structures, one for each of said plurality of lanes, movable through a cycle toward and away from a bowling pin supporting surface of the respective lane after the last ball in each frame is bowled for cleaning any deadwood from the surface and deposing a new setup of pins on the surface, each said pinsetter including a rake structure movable from a normally "up" position to a "down" position for sweeping deadwood from the surface and thence returning to the "up" position during the normal pinsetter cycle; a plurality of pin detecting means, one for each lane, for providing said pinfall information relative to pinfall on their respective lanes; a single means common to said plurality of lanes for receiving pinfall information from each of said pinfall detecting means and for totaling and computing bowling scores for each of the plurality of players based on pinfall information achieved thereby, said single computing and totaling means comprising a single counting means and a multiplayer memory having a plurality of logical parallel memory channels manually operable means for identifying to the totaling and computing means each of the multiplicity of bowlers and for selecting a memory channel to cause pinfall information to be awarded to the bowler, and means for stopping each of said pinsetters with said rake in said "down" position when said manual means have not been operated by the bowler about to bowl in the lane associated with the pinsetter to indicate to the bowler that said manual means should be operated prior to bowling the next ball, operating of said manual means being adapted to cause the respective pinsetter to normally cycle.

21. An apparatus for scoring a bowling game wherein balls are rolled concurrently by a multiplicity of players on a plurality of bowling lanes comprising separate means associated with each lane for providing said pinfall information, a single totaling and computation means connectable to each of said pinfall information providing means for converting pinfall information from each of said providing means to bowling score signals for each of the multiplicity of players, and printing means for printing bowling score signals including digits 0 through 9 being positionable seriatim through a separate printing station corresponding to a separate digit of a three digit number including 100's, 10's and units digits, wherein said computation means includes means for computing a bowling score for each ball bowled in each frame and including a separate control means for positioning the digit of said type set means at said printing stations corresponding to the same digit of the computed score to be printed, means providing a print signal for said printer after each ball bowling means being adapted to print type aligned at said printing stations upon receipt of the print signal and means blocking said print signal until said type is positioned at said station.

22. An apparatus for scoring a bowling game wherein balls are rolled concurrently by a multiplicity of players on a plurality of bowling lanes comprising separate means associated with each lane for providing pinfall information, a single totaling and computation means connectable to each of said pinfall information providing means for converting pinfall information from each of said providing means to bowling score signals for each of the multiplicity of players, and printing means for printing bowling scores for said multiplicity of players responsive to score signals, said printing means being reciprocally positionable along at least one axis with respect to a printable surface for selective printing in one of a plurality of frame score areas on the printable surface, each said frame score area including one separate score area for each of a plurality of bowlers and at least one score area for printing score information relative to the performance of a team of said players and including means for determining said score information and positioning said printing means for printing in said one separate score area.

23. In a bowling scoring apparatus for scoring bowling games wherein at least one ball is rolled during each of a succession of scoring frames and including means for providing pinfall information relative to pins downed on a bowling lane by a plurality of players bowling as a team, computer means connectable to said pinfall information providing means for receiving said pinfall infor-
mation therefrom and undergoing a cycle to compute the bowling scores for each of the plurality of players for each of the scoring frames in the bowling game, and movably mounted printing means responsive to said computing means for printing, at separate locations on a score sheet, each of the bowling scores for each of the scoring frames in a bowling game for each of the plurality of players, the improvement comprising: means mounting said printer for movement to an additional location relative to the score sheet for each frame in the bowling game to print information relative to the performance of a team for each frame in a bowling game, means for causing said computing means to undergo a second cycle for computing information relative to the performance of a team when each of the players bowling as a team have completed a frame in a bowling game and means responsive to said computing means when said computing means is undergoing said second cycle for causing said printing means to print information computed by said computing means relative to the performance of a team in the one of said additional locations on said score sheet corresponding to the frame completed by the players bowling as a team.

24. An apparatus for scoring a bowling game for a multiplicity of players on a plurality of teams bowling alternately on a plurality of bowling lanes, comprising:

(a) a plurality of means, one for each of said plurality of lanes for receiving pinfall information for a multiplicity of players obtained on said plurality of lanes;

(b) a single totaling and computation means for computing bowling scores for said multiplicity of players connectable to said receiving means;

(c) storage means including a plurality of memory channels, one for each player, for receiving and storing scores earned by each of said multiplicity of players and computed by said single totaling and computation means, and for providing stored scores to said single totaling and computation means, each said memory channel being connectable to said single totaling and computation means;

(d) means for sequencing said single totaling and computation means between said lanes and said players including manual selection means for correlating bowling scores with bowler identity and for connecting a memory channel to said single totaling and computation means, said manual selection means comprising a plurality of sets of switch means, one set corresponding to each lane, and sufficient in number to provide for the bowlers on two teams, each set being adapted to be placed in a plurality of unique electrical positions, each said position corresponding to a different bowler on each of the two teams;

(e) means responsive to the presence of pinfall information in any of said receiving means obtained on any of said plurality of lanes for connecting the corresponding one of the receiving means to said single totaling and computation means to provide the latter with the pinfall information obtained on a particular one of said lanes.

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ANTON O. OECHSLE, Primary Examiner.

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PO-1050 UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION


Inventor(s) William D. Cornell, Morton F. Disney, Paul R. Hoffman

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 31, line 12, change "rest" to --reset begin--;
Column 31, line 19, after "rotation" and before the comma, insert --(Fig. 45)--;
Column 31, line 28, delete "the" and insert --a--; same line, after "position" insert --45° counterclockwise from that--.

SIGNED AND SEALED
APR 28 1970

(SEAL)
Attest:
Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents