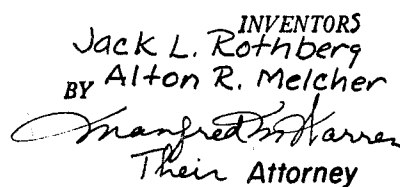


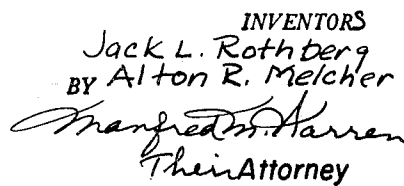
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5 Sheets-Sheet 1



3,093,374

5 Sheets-Sheet 2



June 11, 1963

J. L. ROTHBERG ET AL

3,093,374

BOWLING SCOREKEEPING MACHINE

Filed Jan. 22, 1960

5 Sheets-Sheet 3

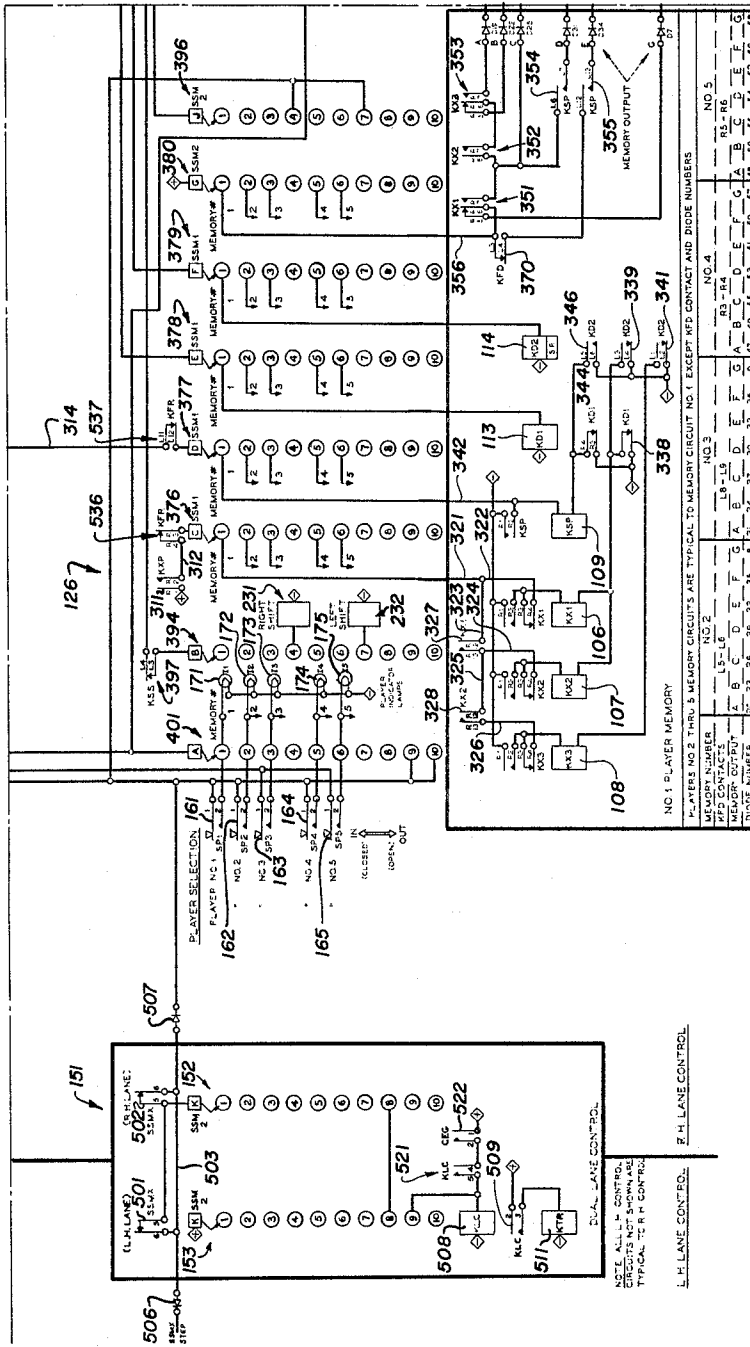


Fig. 3

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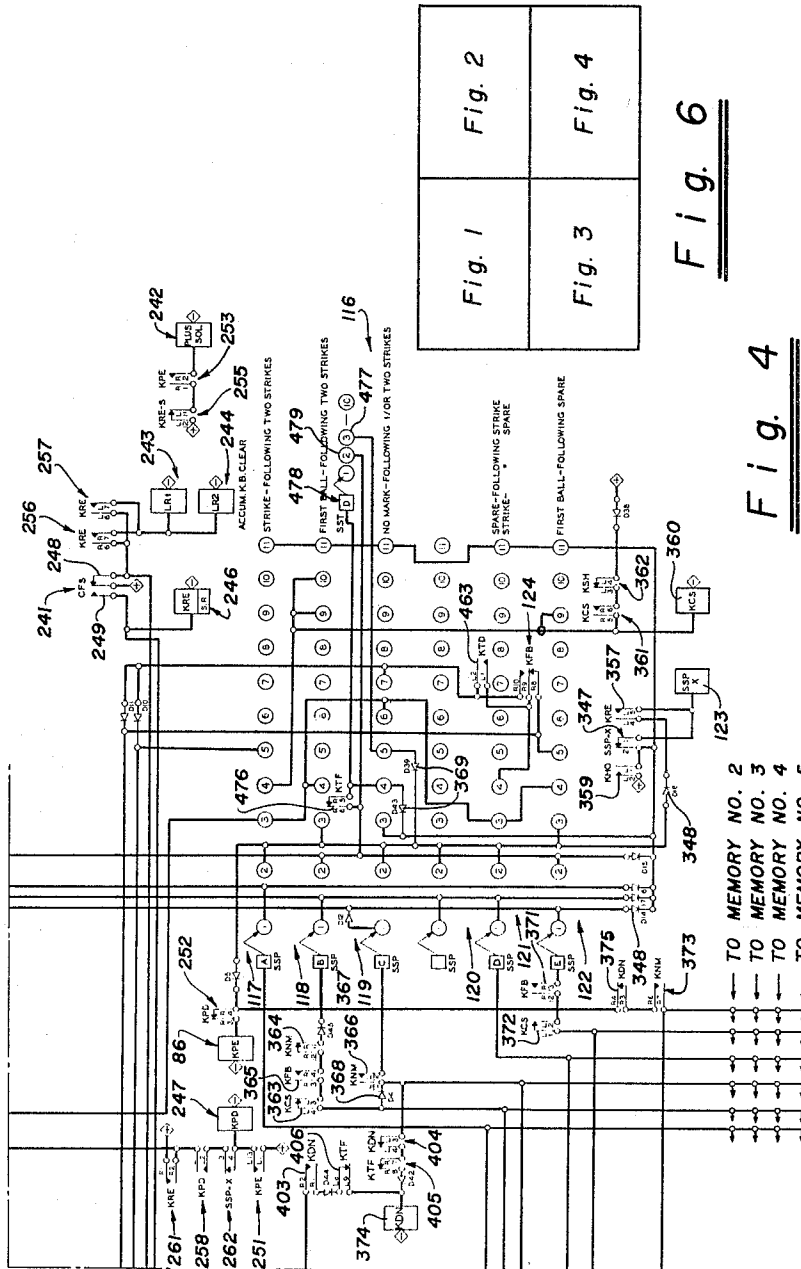
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BOWLING SCOREKEEPING MACHINE

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5 Sheets-Sheet 4



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BOWLING SCOREKEEPING MACHINE

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5 Sheets-Sheet 5

COUNTER	1 NO MARK SECOND BALL FOLLOWING A STRIKE		2 STRIKE FOLLOWING TWO STRIKES		3 NO MARK FIRST BALL FOLLOWING TWO STRIKES		4 NO MARK SECOND BALL FOLLOWING A STRIKE		5 SPARE FOLLOWING A STRIKE		6 STRIKE FOLLOWING A SPARE		7 NO MARK FIRST BALL FOLLOWING A SPARE	
	FIRST FRAME BALL 1	CURRENT FRAME BALL 2	FIRST FRAME BALL 1	SECOND FRAME BALL 2	FIRST FRAME BALL 1	SECOND FRAME BALL 2	FIRST FRAME BALL 1	CURRENT FRAME BALL 2	FIRST FRAME BALL 1	CURRENT FRAME BALL 2	FIRST FRAME BALL 1	CURRENT FRAME BALL 2	FIRST FRAME BALL 1	CURRENT FRAME BALL 2
SSC	3	6	0	0	0	0	0	0	0	0	0	0	0	0
SSS	SSS	SSS	SSS	SSS	SSS	SSS	SSS	SSS	SSS	SSS	SSS	SSS	SSS	SSS
SSS 29	SSS	SSS	SSS	SSS	SSS	SSS	SSS	SSS	SSS	SSS	SSS	SSS	SSS	SSS
SSS 30	SSS	SSS	SSS	SSS	SSS	SSS	SSS	SSS	SSS	SSS	SSS	SSS	SSS	SSS
SSS 31	SSS	SSS	SSS	SSS	SSS	SSS	SSS	SSS	SSS	SSS	SSS	SSS	SSS	SSS
SSS 32	SSS	SSS	SSS	SSS	SSS	SSS	SSS	SSS	SSS	SSS	SSS	SSS	SSS	SSS
KFB	KFB	KFB	KFB	KFB	KFB	KFB	KFB	KFB	KFB	KFB	KFB	KFB	KFB	KFB
KFD	KFD	KFD	KFD	KFD	KFD	KFD	KFD	KFD	KFD	KFD	KFD	KFD	KFD	KFD
KNM	KNM	KNM	KNM	KNM	KNM	KNM	KNM	KNM	KNM	KNM	KNM	KNM	KNM	KNM
KXP	KXP	KXP	KXP	KXP	KXP	KXP	KXP	KXP	KXP	KXP	KXP	KXP	KXP	KXP
KXM	KXM	KXM	KXM	KXM	KXM	KXM	KXM	KXM	KXM	KXM	KXM	KXM	KXM	KXM
KSW	KSW	KSW	KSW	KSW	KSW	KSW	KSW	KSW	KSW	KSW	KSW	KSW	KSW	KSW
KX3	KX3	KX3	KX3	KX3	KX3	KX3	KX3	KX3	KX3	KX3	KX3	KX3	KX3	KX3
KSP	KSP	KSP	KSP	KSP	KSP	KSP	KSP	KSP	KSP	KSP	KSP	KSP	KSP	KSP
KX2	KX2	KX2	KX2	KX2	KX2	KX2	KX2	KX2	KX2	KX2	KX2	KX2	KX2	KX2
KX1	KX1	KX1	KX1	KX1	KX1	KX1	KX1	KX1	KX1	KX1	KX1	KX1	KX1	KX1
SSP	SSP	SSP	SSP	SSP	SSP	SSP	SSP	SSP	SSP	SSP	SSP	SSP	SSP	SSP
PROGRAM	PROGRAM	PROGRAM	PROGRAM	PROGRAM	PROGRAM	PROGRAM	PROGRAM	PROGRAM	PROGRAM	PROGRAM	PROGRAM	PROGRAM	PROGRAM	PROGRAM
MEANS	MEANS	MEANS	MEANS	MEANS	MEANS	MEANS	MEANS	MEANS	MEANS	MEANS	MEANS	MEANS	MEANS	MEANS

Fig. 5

NOTES:
1. INITIAL FRAMES ARE REPRESENTATIVE.
2. BOLDFACE LETTERING INDICATES MAIN ELEMENTS ACTIVATED TO PRODUCE SCORING ACTION.
3. GROUPS IN BRACKETS INDICATE SCORING ACTION FOR POSSIBLE PRIOR STRIKE SITUATIONS.
4.5 WHEN PRECEDING FRAME ALSO HAD A STRIKE.

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3,093,374

BOWLING SCOREKEEPING MACHINE

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9 Claims. (Cl. 273-43)

This invention relates to automatic scorekeeping machines particularly for the game of bowling.

An object of the present invention is to provide a bowling scorekeeping machine for automatically computing and for keeping and displaying a running total of the scores made by one or more individual players in the game of bowling, including both the basic scores made by each player as a result of pinfall for each ball he bowls, and the extra scores awarded the player as a result of pinfalls of special classes, as provided by the game rules; the machine being designed for fast and accurate response to the various possible scoring situations as they arise and for foolproof and errorproof operation to swiftly provide appropriate computation, totalization and display.

A further object of the invention is to provide a bowling scorekeeping machine of the character described of high quality and reliability and which may be produced and installed at a reasonable cost.

A further object of this invention is to provide a bowling scorekeeping machine as above described and adapted for easy connection to a scoreboard of conventional appearance for the excerpting and display of the frame scores of each player as the game progresses and in correspondence with the standard method of keeping score, as provided by the game rules.

Still another object of the invention is to provide a bowling scorekeeping machine as above described and adapted for use in pairs to keep the scores of two different teams of bowlers alternately bowling their frames on two different bowling lanes.

The invention possesses other objects and features of advantage, some of which of the foregoing will be set forth in the following description of the preferred form of the invention which is illustrated in the drawings accompanying and forming part of this specification. It is to be understood however, that variations in the showing made by the said drawings and description may be adopted within the scope of the invention as set forth in the claims.

Referring to said drawings (five sheets):

FIGURE 1 is a schematic circuit diagram of a portion of a scorekeeping machine constructed in accordance with the invention.

FIGURE 2 is a schematic circuit diagram of another portion of the machine of FIGURE 1.

FIGURE 3 is a schematic circuit diagram of another portion of the machine of FIGURES 1 and 2.

FIGURE 4 is a schematic circuit diagram of another portion of the machine of FIGURES 1 to 3.

FIGURE 5 is a table illustrating some of the relationships and functions of elements of the machine of FIGURES 1 to 4.

FIGURE 6 is a key chart showing how the sheets of FIGURES 1-4 fit together.

The scorekeeping machine of the present invention is designed for use in a bowling game in which the players are awarded "basic" scores for pinfall count and "extra" scores for pinfalls of special classifications, such as those following strike and spare scores. Briefly the machine consists of an accumulator registering the accumulated score of the player from frame to frame, the accumulator being of a type having separate input means for different

2

multiples of scoring points, and pinfall scoring means operable after the bowling of each ball. The pinfall scoring means indicates (at least to other portions of the apparatus) both the basic scoring count of the pinfall of each ball and the extra-scoring classification of the pinfall, and is especially designed for and is operatively connected with the accumulator input for entry of the pinfall scores therein. Such is the basic machine, suitable at least for the use of one player. For the use of a plurality of players, the accumulator is provided with a score register for each player, and there is also provided a player programming means adapting the machine to score the game of each player separately, a frame counter for counting the frames played by each player, and a tenth frame programming means; and when it is desired to use two machines for scoring the games of two teams of players bowling alternately on two different bowling alleys, there is provided a lane transfer means connecting the two machines for this purpose.

An important feature of the scorekeeping machine of the invention is that the accumulator 31 thereof (FIGURES 2 and 4) has a score register 32 operable for advancing in multiples of scoring points (i.e. by one, two, or three etc., or by ten, twenty or thirty points) in a single operation, and the accumulator has a number of input elements, here shown as including electrical input leads 36, 37, 38, 39, 40, 41, 42, 43 and 44, the leads 36-41 being operable as described under the heading "Accumulator" below, to advance the register by various multiples from one to nine, and the leads 42, 43 and 44 being operable to advance the register by ten, twenty, and thirty points respectively. While any accumulator of the class described may be used in the invention, the one illustrated is an accumulator manufactured by the Friden, Inc., in which the input leads 36-44 are connected to energize a number of solenoids 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79 and 80 in various selected combinations to "set" the accumulator for entry of the required scores into the register, and a plus-entry KPE solenoid 86 is energized to make the entry from the solenoids 51-80 to the register 32. An important advantage of combination including the accumulator as described is that such an accumulator is readily adapted for electrical "take-off" of the scores for recording on an electrically operated display scoreboard and for excerpting and display of the frame scores of each player according to the standard method of keeping score as provided in the game rules, and for making permanent printed records of each player's frame and game scores.

The pinfall scoring means 87 (shown in all of the figures) includes a pinfall counter 88 (FIGURES 1 and 2) to perform the above ascribed function of indicating the scoring count of each pinfall. As here illustrated, the counter includes a pin counting SSC step switch 89 cycling through ten positions and having the accumulator input leads 36-41 connected to various position contacts thereof for entering pinfalls aggregating from one to nine therein as "basic" scores. Also provided is a set of ten pin-sensing members 91, here shown as including ten normally closed switches 92, which may be opened by hand to put the pin sensing members 91 in "pin-standing" position or left closed to leave the pin-sensing members in "pin-felled" position; or the switches 92 may be mounted on a vertically reciprocating pinsetting mechanism (not shown) in a manner well known in the art for opening by direct contact with the pins themselves when the pinsetting mechanism descends to pin-setting position. A scanning means, here shown as a scanning SSS step switch 93 is activated as by a table-drop switch 94, which is closed either by hand after the bowling of

each ball or is mounted on the pinsetting mechanism for automatic closing thereby each time the mechanism descends; and upon activation the wiper 95 of the SSS step switch cycles through a series of positioned contacts 96 (numbered 1 through 32), various ones of which are included in the respective pin-sensing members 91, so that upon alignment with each of the pin-sensing members 91 that is in "pin felled" position the SSS step switch 93 comes to a "sensing" position as by completing an electrical circuit therethrough to the SSC step switch 89, so that the SSC step switch is advanced one position for each pin felled, and, at the end of the SSS step switch cycle, is left indicating the total number of pins felled. Energization of the SSC step switch wipers and the KPE solenoid 86 of the accumulator for entry of the pinfall into the register 32 is controlled by a KFB first ball relay 97 (FIGURE 1) energized from a contact point number "32" of the SSS step switch and a no-mark second ball KNM relay 98 (FIGURE 1) energized from a contact point "31" of the SSS step switch and connected to the KFB relay for energization only sequentially thereafter, so that the entry of a no-mark second-ball score is always made at the end of a no-mark frame, and only then, and always includes the pinfall counts of the two most recent balls, i.e. the total no-mark frame score. Details of the circuits involved in these elements are given under the heading "Pin Sensing and Counting" below.

The above and what follows may be better understood by reference to the following table, which shows seven "significant" scoring situations possible in the game of bowling, i.e., situations in which a score is required to be computed after the rolling of a ball; and to the diagram of FIGURE 5, which shows how these situations are met by the machine of the invention. It will be seen that these seven situations encompass all of the scoring requirements of the game, except some occurring in tenth frame.

Significant scoring situations	Previous frames (memory)			Current frame (CBI)	
(1) No-mark second ball.....	10	10	3	3	3
(2) Strike following two strikes.....	10	10	10	10	3
(3) First ball following two strikes.....	10	10	3	3	7
(4) No-mark following a strike.....	(10)	10	3	3	3
(5) Spare following a strike.....	10	10	3	3	3
(6) Strike following a spare.....	3	7	10	3	3
(7) First ball following a spare.....	3	7	10	3	3

NOTE.—Pinfall figures are representative.

In the scorekeeping machine of the invention, the above-described elements take care of entering the basic scores of each no-mark frame bowled (line 1 of the table), even when the no-mark frame follows a frame in which a mark was scored (line 4 and possibly line 7 of table). But as is well known in the standard game of bowling, extra scores are awarded whenever all ten pins are knocked down on the first ball of a frame (a strike) or upon the second ball of a frame (a spare). When a strike is scored, the total pinfall of the next two balls is added to the strike-frame score, and for a spare the pinfall of the next subsequent ball is added to the spare-frame score, and the pinfalls of these subsequent balls are also scored as basic scores for the frames in which they occur. Consequently when a strike or spare is made, scoring for the frame in which it occurs must be postponed until the appropriate subsequent balls are bowled and the pinfalls thereof are known. When the play advances to the point that the "current" ball (i.e. the ball most recently bowled) is the second ball following a strike (lines 2, 3, 4 and 5 of table) or the first ball following a spare, (lines 6 and 7 of table) then a significant scoring situation arises, and scores must be entered for the total pinfall counts of the three most recent balls. For the strike scoring situations, these three balls include the two balls following the strike as extra scores and the strike ball as a basic score. For the spare scoring

situations these three balls include the ball following the spare as an extra score and the two spare balls as basic scores.

For performing the action above described the pinfall scoring means 87 is accordingly provided with a pinfall classification indicator 99, which includes the KFB and KNM relays 97 and 98 (FIGURE 1), for activating the counter to enter the basic scores for each no-mark second-ball scoring situation as above described; and the classification indicator also includes a first-ball detector KFD relay 101 (FIGURE 1), a strike master KXM relay 102 (FIGURE 2), a spare master KSM relay 103 (FIGURE 2), a strike-pulse KXP relay 104, a first-strike KX1 relay 106 (FIGURE 3), a second-strike KX2 relay 107 (the relays KX1 and KX2 comprising a strike counter) a third-strike KX3 relay 108, and a spare KSP relay 109 (constituting a spare counter), which are actuated in various combinations to indicate the second-ball-following-a-strike scoring situations and the first-ball-following-a-spare scoring situations and for causing the accumulator to enter the corresponding extra scores, plus the strike and spare basic scores, into the register.

To perform these selected operations, the elements of the pinfall classification indicator are grouped into a current-ball indicator 111 (FIGURE 5) normally including the KFB, KFD, KNM, KXM, KSM and KX3 relays, and a memory unit 112 normally including the KX1, KX2 and KSP relays. Generally speaking, in the current-ball indicator, the activation of the KXM relay indicates a strike scored by the current ball, the activation of the KSM relay indicates a spare scored on the current ball, the activation of the KFB and KFD relays indicates a no-mark first ball, and the activation of the KNM relay indicates a no-mark second ball, these being the four possible results of the current ball. Some of the scoring actions of the machine call for indications additional to those listed above, and the details of how the circuits are arranged for such indications and actions are in the headed paragraphs below.

The relays of the memory unit are devoted to storing strike and spare information from previous frames, the activation of relay KX1 alone (when no strike indication appears in the current-ball indicator), or relay KSP alone (when no spare indication appears in the current-ball indicator), indicating that a strike or a spare respectively was scored in the previous frame, and the activation of KX1 and KX2 together (when no strike indication appears in the current-ball indicator) indicating that strikes were scored in the two previous frames. The activation of KX3 can be effected only in a frame subsequent to a frame in which KX2 was activated, and then only in conjunction with the concurrent activation of KXM and KX2 and indicates that the current ball is a strike following two previous strikes. Both the current-ball indicator and the memory unit have connections to the pinfall counter 88 and associated accumulator input lines 36-41, and also to the "tens" input lines 42, 43 and 44 for entry of appropriate scores as shown in the numbered columns of FIGURE 5.

Briefly the pinfall classification indicator operates as follows: (1) when a previous-strike indication appears in the memory unit and a second-ball (either no-mark or spare) indication appears in the current-ball indicator as shown in columns 4 and 5 of FIGURE 5, then circuits are closed to input line 42 plus appropriate lines 36-41 (column 4), or to line 43 (for column 5) of the accumulator to enter "ten" plus the second-ball frame-accumulated count of the current frame; (2) when an indication of two previous strikes appears in the memory unit and an indication of a first ball (either strike or no-mark) appears concurrently in the current ball indicator as shown in columns 2 and 3 of FIGURE 5, then a circuit is closed to accumulator input line 44 (column 2, FIGURE 5) or to line 43 plus appropriate lines 36-41 (column 3, FIGURE 5) to score "twenty" plus the first-ball

5

count of the current frame; (3) when a spare indication appears in the memory unit and a first-ball indication (either strike or no-mark) appears in the current-ball indicator (columns 6 and 7, FIGURE 5), then a circuit is closed to line 43 (column 6, FIGURE 5) or to line 42 plus appropriate lines 36-41 (column 7, FIGURE 5) to score "ten" plus the first ball count of the current frame; and (4) whenever any indication of a no-mark second ball appears in the current-ball indicator (columns 1 and 4, FIGURE 5) a circuit is additionally closed to appropriate input lines 36-41 of the accumulator to enter the second-ball frame-accumulated count of the current frame.

For use in special situations where, after a scoring operation has been made, it is necessary to erase the strike or spare information from the memory unit or (as with KX3) from the current ball indicator as shown in columns 2, 4 and 7 of FIGURE 5, or to erase strike while leaving spare or spare while leaving strike information as shown in columns 5 and 6 of FIGURE 5, the memory unit is provided with clearance means here shown as drop-out KD1 and KD2 relays 113 and 114. Operation of relay KD2 alone deactivates the relay KX3 of the current-ball indicator without disturbing relays KX1, KX2 or KSP; operation of relay KD1 alone deactivates spare memory relay KSP without disturbing the strike memory relays KX1 or KX2; and operation of KD1 and KD2 simultaneously deactivates both strike relays KX1 and KX2 together (and KX3 if it is energized), without deactivating the KSP relay if it is energized. It is not necessary to clear the strike indications represented by KX1 and KX2 one-at-a-time; rather it is only necessary to clear them both together upon any subsequent indication of a second ball in the current-ball indicator as shown in columns 4 and 5 of FIGURE 5 since the situations represented by these columns naturally follow the situations represented by columns 2 and 3, and the circuitry is arranged so that only one strike is scored for when such is proper, even though two strikes may be shown in the memory; and likewise any indication existing in the memory is cleared upon any subsequent indication of a first ball in the current-ball indicator, as shown in columns 6 and 7 of FIGURE 5. It is also noted that the apparatus is arranged to selectively preserve any existing spare indications in the memory while erasing the strike indications therefrom (column 5 of FIGURE 5); and to preserve existing strike indications in the memory while erasing spare indications therefrom (column 6 of FIGURE 5); since it is intrinsic to the game that whenever a strike follows a spare or a spare follows a strike, then after scoring has been completed for the earlier (previous) mark and the memory indication therefor is to be erased, the memory indication for the latter (current) mark must be preserved in the memory as a new "previous" mark indication for later scoring.

As an important feature the scorekeeping machine of the present invention also includes a programming means here shown as an SSP programming step switch 116 (FIGURE 4), having a number of program units (step switch levels) 117, 118, 119, 120, 121 and 122 arranged for selective actuation to enter pinfall count and extra scores into the accumulator. The various levels 117-122 are connected to the memory unit, to the current-ball indicator and to the accumulator entry lines 42, 43, 44 and 293 in various combinations, so that upon actuation of the SSP step switch through energization of the SSP step switch coil 123, one of the levels 117-122 is selected to perform a scoring operation as follows:

SSP level A (117): Selected by concurrent indications of two previous strikes in the memory and a strike in the current-ball indicator, and actuates entry line 44 (column 2 of FIGURE 5).

SSP level B (118): Selected by concurrent indications of two strikes in the memory and a no-mark first ball in the current-ball indicator, and actuates lines 43 and appropriate lines 36-41 (column 3 of FIGURE 5).

6

SSP level C (119): Selected by concurrent indications of one or two strikes in the memory and a no-mark second ball in the current-ball indicator, and actuates lines 42 and appropriate lines 36-41 (column 4 of FIGURE 5).

SSP level D (120): Selected by concurrent indications of a strike in the memory and a spare in the current-ball indicator and actuates line 43 (column 5 of FIGURE 5). Note: Level D is actually two levels operating in two different programs according to the setting of a double set of KFB contacts 124 connected thereto, the other program being as follows:

SSP level D (121): Selected by concurrent indications of a spare in the memory and a strike in the current-ball indicator, and actuates line 43 (column 6 of FIGURE 5).

SSP level E (122): Selected by concurrent indications of a spare in the memory and a no-mark first ball in the current-ball indicator, and actuates line 42 and appropriate lines 36-41 (column 7 of FIGURE 5).

For use with a group of players bowling in a pre-determined order and each player bowling one frame per turn, the pinfall classification indicator of the invention is provided with a separate memory unit for each player, all of the memory units being connected to a single programming (SSP) step switch 116; and the operative connections between the (single) current-ball indicator and the individual player memory units are made by means of a player programming means, here shown as an SSM step switch 126 (FIGURE 3 and parts in FIGURE 2, actually two step switches SSM-1 and SSM-2 are used in tandem in the illustrated form of the invention, because of the large number of step switch levels that are needed). This arrangement, depending on which memory unit is connected, provides an individual classification-indicator array for each player; and in each position the switch makes the necessary connections to enter upon the particular player's own register the pinfall counts of his three most recent balls for mark scoring situations and of the two most recent balls for no-mark scoring situations.

The SSM step switches 126 are arranged to cycle through a number of player positions represented by sets of contact points numbered "1," "2," "3," etc., the switch being arranged for connecting the pinfall counter and the current-ball indicator to the memory unit of the first player when the switch is positioned with its wipers on the set of number "1" contact points as illustrated in the drawing; and the switch also being arranged for cycling from one set of contact points to another, sequentially upon energization and release of the SSM actuating coils 127 and 128 as for making a connection to the memory unit of the second player when his turn comes. As will be explained under the heading "Player Programming Means" below, such actuation of coils 127 and 128 is controlled by the current-ball indicator and counter to be effected upon indications therein of a strike, a spare, or a no-mark second ball (these signals corresponding with the end of a frame), except under certain tenth frame conditions as follows:

When a player in the tenth and last frame of his game bowls a no-mark score, the score is duly recorded by the machine just as it would be for any other frame, and the game is ended. But when a player in his tenth frame bowls a strike or a spare, the rules of the game provide that he be accorded an immediate opportunity to roll two more "bonus" balls for the strike or one more bonus ball for the spare so that he can obtain the "extra" scores he has earned. Accordingly there is provided a frame counter for each player, here shown as a frame counter 131 (FIGURE 2), having five frame registers here shown as SSF frame counting step switches 132, 133, 134, 135 and 136 for the individual players of a team, each register having ten positions (as explained in detail under the heading "Frame Counter" below) for indicating the number of frames bowled by the corresponding player. The frame counter 131 is connected to the current-ball indicator and to the SSP step switch 116 for controlled selec-

tive actuation thereby to keep track of the progress of the players through the game. In addition there is provided a tenth frame programming means, here shown as comprising an SST tenth frame step switch 141 (FIGURE 2) connected to the frame counter 131 and to the SSM step switch 126 so as to be brought into actuation whenever a player begins his tenth frame. When actuated the SST step switch 141 has an operative connection with the current-ball indicator and with the SSM step switch 126 to break the connection therebetween so as to suspend the cycling of the SSM step switch as to a new player position until the current player has bowled his tenth frame balls and it is known whether he will have bonus balls to bowl; and if so to continue the suspension until the bonus balls have been bowled and the extra scores therefrom have been entered into the accumulator. For return to deactuated position after the bowling of the tenth frame and the bonus balls if any, the SST step switch 141 has a connection to the current-ball indicator and the programming SSP step switch 116 for deactuation upon the bowling of a no-mark second ball in the tenth frame or upon the actuation of the SSP step switch through any of its programming cycles in response to a scoring situation involving the bonus balls. Because the bonus balls, unlike any of the other balls bowled in the game, have status only as extra-scoring balls and do not have any basic scoring status, the SST step switch 141 also has an operative connection with the pinfall scoring means to control the scoring of the bonus ball pinfall as extra scores only. The details of these elements and their interconnections are explained more fully in the paragraphs below.

Because in competition play between two teams of players it is customary to use two bowling lanes or alleys concurrently, each lane being occupied by one team, and with the teams changing lanes at the end of each frame, the present invention also comprises two scorekeeping machines as above described, plus associated apparatus for making automatic transfer of the machines from one lane to the other as the players change over. Briefly the arrangement is as follows: Each pinfall scoring means of the machines has an input unit which is permanently positioned and stationed at one of the alleys and the corresponding machine is assigned to a particular group of players, i.e., the input units are assigned permanently to the bowling lanes and the remaining portions of the machines are assigned to the players for the duration of the game. In this arrangement there is provided a lane transfer means 151 (FIGURE 3), here shown as comprising the K level 152 of the SSM step switch 126 of one machine, plus the K level 153 of the SSM step switch of the other machine, and especially inter-connected for cross-connecting the input unit of the machine with the scoring means of the other machine upon transfer of the teams from alley to alley. The input means referred to above may comprise the switches 92 and associated circuitry, the switches being hand operated as previously described or connected to a pin-setting mechanism at the respective bowling alley, and in fact they may include the complete pinfall sensing means as previously described. The lane transfer means 151, since it comprises portions of both of the player programming step switches, is particularly adapted to effect the required cross-connecting action upon arrival of both the programming means at positions corresponding with the completion of a frame by all players of both teams. As explained more fully hereinafter, the lane transfer means particularly effects disconnection of each sensing means from its corresponding pinfall counter as soon as all the players of the corresponding team have completed their frame and the cross-connection is made only upon the completion of the frame by all players of both teams.

A plurality of manually operable player control units, here shown as switches 161, 162, 163, 164 and 165 is provided, each having operative and inoperative positions

controlling the actuation of the player programming step switch 126, so that if a player is unavoidably absent or misses his turn for one reason or another the machine may be manually moved forward to the next player, and then may later be reconnected for scoring the bowling of the missing player when he returns. Also connected with the switches 161-165 is a plurality of sensible (i.e. capable of being sensed by a person) individual player signal indicators here shown as signal lamps 171, 172, 173, 174, 175, which are energized in connection with the switches 161-165 to indicate which player is scheduled to bowl.

Details of all of the above elements and circuitry are given in the headed paragraphs that follow:

ACCUMULATOR

The accumulator 31 has a register 32 upon which are mounted twenty rotating numbered dials 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219 and 220 (the dials 211-217 not shown, being mounted on a broken-out portion of the register 322. Each dial has numbers from "zero" through "9" printed on the periphery thereof and arranged so that the digit matching with an index point (shown in the drawing as being directly beneath the center of the dial) indicates the setting of the dial. Dials 201 through 220 are arranged in groups of three to form individual player registers 221, 222, 223, 224, and 225 (the registers 224 and 225 being part of the broken-away portion of register 32, and dial 210 being unused). Register 221 is for recording the progressive total score of player number 1, register 222 is for the score of player number 2 and so forth. In each player register the right hand dial indicates "units," the middle dial indicates "tens" and the left hand dial indicates "hundreds." The dials 217 through 220 are formed into a team total register 226, recording in "thousands," upon which the individual player totals are summarized at the end of the game as an inherent function of the (Friden) accumulator.

Setting of the dials to show a number is performed by mechanical means of a class well known in the art (and not shown) and is controlled by the solenoids 51-80 in the keyboard of the accumulator. The solenoids are arranged in three columns 227, 228 and 229 and the register 32 is arranged above them and is mechanically shiftable from left to right or from right to left so that in the "left shift position" as shown in the drawing individual player register 221 is aligned with solenoid column 227, register 222 is aligned with column 228 and register 223 with column 229. In the "right shift" position individual player register 224 representing the fourth player on the team is aligned with column 227 and individual player register 225 representing the fifth player is aligned with column 228. This solenoid column 227 is arranged to control the entries for player number 1 and player number 4, column 228 controls the entries for player number 2 and player number 5, and column 229 controls the entries for player number 3 and the team total.

Shifting of the register 32 is controlled by right shift and left shift solenoids 231 and 232 through mechanical means well known in the art (and not shown). Each of the solenoid columns 227-229 is divided into two sub-columns, one for "units" (as for example the solenoids 51-56 of column 227) and the other for "tens" as for example the solenoids 57-60 of column 227. In the units column solenoid 53, for example, when energized will control the mechanical actuation of dial 201 to a position indicating either a "one" or a "six," solenoid 54 enters either a "two" or a "seven," solenoid 55 enters a "three" or an "eight," and solenoid 56 enters either a "four" or a "nine." Solenoid 51 is termed a "HI" solenoid and solenoid 52 is termed a "LO" solenoid and when one of them is energized along with one of the solenoids 53-56 the entry of either the "high" or "low" digit of the corresponding pair is selected for entry into the dial. For example upon concurrent energization of "HI" sole-

noid 51 and the 1-6 solenoid 53 the digit "six" is entered on dial 201, but upon concurrent energization of the "LO" solenoid 52 with the 1-6 solenoid 53 the digit "one" is entered on dial 201. Entry of the digit "five" is made by energization of the "LO" solenoid 52 alone. In the "tens" sub-column solenoid 57 is a "LO" solenoid, 58 is a 1-6, solenoid 59 is a 2-7, and solenoid 60 is a 3-8 solenoid. In this tens column no "HI" solenoid and no 4-9 solenoid is needed because of peculiarities of scoring in the standard game of bowling; for example no player can ever score greater than "thirty" in a single frame and consequently the forties, fifties, sixties, seventies, eighties and nineties are not needed. Solenoid columns 228 and 229 are similar to column 227 with solenoids 61 and 71 both being high units solenoids similar to the solenoid 51 and so on, the extra (left hand) column of solenoids in column 229 being used for "thousands" in team total scoring.

As shown in the drawing accumulator entry line 36 controls the energization of the "units" 1-6 solenoids 53, 63, and 73, entry line 37 controls the units 2-7 solenoids, 54, 64, and 74, entry line 38 controls units 3-8 solenoids 55, 65, and 75, entry line 39 controls units 4-9 solenoids 56, 66 and 76, entry line 41 controls units "HI" solenoids 51, 61 and 71, entry line 40 controls units "LO" solenoids 52, 62 and 72, entry line 42 controls the tens 1-6 solenoids 58, 68 and 78 together with the tens "LO" solenoids 57, 67 and 77 for entry of "ten" into the tens dials, entry line 43 controls tens 2-7 solenoids 59, 69 and 79 together with tens "LO" solenoids 57, 67 and 77 for entry of "twenty," and entry line 44 controls tens 3-8 solenoids 60, 70 and 80 together with tens "LO" solenoids 57, 67 and 77 for entry of "thirty."

Selection of which column 227-229 is to be used according to which of the five players is bowling is controlled by having the negative return lines for all of the solenoids in each column channeled to a single negative return line such as line 233 for column 227, line 234 for column 228, and line 235 for column 229, and these negative return lines are selectively coupled to negative potential through the player programming means described below.

A feature of the accumulator is that several entries may be made on the solenoids 51-80 before the actual mechanical entry is made to the dials 201, etc., the actual mechanical entry being effected upon energization of a plus solenoid 242 (through plus entry KPE solenoid 86). For example, following the program of column 3 of FIGURE 5, solenoids 57 and 59 are energized through entry line 43 to enter "twenty" in the solenoids and subsequently solenoids 52 and 55 are energized through entry lines 38 and 40 to enter "three" on the solenoids and then plus solenoid 242 is energized (through KPE relay 86) to enter "twenty-three" on to dials 201 and 202, and the dials are moved to their respective positions in a single mechanical action.

The accumulator includes as part of its regular equipment a CFS switch 241, a "plus" solenoid 242, two keyboard-clearing solenoids 243 and 244, and, as part of the circuitry of the invention, there are also provided a KRE keyboard restore relay 246 and a KPD (plus drop-out) relay 247. The CFS switch is a cam operated switch that is arranged for actuation at the beginning of any mechanical function of the accumulator, and its purpose is to prevent the beginning of another function until the first function has ended. It is shown in FIGURE 4 connected to positive potential in its unactuated position with normally closed contacts 248 and with normally open contacts 249.

As noted above each accumulator plus entry function for mechanical entry of a score from the solenoids 51-80 into the dials is initiated by energization of plus entry KPE relay 86, which has normally open contacts 251 in the positive potential line of relay KPD, so that relay KPD is also immediately energized. But relay KPD has

normally closed contacts 252 in the positive potential line of relay KPE so that upon energization it immediately drops out relay KPE. Plus solenoid 242 has normally open KPE contacts 253 in its positive potential line, so that it is momentarily energized by KPE and then is dropped out along with KPE. The momentary energization of the plus solenoid 242 begins the mechanical function of entering the score from solenoids 51-80 into the dials, and immediately upon the beginning of this mechanical operation the CFS cam operated switch 241 is actuated, closing a positive potential circuit through contacts 249 to KRE relay 246 and energizing the latter, which in turn closes normally-open KRE contacts 256 and 257 in the positive potential line to keyboard-clearing solenoids 243 and 244 and at the same time switch 255 is opened in the plus solenoid energizing lines. But the keyboard-clearing solenoids' positive potential line is still broken by opening of the contacts 248 of the CFS switch 241, and the keyboard clearing solenoids cannot be energized until completion of the mechanical entry operation. It is noted that the KRE relay is a "slow release" type, so that upon de-actuation of the CFS switch, the KRE switches 256 and 257 remain closed sufficiently long to permit CFS switch 248 to close the circuit to relays 243 and 244.

Meanwhile, the KPD relay 247 when it is energized locks itself into energized condition by closing its normally open contacts 258 in a subsidiary positive potential line 259 (FIGURES 1 and 2), that is controlled by the player programming means as will be seen below, so that relay KPD, in ordinary no-mark scoring, cannot be dropped out to permit undesirable re-energization of the KPE relay 86 until the circuits of the scorekeeping machine are arranged to accommodate the next subsequent player. But it is noted that the energization of KPE, in no-mark scoring, is made through normally open contacts (373) of the KNM relay 98, which might possibly be delayed in dropping out because of the chain of events (later explained) required for such action; so in order to safeguard against an undesired second plus entry cycle in such event, another precaution is taken. The KRE relay 246 upon energization also closes a set of normally open contacts 261 in another subsidiary positive potential line to the KPD relay, this line also being a subsidiary positive potential line to the line 259, so that KPD relay 247 and KNM relay 98 are both locked in thereby and cannot but be released at the same instant, as by release of KRE, which, in no-mark scoring, always releases after line 259 would otherwise have been dropped out. And the contacts 373 are mechanically set to open before KPD 252 closes.

In other scoring situations, as for instance those in which SSP enters a program, it will be seen that there is no danger of a second energization of KPE through KNM 373 switch. In fact in these circumstances it is sometimes desired to make a second plus entry, and so to enable such action the KPD relay 247 is de-energized (if it is energized) each time the SSP step switch steps forward, as by opening of a set of normally closed SSP-X breaker points 262 in the KPD subsidiary lock-in line.

Use of the described accumulator in the combination of the present invention makes it possible to electrically "take-off" or extract each frame score for separate recording on a scoreboard, so that the frame scores as well as the running totals can be displayed in the form customarily used for scoring the game.

PIN SENSING AND COUNTING

As described above each of the ten pin sensing switches 92 (FIGURE 1), is opened by direct contact with a pin when the pin setting mechanism descends after the rolling of each ball, or remains closed if the corresponding pin happens to have been felled (or the switches 92 may be opened by hand to indicate pins remaining standing after the ball is rolled). Each of the switches 92 is connected

in the positive potential circuit of a corresponding pin sensing relay 271, the ten relays being shown on the drawing as KP1, KP2, KP3, etc. After each ball is rolled and upon descent of the pinsetting mechanism, the table drop switch 94 is closed (either by the pin setting mechanism or by hand), which action closes a positive potential circuit to the SSS step switch operating coil 272 (FIGURE 2), and the SSS A wiper 95 and another SSS B wiper 273 are set in motion to cycle through their respective positions concurrently.

The SSS step switch is self-cycling from a "zero" home position and the SSS coil 272 has a set of off-normal contacts 274 (FIGURE 1) which are normally open at the home position of the SSS step switch but which are closed as soon as the step switch wipers move off home position and remain closed until it returns to home position, and these contacts 274 are connected in a subsidiary positive potential line to the SSS step switch coil 272 so that this coil remains energized through this positive potential line until it returns to home position no matter what happens to the table drop switch 94. The SSS relay 272 also has a set of SSSX breaker points 276 which are mechanically opened only during the time that the step switch wipers are moving from one position contact to another in order to prevent arcing, but which close while the wipers are on their contacts so as to energize the coil 272 for movement to the next position.

The table drop switch 94 upon closing also closes a positive potential circuit to the SSS B wiper 273 to the various contacts of which the switches 92 are connected, so that as the B wiper 273 cycles over the contacts, each of the KP relays 271 that has its corresponding switch 92 closed is sequentially energized by completion of the positive potential circuit thereto.

Each of the KP relays 271 upon initial energization as described, locks itself into energized condition by the closing of a corresponding set of KP contacts 277, each of which is connected in a subsidiary positive potential circuit to the corresponding KP relay. Thus each of the KP relays once energized remains energized at least until the end of the frame; and at the end of the frame the KP relays, which has a common negative return line 278, are all dropped out together by energization of a KSH relay 279, which has a set of normally closed contacts 280 connected in the line 278, the KSH relay 279 being energized only at the end of a frame as will be seen below.

Each of the KP relays 271 has another normally open switch 281 closed upon energization of the relay and connected between a corresponding position contact 96 of the SSS A wiper 95 and the SSC step switch operating coil 282. The SSS A wiper 95 has its own positive potential applied thereto and consequently each time it contacts one of the contacts 96 that has its corresponding switch 281 closed, an electrical circuit is completed to the positive potential side of the SSC coil 282; and the SSC A, B and C wipers 283, 284 and 285 (FIGURE 2) are concurrently advanced one contact point each. Consequently, it will be seen that for each pin that is knocked down the SSS A wiper 95 completes a circuit and sends a pulse to the SSC coil to advance the SSC wipers each one point, and the total of the number of pins felled is thus recorded by the SSC step switch.

The SSC step switch is self-homing (to a "zero" position, not shown) after the return of the SSS step switch to home position, and returns home after the rolling of each ball when the SSS step switch completes its cycle; the SSC coil 282 has a set of off-normal contacts 286 which are closed as soon as the SSC step switch gets off home position; these contacts 286 are connected in a subsidiary positive potential line to the relay 282, but this line is opened as soon as the SSS step switch goes off home position by means of a set of normally closed SSS off-normal contacts 287 connected therein. When the SSS step switch returns to home position these contacts are closed and the subsidiary positive potential line to SSC coil 282 is closed for self-cycling and homing of the SSC

step switch to home position. The SSC coil 282 also has a set of SSCX breaker points 288 connected in its subsidiary positive potential line for opening when the coil is energized (as for cocking the stepping mechanism) thus to deenergize the coil and to release the stepping mechanism for advancing during the self-cycling homing phase.

ENTRY OF SCORE FROM COUNTER (SSC) TO ACCUMULATOR

As will be seen in FIGURE 2 the SSC A level contacts "1" and "6" are connected to the accumulator entry line 36, contacts "2" and "7" to line 37, contacts "4" and "8" to line 38, and contact "9" to line 39; and the SSC B level contacts "1" through "5" are connected to entry line 40 and contacts "6" through "9" to entry line 41. Thus whenever any score from "one" through "nine" is registered on the SSC step switch, then completion of a positive potential circuit through the A and B wipers 283 and 284 thereof causes entry of the score to the accumulator solenoids 51-80, depending on which column 227-229 is under selection.

To get the required positive potential for the entry, the A and B wipers 283 and 284 are connected through a set of normally open KFB contacts 289 to the number "30" contact 291 of SSS A level. As will be seen below the KFB relay 97 is energized from the number "32" contact 292 of the SSS A level; consequently it follows that upon a first cycling of the SSS step switch as after the bowling of a first ball of a frame, the SSC A and B level wipers 283 and 284 cannot be energized and no entry can be made to the accumulator thereby, since the KFB relay 97 is not energized and its contacts 289 are not closed until after the SSS A level wiper 94 passes beyond contact point 291 thereof.

However, after the bowling of a second ball of a frame, the KFB 97 having been energized upon the bowling of the first ball, then the contacts 289 are closed and the entry of the score to the accumulator is carried through. The presence of the SSS A wiper 94 on "30" contact 291 while the KFB relay 97 is energized consequently provides an indication to the counter (SSC) that a no-mark second ball has been bowled and that it is time to enter the score for the no-mark frame into the accumulator.

It is here noted also that for special circumstances such as when it is desired to enter the first-ball score as in the case of a no-mark first ball following two strikes (column 3 of FIGURE 5) or a no-mark first ball following a spare (column 7 of FIGURE 5), or when it is desired to enter a no-mark frame score for a second time as in scoring a no-mark second ball following a strike (column 4 of FIGURE 5), then the SSC A and B wipers are energized through a subsidiary positive potential line 293.

CURRENT-BALL INDICATOR

The KFB first ball relay 97 is initially energized upon a first cycle of the SSS A step switch wiper through number "32" contact 292 thereof, and locks into energized condition by closing a set of KFB contacts 294 in a subsidiary positive potential circuit thereto; and the KFB relay is dropped out either by the energization of the KNM relay as described below, or by opening of a set of SSM contacts 402 at the end of the frame, as will hereafter be described.

The KNM no-mark second-ball relay 98 has a positive potential line to the number "31" contact 296 of the SSS A level and this circuit has a set of normally open KFB contacts 297 connected therein so that the KNM relay 98 cannot be energized except sequentially after the KFB relay 97, as upon the rolling of a second ball of a frame. A set of normally closed KNM contacts 298 in the negative return line of the KFB relay 97 causes the dropout of the latter upon energization of the KNM relay 98. The KNM strike master relay 102 has a positive po-

tential line through a set of normally closed KFB contacts 299 to the number "10" contact point of the SSC C level, the wiper of which is connected to the number "29" contact point 306 of SSS A level, so that the KXM relay is energized upon a first ball score of "ten" recorded by the SSC step switch. Since the SSC C wiper 285 is advanced to its contact point number "10" while the SSS A wiper 95 is on its point number "28" it follows that the KXM relay 102 is energized before the KFB relay can be energized on a first ball cycle, but cannot be energized on a second ball cycle when the KFB relay has already been energized. The KXM relay 102 has a set of contact points 301 in the KFB relay negative return line to prevent energization of the KFB relay on a "strike" first ball. Of course, in this circumstance the KNM relay could not be subsequently energized since the KFB relay has not been energized.

The KXP strike-pulse relay 104 is energized in exactly the same way as the KXM relay, i.e. through SSC C level and KPB contacts 299.

The KSM spare master relay 103 is energized by a positive potential from the number "10" contact point of SSC B level and has a set of normally closed contacts 302 in the positive potential line of the KNM relay 98 to prevent energization of the latter subsequent to the rolling of a "spare" second ball. Both the KNM relay 98 and the KXM relay 102 lock themselves in energized condition by closing of their own contact points 303 and 304, respectively, connected to the line 259 of previous mention. The line 259 is an important main positive potential line to which a number of elements are connected, and this line as will be later seen is broken at the completion of each frame for the drop out of the elements connected thereto.

For purposes later to be described there is also provided a KFD first-ball discriminator relay 101 which has a positive potential energizing line running to contact point number "11" of the SSS A wiper with a set of normally open KFB contacts 307 and normally closed KNM contacts 308 connected therein, and having a subsidiary positive potential line running through contacts 307 and through a set of normally open KFD contacts 309 to the positive potential line 259, so that this KFD relay is energized only on a second ball after the KFB relay has been energized at the first ball and is dropped out whenever the KFB relay is dropped out.

Thus the four possible results of the bowling of any ball are signalled by the current-ball indicator in terms of the following circuit elements:

No-mark first ball: Energization of first ball KFB relay 97.

Strike: Energization of (1) KXP relay 104 and (2) the KXM relay 102. As will be seen hereinafter, the first indication provides a signal to the memory unit, and the second indication is used to prevent energization of the KFB relay.

No-mark second ball: (1) Energization of first ball KFB relay 97 (and KFD relay 101) along with concurrent positioning of SSS A level wiper 94 on number "30" contact point 291; and (2) energization of no-mark KNM relay 98, after SSS A level wiper has moved on to number "31" contact point 296. As will be seen hereinafter the first indication is used for entry of the frame score into the accumulator solenoids 51-80, and the second indication is used for energizing the accumulator plus-entry KPE relay 86 for entry of the score from the solenoids into the register 32.

Spare: (1) Concurrent positioning of SSC B level wiper on its number "10" contact point, energization of KFB and KPD relays 97 and 101, and positioning of SSS A level wiper on its number "30" contact point; and (2) energization of KSM relay 103. As will be seen hereinafter the first indication provides a signal to the memory unit and the second indication ends the first indication (pulse) and prevents energization of the KNM relay.

Strike and spare signals are sent to the memory unit as follows:

When the KXP relay 104 is energized as by energization of SSC C level wiper 285 through contact point number "10" thereof, a set of normally open KXP contacts 311 (FIGURE 3) connected in the positive potential line 312 to the memory unit is closed, beginning a pulse to the memory unit. When the KXM relay is energized at the same time as the KXP relay, a set of normally closed KXM contacts 313 (FIGURE 2) in the positive potential KXP relay line is opened de-energizing the KXP relay, and opening the contacts 311 ending the pulse through line 312 to the memory. The contacts of the KXM relay are mechanically timed to open substantially after the contacts of the KXP relay so that the pulse will not be "ended" before it is "begun."

For the spare pulse, the energization of SSC B level wiper 284 through contact point number "10" thereof initiates a pulse through line 314 (FIGURES 1, 2 and 3) to the memory, and at the same time energizes a spare pulse KPS relay 316 (FIGURE 1), the positive potential line of which is connected to line 314. The energization of KPS relay 316 opens the set of its normally closed contact points 317 in line 314 thus breaking the line and ending the pulse to the memory. The energization of KSM relay 103, however (simultaneously with KPS), closes a set of normally open KSM contacts 318 in a line leading from the positive potential line 259 to the positive sides of both KSM and KPS, so that these relays remain energized until dropout of line 259 at the end of the frame, as later explained.

MEMORY UNIT

The strike memory KX1, KX2 relays 106 and 107 (and the KX3 relay 108 of the current-ball indicator), are energized through a positive potential line 321 connected to the line 312 of the current-ball indicator. The relays are connected in parallel to the line 321, KX1 relay 106 having a branch positive potential line 322, KX2 relay 107 having branch lines 323 and 324 and the KX3 relay 108 having branch lines 325 and 326. Relays KX2 and KX3 each have normally open contacts 327 and 328 respectively in lines 323 and 325, so that beginning from the situation with all three of the relays de-energized, the first energizing pulse energizes the KX1 relay 106 only.

Upon energization relay KX1 closes a set of its normally open contacts 329 to a subsidiary positive potential line for locking itself into energized position and opens a set of normally closed contacts 331 in line 322 to relieve itself of dependance upon the original energizing pulse. At this time the contacts 327 are also closed, connecting relay KX2 to the line 321 for energization upon the next subsequent pulse from line 312. Upon this next pulse relay KX2 follows a program similar to that of relay KX1, closing a set of contacts 332 to a subsidiary positive potential line for locking itself into energized position and opening a set of contacts 333 in line 324; and also closing the contacts 328 to prepare relay KX3 for energization upon the next subsequent pulse. Upon this next (third) pulse relay KX3 is energized closing a set of contacts 336 to a subsidiary positive potential line and opening a set of contacts 337 in line 326.

Relays KX1 and KX2 have common negative return lines arranged in parallel through normally closed contacts 338 and 339 of KD1 relay 113 and KD2 relay 114 respectively, so that it requires the concurrent energization of relays KD1 and KD2 to drop out relays KX1 and KX2, and when they are dropped out, they are dropped out simultaneously. Relay KX3 has a negative return line through normally closed contacts 341 of relay KD2, so that KX3 is dropped out upon the energization of relay KD2 whether or not relay KD1 is energized at the same time.

The spare memory KSP relay 109 is energized through

a positive potential line 342 connected to the spare pulse line 314 of the current-ball indicator, and upon energization closes a set of normally open contacts 343 to a subsidiary positive potential line for locking itself into energized position.

Relay KSP has parallel negative return lines through a set of normally closed KD1 contacts 344 and a set of normally open KD2 contacts 346, so that upon energization of the KD1 relay alone, the KSP relay is dropped out. But when KD1 and KD2 are operated concurrently, as for dropping out KX1 and KX2, the KSP relay does not drop out (if it is energized). The contacts 346 are mechanically adjusted to close before the contacts 344 can open, and in addition the KD2 relay is a "slow-release" relay in timed delay after the relay KD1 even when both are de-energized simultaneously, so that the contacts 344 are closed before the contacts 346 are opened, and the energization of the KSP relay is preserved.

As will be explained hereinafter, the relay KX3 is always de-energized after scoring at the end of the same frame in which it was energized. Consequently, it follows that the energization of this relay reflects an indication of a "current" strike in the current-ball indicator when two "previous" strikes, represented by the energization of KX1, KX2, appear in the memory unit. It also follows that either of the relays KX1 or KX2 reflect "current" strikes during the frames in which they are initially energized, but that after the frame is over, if they remain energized, they constitute indications of "previous" strikes.

In terms of actual circuitry this latter distinction is made as follows: When the current-ball indicator is signalling a strike as described above, so that the KXP relay 104 is energized and a pulse is being transmitted to the memory unit, with one or more of the KX relays 106-108 concurrently energized, then it follows that one of these KX relays 106-108 indicates a "current" strike and the others, if any, indicate "previous" strikes; but when the current-ball indicator is not signalling a strike, so that both KXP and KXM are de-energized, then the relays 106-108 indicate "previous" strikes entirely.

A similar distinction is made, when relays KX1 and KSP are concurrently energized, for distinguishing between a spare in the current frame following a strike in the previous frame or a strike in the current frame following a spare in the previous frame: i.e. both KX1 and KSP being energized; then if the current-ball indicator shows a spare, with the SSP step switch wipers resting on their number "10" contact points and the circuit being closed to the memory by the concurrent resting of the SSS step switch A wiper on its number "30" contact point, and with the KFB and KFD relays 97 and 101 concurrently energized, it follows that the energization of the KSP relay reflects a "current spare" indication of the current-ball indicator and that the energization of KX1 relay is the indication of a strike in the previous frame. But if the current-ball indicator shows a strike, with KFB relay 97 (and KFD relay 101) not energized, then KX1 reflects a "current strike" indication of the current-ball indicator, while KSP is an indication of a spare in the previous frame; and the scoring circuits are arranged to score accordingly.

Each of the KX relays 106-108 has a double set of contact points 351, 352 and 353 respectively, and the KSP relay 109 has two sets of normally open contact points 354 and 355 connected in circuits having a main positive potential energizing line 356 leading into the memory, for selecting and controlling exterior circuits for making entries into the accumulator according to the indications shown in the memory unit and the current-ball indicator.

PROGRAMMING MEANS (SSP STEP SWITCH)

Ordinarily the wipers of the SSP step switch are at home position when they are resting on their number "11" contact points (FIGURE 4), but are shown in the drawing as at the beginning of a cycling operation and contacting their number "1" contact points to execute the first of a sequential series of score entry operations.

All of the contact points number "11" are connected to the positive potential energizing side of the SSP relay 123 so that as soon as any of the levels are energized as by receiving a positive potential through the memory unit the SSP relay 123 is energized, opening an SSP X breaker-point switch 347 to release the mechanism, and the step switch wipers are advanced to their number "1" contact points for selectively energizing one of the lines 42-44 of the accumulator.

As shown, the various number "1" contact points are connected to selected lines 42-43 and the lower ends of the lines 42-44 are also connected to the positive potential side of the SSP relay 123 through corresponding diodes 348, arranged to permit an energizing current to the relay 123 but not to permit a reverse current to the accumulator when the SSP relay 123 is originally energized with the wipers at home position (number "11" contact points). The accumulator entry line 293 is similarly connected to various SSP contact points and to the SSP relay 123 through one of the diodes 348.

Various of the contact points are also connected to the positive potential side of the KPE relay 86 for beginning a plus entry of the accumulator after the solenoids 51-80 have been selectively energized and these contact points are similarly connected through a diode 348 and a set of normally open KRE contact points 357 to the positive potential side of the SSP coil 123 for further advance of the SSP wipers on energization of the KRE relay 246 subsequent to energization of the KPE relay 86.

The SSP step switch also has a KHO homing relay 358 (FIGURE 2) connected for energization from various contact points on each SSP level and having a set of normally open contact points 359 (FIGURE 4) in a subsidiary positive potential line to the SSP coil 123 for carrying the SSP step switch to its home position through all of the remaining contact points after its scoring operations are completed. The KHO relay also has a set of normally closed contacts of an SSP off-normal switch 349 in the negative return line, so that upon reaching home position the cycling of the switch is stopped.

A cycle stop KCS relay 360 is also provided to stop the SSP wipers in their home position on number "11" contact points, thus to prevent a second repetitive cycling operation under certain circumstances, the KCS relay 360 being connected for initial energization to the number "9" and "10" contact points of B level 118, and the number "9" contact point of E level 122; and having a set of normally open contact points 361 in a subsidiary positive potential line for locking itself into energized position. This line also has a set of normally closed KSH contacts 362 connected therein for dropout of the KCS relay upon the ending of the frame and rearrangement of the circuit to accommodate the next player.

Considering now the selection of the SSP step switch levels it will be seen that a different level is selected for each of the six possible significant scoring situations in which an "extra" score is required:

Strike following two strikes (column 2, FIGURE 5).— SSP A level 117 is selected by connection of the wiper through the normally open contacts of memory switches 351, 352 and 353 to the positive potential line 356 upon activation of memory relays KX1, KX2 and KX3 indicating a current strike and two previous strikes. A number "1" contact point the A level wiper connects with accumulator input line 44 to enter "thirty" therein and to advance the step switch to number "2" contact point. At number "2" contact point the wiper connects with the

KPE relay 86 to initiate an accumulator plus entry and to advance itself to number "3" contact point. At number "3" contact point the wiper connects with KHO homing relay 358 to initiate a homing cycle of the step switch to return the wiper to number "11" contact point. At number "5" contact point the wiper connects with memory dropout relay KD2 (114) to drop out KX3 strike memory relay 108.

No-mark first ball following two strikes (column 5, FIGURE 5).—SSP B level 118 wiper is selected through its positive potential line in which are connected normally closed KNM and KCS contacts 364 and 363, normally open contacts 365 of the KFB relay (now closed), normally closed contacts of the KX3 switch 353 in the memory, normally open contacts of the memory switches 351 and 352 (now closed) to positive potential line 356, this being the circuit condition corresponding with a no-mark first ball in the current-ball indicator and two previous strikes in the memory. At the number "1" contact point the B level wiper connects with accumulator entry line 43 to enter "twenty" therein and advance itself to number "2" contact point. At number "2" contact point the wiper connects with accumulator entry line 293 to enter the current first-ball scoring count into the accumulator and advance itself to number "3" contact point. At number "3" contact point the wiper connects with the KPE relay 86 to initiate a plus entry of the accumulator and advance itself to number "4" contact point. At number "4" contact point the wiper connects with the KHO homing relay 358 to home the step switch to number "11" contact points. At numbers "9" and "10" contact points the wiper connects with the KSC cycle stop relay 360 to open the switch 363 in the B level wiper energization line to prevent a second cycle of the step switch.

No-mark second ball following a strike (column 4, FIGURE 5).—If at least one previous strike shows in the memory (KX1 energized), SSP C level 119 wiper is selected through normally open KNM contacts 366 (now closed) and the normally open contacts of KX1 memory switch 351 (now closed) to positive potential line 356. If two previous strikes show in the memory (activation of both KX1 and KX2 together) the C level may also be selected through switch 366, a one-way current diode 368, the normally closed contacts of KX3 memory switch 353 (still closed), and the normally open contacts of switches 351 and 352 (now closed) to line 356. Even if two previous strikes show in the memory, C level is selected as described and the scoring is as for only one previous strike: At number "1" contact point the SSP C level wiper connects through a one-way current diode 367 to the accumulator entry line 42 to enter "ten" therein and to advance itself to number "2" contact point. At number "2" contact point the wiper connects with KPE relay 86 to initiate a plus entry cycle of the accumulator (which action makes a first entry to the registers of "ten" plus the frame-accumulated pinfall count, which was previously entered to the accumulator by SSC) and to advance itself to number "3" contact point. At number "3" contact point the wiper connects to SSP coil 123 to advance itself to number "4" contact point, where a connection to line 293 is made (through KTF contacts 476) for a second entry of the no-mark score, and where the connection is repeated through a one-way current diode 369 to advance the wiper to number "5" contact point. Here the KPE relay is again energized for the entry function and another connection through the normally open KRE contacts 357 (now closed) is made to SSP coil 123 to advance the step switch to number "6" contact point; and at number "6" contact point the wiper connects with KHO homing relay 358 to return itself to homing number "1" position. At number "7" contact point the wiper connects with both KD1 and KD2 memory dropout relays 113 and 114 to drop out KX1 and KX2 together, or KX1 alone if it alone has been energized.

Spare following a strike (column 5, FIGURE 5).—SSP D level wiper is selected through normally open KSP memory switch 354, and the normally open contacts of switch 351 (now closed) to positive potential line 356, this being the condition corresponding to a strike and a spare, one being a reflection of the current-ball indication and one being a previous mark indication. At number "1" contact point the D level wiper connects with accumulator entry line 43 to enter "twenty" therein and to advance itself to number "2" contact point. At number "2" contact point the wiper connects with KPE relay 86 to initiate a plus entry cycle of the accumulator and to advance itself to number "3" contact point. At number "3" contact point the wiper connects with KHO homing relay 358 to return itself to number "11" home position. At number "4" contact point, the normally open contacts of KFB switch 124 being closed, corresponding with the condition of a spare in the current frame, the wiper connects with KD1 and KD2 memory dropout relays 113 and 144 operating them together to drop out the strike memory relay KX1 while leaving the spare memory relay 109 in activated condition for future scoring. It is noted that even if two previous strikes are shown in the memory the D level is still selected as through switch 354, and the normally open contacts of switch 351 (now closed).

Strike following a spare (column 6, FIGURE 5).—The scoring for this situation is the same as the scoring for a spare following a strike but the drop-out of the memory relays is different. SSP D level is selected as above described and the wiper makes its above-described cycle, but at number "4" contact point, the KFB switch 124 having its normally closed contacts in closed condition corresponding with an indication of a current strike in the current-ball indicator, the wiper is connected with KD1 dropout relay only, for the drop-out of KSP spare memory relay 109 alone, while leaving the KX strike relays in energized condition for future scoring.

No-mark first ball following a spare (column 7, FIGURE 5).—The SSP E level 122 wiper is selected by an energizing line through normally opened KFB switch 371 (now closed), normally closed KCS switch 372, normally open KSP memory switch 355 (now closed) and normally closed contacts of a KFD switch 370 to positive potential line 356, this being the condition corresponding with a no-mark first-ball indication in the current-ball indicator and a "previous" spare indication reflected in the memory.

It is noted here that the KFD relay 101 and its contacts 370 are used to prevent selection of this level as for an ordinary "current" spare indication of the current-ball indicator, in which instance the contacts 370 would be opened upon second passage of the SSS A wiper over its point "11," while leaving KFB contacts 371 closed and subsequently closing switch 355.

At its number "1" contact point, E level wiper energizes accumulator entry line 42 to enter "ten" therein and to advance itself to number "2" contact point. At number "2" contact point the wiper connects with accumulator entry line 293 to enter the first-ball count into the accumulator and to advance itself to number "3" contact point, where the wiper connects with KPE relay 86 to initiate a plus entry cycle of the accumulator, and with SSP coil 123 through KRE contacts 357 to advance itself to number "4" contact point; and at this point the wiper connects with KHO homing relay 358 to return itself to number "11" homing position. At number "5" contact point the wiper connects with KD1 memory dropout relay 113 to drop out the KSP spare memory relay 109. At number "9" contact point, the wiper connects with the KCS relay 360, energizing the relay and opening KCS switch 372 to prevent a second cycle of the SSP step switch.

For the no-mark-second-ball-following-a-strike situation indicated above as well as for any no-mark-second-ball (as for a no-mark frame) scoring situation, a basic score

entry from the SSC A and B levels is additionally made in the normal way and the KPE solenoid 86 is separately energized (except when a strike shows in the memory and switch 351 is activated) as through the memory positive potential line 356, the normally closed contacts of memory 351, normally open KNM contacts 373 (now closed) to KPE relay 86.

It is noted that a KDN relay 374 is provided and is connected for energization from the SSP B and C level input lines, and, for locking in, to a KDN switch 403. This relay has normally closed contacts 375 in the normal energizing line for KPE relay P6 and is used to prevent undesirable energization of KPE during the B and C level programs. KDN switch 404 is provided to break the energizing line after energization; and KTF switches 405 and 406 to cut the relay out during tenth frame.

It will be seen from the above that the KX1 and KX2 relays constitute a strike counter connected through the KD relays to the third and fourth SSP programming units for delayed clearance upon actuation of either level; and the KSP relay constitutes a spare counter similarly connected to the fifth and sixth SSP programming units.

PLAYER PROGRAMMING MEANS (SSM)

The SSM C level 376 is arranged to make selective connections from the current-ball indicator strike-pulsing line 312 to the various strike-pulse entry lines 321 of the respective individual player memories; the D level 337 makes selective connections from the current-ball indicator spare-pulsing line 314 to the spare-pulse entry lines 342 of the respective individual player memories; the E level 378 makes selective connections from the SSP wiper contact points to the respective KD1 drop-out relays 113 of the individual player memories; the F level 379 makes connections from the SSP wiper contact points to the KD2 drop-out relays 114 of the player memories; and the G level 380 makes selective positive potential connections to the player memory selection lines 356 for the energizing of the KPE relay and for energizing the various SSP levels.

The energizing of the SSM actuating coils 127 and 128 is as follows:

The KSH relay 279 is energized through normally closed off-normal contacts 287 of the SSS step switch when the SSS step switch returns to home position, the energizing line being through normally closed KFB contacts 381, and normally open KXM and KNM contacts 382 and 383, the latter being connected in parallel, or through normally open KSM contacts 384; the energizing line also having connected therein the normally closed contacts of the SSC off-normal switch 286, so that the KSH relay can be energized only after return of both the SSS and SSP step switches to home position, as follows:

The SSS coil 272 has the normally closed contacts of SSP off-normal switch 349 in its negative return line and the positive potential line of SSS coil 272 includes normally closed contacts 386 and 387 of the KRE and KPE relays respectively so that the SSS step switch cannot possibly return to home position until after the SSP step switch has returned to its home position and until after the accumulator has completed its plus cycle or until whatever other action (shift) has been undertaken has been completed. Consequently the SSC step switch (which is timed to home after SSS as by switch 287 described previously) likewise cannot begin its home cycling action from its ball-score-marking position until all of the accumulator functions have been completed, thus avoiding the undesirable double entry of a score therein; and as a further consequence the KSH relay 279, which initiates the next step-cycling of the player programming step switch SSM to the next player position cannot be energized until all of the scoring functions of the machine have been completed and all of the apparatus is returned to its initial position.

The combination of switches 286, 287, 381, 382, 383 and 384 in the positive potential energizing line of the KSH relay 279 thus ensures that this relay is energized only at the end of a frame when all of the scoring step switches have completed their cycles.

The energization of KSH relay 279 closes a set of normally open KSH contacts 388 establishing a positive potential line (the same line as for the KSH relay) to a KSS relay 389, which has a negative return line connected in parallel through two sets of normally closed SSM contacts 391 and 392 and through the normally closed SSP off-normal contacts 349 to negative. The energization of KSS relay closes a set of normally open KSS contacts 393 in the positive potential line to the SSM solenoids 127 and 128, which also have a negative return through the normally closed contacts of SSP switch 349. The SSM coils 127 and 128 only "cock" the cycling mechanism upon energization and the cycling of the SSM step which is not effected until the coils are de-energized to release the mechanism. But the energization of the SSM coils 127 and 128 causes them to open their switches 391 and 392, thus dropping out the KSS relay 389 which in turn opens KSS switch 393, de-energizing the SSM relays 127 and 128 and causing the SSM step switch to step forward to the next position. This is normal stepping operation as for stepping from number "1" contact points representing the first player to number "2" and from number "2" to number "3," but when the play is proceeding from the third player to the fourth player, or from the fifth player back to the first player it will be remembered that the carriage 32 of the accumulator must be shifted and special arrangements must be made to coordinate with the shifting operation, as follows:

The accumulator right shift and left shift coils 231 and 232 are connected to points "4" and "7" respectively of the SSM B level, the wiper of which has a positive potential applied through the normally closed contacts 248 of the CFS switch, so that upon stepping of the SSM step switch from point "3" to point "4" as after the scoring for the third player of the team, or from point "6" to point "7" as after the scoring for the fifth player of the team has been completed, the appropriate shift coil 231 or 232 is energized and the shifting function of the accumulator is initiated for realigning the register 32 thereof in appropriate alignment for recording the scores of the next player (the fourth or the first player). Contact points "4" and "7" of the SSM J level 396 are connected to the positive potential side of KSS relay 389 and the wiper of the SSM J level is connected to positive potential through the normally open contacts 249 of the CFS switch, so that after arrival of the step switch at point "4" (or "7") and immediately upon the beginning of an accumulator shift cycle, the KSS relay 389 is energized to cock the SSM coils 127 and 128 for further stepping action of the step switch to the next contact points ("5" or "8"), and upon energization the KSS relay 389 opens a pair of its normally closed contacts 397 in the positive potential line of the SSM B level 394 wiper to end the pulse that originally energized the shift coil 231 (or 232), but de-energization of these coils does not stop the mechanical shifting function of the accumulator, which has already been initiated. It is desired however not to immediately de-energize the KSS relay 389 to open its contacts 393 and to permit the SSM coils 127 and 128 to uncock and complete the SSM stepping action to points "5" or "8" until the accumulator shifting function has been completed, since if the intervening player selection switches between the two shift positions happened to be closed in this situation, i.e., for example, if the switches 164 and 165 are closed while the accumulator is making a right shift and the step switch is resting on point "4" of the B level, then the step switch stepping to point "5" would immediately step on to point "6" and then to point "7" to energize the left shift coil

232, possibly before the right shift has been completed, causing confusion to the apparatus. For this reason the KSS relay 389 is provided with an alternate negative return line 398 (FIGURES 1 and 2) bypassing the SSM 1X and 2X switches 391 and 392 and leading to points "4" and "7" of the SSM H level 399, the wiper of which is connected to negative potential. Thus for the two accumulator shifting positions of the SSM step switch, corresponding with points "4" and "7" thereof, when the KSS relay is energized as by actuation of the CFS switch and closing of its contacts 249, the energization of the KSS relay is perpetuated even though the switches 391 and 392 are opened by cocking of the SSM coils 127 and 128, and the KSS relay remains energized until the accumulator shifting function is completed and the CFS switch has returned to unactuated position, opening the switch 249 and de-energizing the relay, which action in turn opens KSS contacts 393 and permits the de-energization of coils 127 and 128 to permit the step switch to step to its next position.

PLAYER SELECTION SWITCHES

The normally open player selection switches 161-165 are arranged in parallel with the positive side of each connected to a corresponding one of contact points "1," "2," "3," "5," and "6" of the SSM A level 401, the wiper of which is connected to positive potential through a set of normally closed SSM 1X breaker points 402 (FIGURE 1); and the negative return of the switches 161, 162 and 164 is connected to the positive side of KSS relay 389, while the negative return of the switches 163 and 165 is connected to a positive side of the KSH relay 279. Thus whenever it is necessary for a player to miss his turn at bowling he has only to close the switch assigned to him and the SSM step switch upon reaching that player's position will automatically cycle on to the next player. For example if while player number 1 is bowling, player number 2 is called to the telephone, he first closes switch 162. When player number one has finished his frame and the step switch cycles to its number "2" contact points, the switch 402 is closed, the SSM A level 401 wiper transmits a positive potential through its number "2" contact point, the closed switch 162, and the KSS relay 389, energizing the latter and perpetuating the stepping of the SSM step switch to the number "3" contact points thereof. As soon as the number 2 player returns from the telephone, switch 162 may be opened and all of the other switches 161, 163, 164 and 165 may be closed, so that at the end of the frame being bowled the step switch, whatever position it may start in, cycles all the way back to the number 2 player position so that he may bowl his frame and have the score recorded. By appropriate manipulation of the switches, the step switch may then be cycled back to the next player in order, all of the switches then being opened and the play continuing as before the interruption. In the case of players number 3 and number 5, the closing of the switches 163 or 165 has the effect of causing the stepping of the SSM step switch to take place through energization of the KSH relay 279, the action of which has previously been described. Cycling of the step switch from point "7" to point "8" has also previously been described. Cycling from point "8" to point "9" is handled by the SSM step switch K level 152 as part of the lane transfer function described hereinbelow, and from point "9" to point "10" and from point "10" to point "1" the cycling is automatic as by connection, as shown in the drawing, of points "9" and "10" of the SSM A level 401 to the positive potential side of the KSS relay 389.

The signal lamps 171-175 are connected in parallel with the common negative return and with the positive potential side of each connected to a corresponding one of the contact points "1," "2," "3," "5" and "6" of the SSM A level 401, so that whenever the SSM step switch is resting on one of the player positions, the corresponding

signal lamp is lighted to indicate which player is supposed to be bowling.

It is noted that the SSM H level 399 is used also as the negative return for portions of the frame counter 131 as described below, and also for providing negative returns for the accumulator solenoids 51-80, the negative returns of the solenoids 51-60 being connected to points "1" and "5" of the SSM H level as for energizing the solenoids to record the scores of players number 1 and number 4, the negative returns of the solenoids 61-70 being connected to points "2" and "6" for players numbers 2 and 5, and the negative returns of solenoids 71-80 being connected to H level contact number "3" for player number 3. Thus the SSM step switch coordinates the selection of the appropriate solenoid column 227-229 for the player who is actually bowling and shifts the register 32 for alignment with the solenoids appropriate to that player.

FRAME COUNTER (SSF STEP SWITCHES)

The individual player frame counting SSF step switches 132-136 have coils 411, 412, 413, 414 and 415, respectively, and each step switch is advanced by the energization (for cocking) and de-energization (for releasing and advancing) of its coil. Before the game starts, all the step switches are at a "zero" home position (not shown). Each coil 411-415 has a separate negative return through respective contact points numbers "1," "2," "3," "5" and "6" of the SSM-2 H level, so that a particular player's switch can be advanced only when he is "up" for bowling as indicated by the SSM step switch. The coils 411-415 also have a common positive potential line through normally-closed contacts 421 of a KTF relay 442 and normally-closed contacts 422 of the KFB relay, to the number "1" contact point of the SSS A level. Thus a particular player's SSF coil is energized and de-energized as the SSS wiper passes over the number "1" contact point just after the player has bowled his first ball, and the SSF coil advances the appropriate switch 411-415 to the point corresponding with the frame that is being bowled. In the event of a (non-tenth-frame) second ball (i.e., no strike), the KFB contacts 422 are open, and no further advance of the frame counting step switch is provoked before the end of the frame.

Each switch 132-136 has its number "10" contact point connected to the positive side of the KTF relay 422, which has its own negative return, so that this relay is energized at the beginning of each player's tenth frame, when the SSS A level wiper passes over its number "1" contact point.

As will be later seen, the KTF relay is used to bring the tenth frame scoring apparatus into play, and, because the KFB relay is sometimes de-energized during tenth frame procedure, the KTF contacts 421 are opened upon energization of the KTF relay to ensure that the frame-counting step switch is not advanced again (to home position) until the end of the tenth frame.

Also, as will be later seen, the SSM step switch is suspended from its normal cycling action during tenth frame, and the SSF coils 411-415 are given a subsidiary positive potential line through normally-open SSM-X breaker points 427 and normally-open KTF contacts 428. Thus at the beginning of the tenth frame, contacts 428 are closed and at the end of tenth frame, when the SSM step switch resumes its cycling, the breaker points 427 are quickly opened and closed to energize and then de-energize the appropriate coil 411-415 and to cycle the corresponding switch 132-136 to home position; and the later action de-energizes KTF relay 442 and re-opens contacts 428.

The tenth frame apparatus is normally brought into play by energization of the KTF tenth frame relay 442 as by arrival of the appropriate tenth frame counter at its number "10" contact point as above described; and by energization of an SST solenoid 452 through a set of normally-closed KTF contacts 444 connected in a line

from SST solenoid 452 to the number "2" contact of SSS A level. The SST coil 452 is thus energized and de-energized for cocking and advancing the SST step switch 121 as SSS A level wiper passes over its number "2" contact point after bowling of the first ball of the tenth frame, and after energization of the KTF relay.

Upon initial stepping of the SST step switch, a set of SST off-normal normally closed contacts 446 in the negative return line of the SSM coils 127 and 128 is opened and remain open as long as the SST step switch is off its home position, so that normal stepping of the SSM step switch at the completion of the tenth frame is suspended until after the bonus balls are bowled, if any, and until after the SST step switch has accomplished its scoring function.

The tenth frame SST step switch 141 has four levels: level A with a negative return wiper, levels B and C with positive potential wipers, and level D the wiper of which is especially connected for energization in connection with the operation of level C of the SSP programming step switch 116. The SST step switch is normally at home position in a zero position (not shown) and each level has at least three contacts, since the maximum number of balls that can be bowled in connection with the tenth frame is three (for example two bonus balls following a strike in tenth frame or one bonus ball following a spare in tenth frame); but as shown in the drawing, a step switch of standard manufacture having ten contact points per level is used.

The SST step switch is advanced from point to point by means of the SST coil 452 which mechanically cocks the step switch for advancing upon energization, the switch mechanism being released for advancement upon de-energization of the solenoid 452. The positive potential line of SST coil 452 is connected to contact point number "2" of the SSS A level 95, so that during the tenth frame the SST step switch is advanced from home to its contact point number "1" position after the bowling of the first ball of the tenth frame and upon the consequent scanning cycle of the SSS step switch; and from contact point "1" to contact point "2" upon subsequent rolling of a second ball of the frame or a first bonus ball if the first ball was a strike, and from point "2" to point "3" upon the subsequent rolling of a third ball which may be either a first or second bonus ball. If the second ball bowled was a no-mark ball, then there are no bonus balls to follow and the switch is advanced from point "2" to point "3" by means of a positive potential applied through SST C level, through normally open KNM contacts 453 (now closed) connected between points "2" and "3" of the SST C level (the KNM relay 98 being energized as a result of the bowling of the no-mark second ball) and through a set of KRE normally-open contacts 454 connected between point "3" of SST C level and the positive side of the SST coil 452, the circuit being made in connection with the plus entry function of the accumulator upon the energization of the KRE relay 246, and being broken by the opening of a set of SSTX contacts 451 in the C level positive potential line to advance the wipers to points "3" where the circuit is again completed (the KRE switch 454 being still closed) and again broken by switch 451 to advance the wipers to points "4." Points "4" through "9" are connected directly to the line leading from KRE contacts 454 to SST coil 452 so that the switch is self-cycling from points "4" to "10."

Upon reaching its number "10" contact point the SST A level wiper is connected through a set of SSC off-normal normally closed contacts 456 to the negative return side of the SSM relays 127 and 128 to provide a subsidiary energizing circuit for these relays upon return of the SSC step switch to home position, so that the SSM step switch is again brought into play for stepping to the next player. This connection also is made to the

negative side of the KSS relay 389, and at the same time the SST C level (positive potential) is connected through its contact point "10" to the positive sides of the KSH relay 279 and the KSS relay 389 through KSH contacts 388, so that the complete circuit for operating the SSM step switch is established, and it duly performs its function. Thereupon a positive potential circuit to the SST coil 452 is closed as by the closing of a set of normally open SSM2X contacts 457 and a set of SST off-normal normally open contacts 458 (now closed) to establish a circuit to the positive potential source of the SST wipers, and the SST step switch is consequently stepped to its home or zero position, opening the contacts 458 and coming to rest. It is noted that a normal negative return for the SST coil 452 for all of these stepping operations is provided through a one-way-current diode 459 and through the normally closed contacts of the SSP off-normal switch 349 so that the stepping of SST step switch is normally accomplished in connection with the return of the SSP programming step switch to home position; but certain subsidiary and overriding circuits are provided for special situations below described.

A special circuit is used in providing for the drop-out of the KFB first ball relay 97 on the occasion of a spare being scored in the tenth frame. It is noted that under ordinary circumstances (not tenth frame) the KFB relay 97 is dropped out at the end of the spare frame by the opening of the SSM1X contacts 402 in the positive potential circuit thereof, and upon stepping of the SSM step switch to the next player position. In the tenth frame at the end of a spare the SSM step switch does not step, and to provide for the KFB drop-out, a set of parallel-connected normally closed KTF and KSM contacts 461 and 462 are provided in the negative return KFB relay circuit, the contacts 461 being opened by energization of the KTF relay 442 throughout the duration of the tenth frame and the KSM contacts 462 being opened upon the energization of KSM relay 103, thus dropping out the KFB relay 97. However, it is noted that this drop-out occurs immediately upon energization of the KSM relay and before the SSP step switch has gone through its program if any, so that when the tenth frame spare follows a strike in the ninth frame, calling for a scoring program of the D level 120 of the SSP step switch, then it becomes necessary, during the cycling of the SSP step switch, to provide an alternate path from contact point "4" of the SSP D level to the energization circuits for the KD1 and KD2 drop-out relays, the KFB switch 124 being in its normal unactivated position not making this connection. For this purpose there is provided a set of normally open KTD tenth frame discriminator contacts 463 connected in parallel with the normally open contacts of KFB switch 124. The switch 463 is closed by energization of a KTD tenth frame discriminator relay 464 having a negative return through point number "2" of the SST A level and a positive potential circuit through point number "2" of the SST B level, the latter having connected therein parallel-connected normally open KTD and KFB contacts 466 and 467 so that the relay is energized upon arrival of the SST step switch at its number "2" contact points after the rolling of the second ball of the tenth frame when the KFB switch 467 is closed (it being noted that the SST step switch steps upon passage of SSS A level wiper 95 across its number "1" contact point, whereas the KFB 467 switch is not opened in this instance until much later when the KSM relay 103 is energized as upon passage of the SSS A level 95 wiper across its number "30" contact point 291) and the KTD relay 464 locks in energized position by activation of its switch 466, and is dropped out upon further stepping of the SST step switch to its number "3" contact points.

However, when a spare in the tenth frame is followed by a no-strike bonus ball, it is necessary to be able to

re-energize the KFB relay 97 in order to close contacts 371 to energize the SSP E level to score for this situation, and the contacts KSM 462 in the negative return of the KFB relay being still open, it is necessary to provide an alternate negative return line as shown in the drawing connecting the KFB relay 97 through a one-way current diode 468 to the number "3" contact point of the SST A level, the SST step switch having been advanced to this contact point upon bowling of the first bonus ball.

As for the KNM relay 98, the KXM relay 102, the KSM relay 103, and all of the other relays that are ordinarily dropped out by de-energization of the line 259 upon opening of the SSM1X (402) contacts at the end of the frame when the SSM step switch advances to the next player, these elements are dropped out in the tenth frame circumstance by the opening of a set of SSTX breaker points 471 in the positive potential line leading to line 259, the switch 471 being opened upon advance of the step switch from one point to another and closed upon completion of the movement. However, this drop-out cannot take place when the KRE relay 246 is energized, since the KRE switch 261 provides a subsidiary positive potential line for the line 259.

The normal operation of the SST step switch in homing has been described above as for an ordinary tenth frame in which no mark was scored and in which the arrival of the step switch wipers on their number "3" contact points is only an incidental operation in the process of homing the step switch. But in the circumstance when the step switch arrives on point "3" as the result of the bowling of a first bonus ball following a spare in tenth frame or the bowling of a second bonus ball following a strike in tenth frame, then it is desirable to delay the homing of the step switch until the completion of the cycling of the SSP programming step switch 116, for as has been seen above the arrival of the SSP step switch on its contact points number "10" causes a stepping forward of the SSM player programming step switch, and to have this function take place before the SSP step switch is homed might cause errors in the scoring. Accordingly a subsidiary energizing circuit for the SST coil 452 is provided, with a positive circuit leading from the number "3" contact point of the SST B level through normally open off-normal SSP contacts 472 and normally closed KNM contacts 473 to the positive side of SST coil 452, the negative return being through a one-way current diode 474 to the number "3" contact point of the SST A level. Thus whenever the SSP step switch is off its home position, this energizing circuit is completed for the SST coil 452, and the coil cannot be de-energized as for initiating the stepping of the SST step switch, until the SSP step switch has returned to home position, even though the SSTX switch 451 and the KRE switch 454 may have been opened in the meantime. An exception is made in the case of a no-mark second bonus ball following a strike in tenth frame, when the SSP program corresponds with that of its level C. In this instance it is desirable not to energize the SST coil at the beginning of the SSP program, because if the SST coil were so energized, then the SSTX switch 471 would open, dropping out the KNM relay 98 and opening KNM switch 366, with the result that the SSP step switch would be stopped in the middle of its cycle. Instead the machine performs as follows:

The scoring function of the SSP C-level program in tenth frame, as will be seen, is completed after the passage of the SSP C wiper to its number "2" contact point with consequent energization of the KPE relay 86 and subsequent energization of the KRE relay 246. In this instance, the KNM contacts 473 are opened upon bowling of the no-mark second bonus ball, and the corresponding subsidiary energizing circuit for SST coil 452 is de-energized, the SST step switch being advanced to point "4" through the closing of KRE contacts 454 and opening of SSTX switch 451.

A special circumstance arises in the use of the SSP C level when there is a strike in tenth frame followed by two no-mark bonus balls, when it becomes necessary to ensure that the bonus ball pinfall is scored as an "extra" score only. It will be recalled that ordinarily (i.e. not in tenth frame), the strike score of "ten" is entered to the solenoids 51-80 when the SSP C level wiper crosses its number "1" contact point, a plus entry is initiated at number "2" contact point, a second entry of the no-mark score is made (the first entry having been made through a SSC) from number "4" contact point through normally closed contacts 476 of the KTF relay 442, and a second plus cycle is initiated from number "5" contact point. In this non-tenth-frame situation one of the no-mark score entries is considered to be an extra score to be added to the basic strike score, and the other no-mark score entry is considered to be a basic score pertaining to the frame in which the no-mark score was bowled. Connections are also made from the number "3" and "4" contact points of SSP C level to the SSP coil 123 for advancing the step switch from this point, and another connection is made from number "5" contact point through the KRE switch 357 to the SSP coil 123 for the same purpose. But when the SSP C level is selected upon the rolling of two no-mark bonus balls following a strike in the tenth frame, it is desired to perpetuate these step switch advancing connections but at the same time to eliminate one of the no-mark score entries, because, of course, bonus balls represent extra scores only and do not have any basic scoring status, and consequently must be counted only once. With the KTF switch 476 open as it would be throughout the tenth frame program the second scoring of the no-mark score as from point "4" of the SSP C level is eliminated as is desired. Upon stepping of the SSP C level wiper to its number "5" contact point a connection is made through number "3" contact point 477 of SST D level and through the D level wiper 478 (the wiper, of course, being in contacting position with the contact 477 in this situation) and to the number "4" contact point of SSP C level for energizing the SSP coil 123 directly therefrom instead of through the KRE switch 357. The SSP C level wiper is thus advanced to its number "6" contact point and so on to home position. In the event of the SSP C level being brought into play during the tenth frame for the scoring of a tenth frame no-mark score following a ninth frame strike, however, the double entry of the no-mark score is desired as for a normal non-tenth frame situation. In this situation the SST D level 478 will, of course, be resting on its number "2" contact point 479, which is connected directly to accumulator entry line 293 and to the SSP coil 123 for the entry of the no-mark score and the advancement of the SSP step switch, the SST D level 478 being connected to the number "4" contact point at SSP C level upon which the C level wiper is resting so that a complete circuit is formed for the second entry of the no-mark score and the open KTF switch 476 is bypassed.

LANE TRANSFER MEANS

When, in team play, two scorekeeping machines are used on two adjacent alleys, with the teams changing alleys at the end of each frame, the scorekeeping machines assigned to the teams are made to change lanes at the same times. The wiper of the SSM K level 153 of one of the machines (in the illustrated example, the machine beginning on the left-hand lane) is connected to positive potential and the wiper of the other (right-hand lane) SSM K level 152 is connected through parallel-connected normally closed switches 501 and 502 pertaining to and operated by the SSM coils of the respective machines, and leading to a common line 503, which is connected through one-way current diodes 506 and 507 to the positive sides of the KSS relays of the two machines; and the K level number "8" contact points in the two SSM step switches are interconnected. These

circuits have the following effect: When one of the two SSM step switches reaches its K level point "8" before the other, the first is stopped thereon until the other also arrives at point "8," since neither of the SSM step switches have any other provision for stepping forward from their points "8" (it was previously mentioned that there is no connection from the A level point "8" as for points "9" and "10"). But, when both switches arrive at their points "8" (i.e. when both teams have finished bowling the frame) then a circuit is completed to energize the two sets of SSM coils for stepping forward to the respective points "9," and cycling is automatic therefollowing. The parallel connection of circuit-breaking switches 501 and 502 ensures that the energizing circuit is preserved for one step switch even after the other has been energized, and the stepping of first-to-step does not prevent stopping of the second. Upon reaching point "9," the left-hand lane K level wiper completes a circuit to energize a KLC relay 508, and this relay is de-energized when the wiper goes on to point "10." The KLC relay has a set of cam-operated contacts 509 which are closed and opened upon alternate energizations of the relay (i.e. they are closed on a first energization and opened on the next, etc.). These contacts are connected in the energizing line for a KTR relay 511 so that as shown, at the end of the first frame, contacts 509 are closed and KTR 511 is energized. The next time around for the step switches, at the end of the second frame, contacts 509 are opened and KTR 511 is de-energized, and so on. Whenever KTR 511 is energized (i.e. during the first, third, fifth, seventh and ninth frames), all of the right-hand lane team scorekeeping apparatus is connected to the right-hand lane pin-sensing apparatus through normally-closed KTR switches 512 connected in the various connecting lines as shown and the same is true of the left-hand lane apparatus as shown; but whenever KTR is energized, as during the second, fourth, sixth, eighth and tenth frames, the right-hand lane scorekeeping apparatus is connected to the left-hand lane sensing apparatus and vice versa, through normally open KTR contacts 513 connected in the same lines. For the sake of simplicity, the apparatus and interior connections of the left-hand lane machine are not shown, but they are exactly the same as those of the right-hand lane machine, except for the SSM K-level connections, as described.

Also provided is an alternate positive potential line for the KLC relay, having a set of KLC contacts 521 which open and close on alternate energizations of the relay, and a normally open CEG switch 522, which may be closed by hand at the end of the game or at any time when the players end their play, even though the game may not have been finished. Closing of this switch re-aligns the right-hand lane scorekeeping apparatus with the right-hand lane sensing apparatus and the left-hand lane scorekeeping with left-hand lane sensing apparatus, if they are not so aligned when the play stops. For example, if play stops at the end of the sixth frame (beginning of the seventh), then KLC contacts 521 will be closed, and the closing of CEG switch 522 re-energizes KLC to open KLC 521 and 509, de-energizing the KTR relay and re-aligning the machines in starting position.

FOUL RELAY

When a foul is committed, as by a player crossing the foul line while bowling, an electric eye apparatus, which is well-known in the art, senses the foul and closes a foul switch 531, normally a part of the pinsetter. In the apparatus of the invention, this switch is also connected in the energizing line of KFR foul relay 532, so that the relay is energized upon commission of the foul, closing normally open KFR contacts 533 in a subsidiary positive potential line for the KFR relay, this line also having connected therein the normally open contacts 274 of the SSS off-normal switch. Thus as soon as the SSS step switch begins its cycle after the bowling of the foul

ball, the KFR relay is locked into energized position even though the foul switch 531 be subsequently opened. When the KFR relay is first energized (before SSS begins to cycle) it opens a set of normally closed KFR contacts 534 in the energizing line to the SSS B level wiper so that the pinfall of the foul ball cannot be counted. This action, however, does not prevent counting of the pinfall of the first ball of a frame when the second ball is a foul, since the various KP switches 281 that were closed on the first ball are still closed and are not affected by energization of the KFR relay. As an added safeguard, the KFR relay also has normally closed switches 536 and 537 in the input lines to the strike and spare counters of the memory. The KFR relay is, of course, de-energized at the end of the SSS step switch cycle, by opening of its switch 274, the foul switch 531 having been previously opened by automatic timing means well known in the art.

We claim:

1. In a bowling score keeping machine, a plurality of switches corresponding to the number of pins for indicating the number of pins felled; a self-cycling stepping switch connected to scan said switches and producing output pulses corresponding to the pins felled; pulse responsive totalizing means connected to said stepping switch and including a scoring step switch having a plurality of levels and advanced by successive pulsing to a series of positions corresponding to the number of pins felled and having a mark position; a group of relays for each player including strike memory relay No. 1, strike memory relay No. 2, spare memory relay, and drop-out relay; a programming step switch; strike memory relays Numbers 1 and 2 being so connected as to provide sequential energization on subsequent pulses with relay No. 1 energizing and sealing in on a first pulse and relay No. 2 energizing and sealing in on a second pulse; a master strike relay connected to the mark position of one level of said scoring step switch and energized thereby to provide a pulse energization of said strike relays; a master spare relay connected to the mark position of one level of said scoring step switch and energized thereby to provide a pulse energization of said spare memory relay; said spare memory relay being connected for sealing in when energized; said drop-out relay having normally closed contacts connected in series with said spare memory relay whereby on energizing said drop-out relay said spare memory relay will be de-energized; a first ball relay energized in coordination with the bowling of a first ball and having normally closed contacts in series with said master strike relay and normally open contacts in series with said master spare relay and being connected for energizing in timed subsequent relation to the arrival of the scoring step switch at its mark position whereby a total pin fall on one ball results in said master strike relay being energized and a total pin fall on two balls results in said master spare relay being energized, said first ball relay being connected for sealing in when energized; a no-mark relay connected for energizing in timed subsequent relation to the arrival of said scoring stepping switch at its mark position and in series with a set of normally open contacts of said first ball relay whereby said no-mark relay will be energized only in connection with the bowling of the second ball, said no-mark relay sealing in when energized, the circuit connection of said first ball relay being completed through normally closed contacts of said master strike relay and of said no-mark relay whereby energization of either said master strike relay or said no-mark relay will cause de-energizing of said first ball relay; the circuit of said no-mark relay being completed through normally closed contacts of said master spare relay and the energizing pulse for said no-mark relay being timed to follow the energizing pulse for said master spare relay whereby said no-mark relay will not be energized if a spare occurs but will be energized if less than full pin fall occurs on the bowling of two

balls; an accumulator having electric input means, said scoring step switch and said programming step switch being connected to said electric input means for transmitting no-mark and mark scores respectively thereto.

2. A bowling score keeping machine comprising, a plurality of switches corresponding to the number of pins for indicating the number of pins felled; a self-cycling stepping switch connected to scan said switches and producing output pulses corresponding to the pins felled; pulse responsive totalizing means connected to said stepping switch and including a scoring step switch having a plurality of levels and advanced by successive pulsing to a series of positions corresponding to the number of pins felled; a memory unit for each player including a plurality of strike relays and a spare relay energized from the mark position of said scoring step switch; a programming step switch having a plurality of levels corresponding with various no-mark, strike and spare scoring situations; said strike and spare relays functioning according to the various combinations of their energization to select the various levels of said programming step switch; and an accumulator having electric input means for unit count, ten count, twenty count and thirty count connected to said scoring step switch and said programming step switch, said levels of said scoring step switch being connected to said unit count input means for passing no-mark scoring information to said accumulator, the several levels of said programming step switch being connected to the ten, twenty and thirty unit count input means of said accumulator for the addition of the appropriate strike and spare scores.

3. A bowling scorekeeping machine comprising, an accumulator having a units input, a 10 input, a 20 input, and a 30 input; a pinfall counter operable to indicate the frame-accumulated pinfall count for each ball rolled, a current-ball indicator including a step switch connected to and advanced by said pinfall counter to any of ten positions corresponding with the number of pins felled on each ball rolled; a first ball indicator; a memory unit connected to the tenth position of said step switch and cooperating with said first ball indicator to store strike and spare information; and programming means connected to said accumulator, memory unit, first ball indicator, and current-ball indicator and having pre-set programming circuits and selection means therefor for making operative connections to said accumulator inputs for entering in said 30 input a strike in said current-ball indicator and two strikes in said memory unit, for entering in said 20 input and said units input a no-mark first ball in said current-ball indicator and two strikes in the said memory unit, for entering in said 10 input and said units input a no-mark second ball in said current-ball indicator and a strike in said memory unit, for entering in said 20 input a spare in said current-ball indicator and a strike in said memory unit, for entering in said 20 input a strike in said current-ball indicator and a spare in said memory unit, and for entering in said 10 input and said units input a no mark first ball in said current-ball indicator and a spare in said memory unit.

4. A bowling scorekeeping machine as characterized in claim 3, wherein said accumulator has a plurality of individual player registers assigned one to each of a plurality of players, and is operable to connect said accumulator inputs selectively thereto for accumulating the score of each player on his own register from frame to frame; and wherein there is provided a plurality of said memory units assigned one to each player and arranged for selective connection to said current-ball indicator for accumulating the strikes and spares accumulated by the respective players, and to said programming means for controlling the actuation of said programming circuits for entering scores into said accumulator inputs for the respective players; and also including a player programming means having a plurality of player positions arranged in a predetermined order of players and operable for cycling

through said player positions in said order, said player programming means being connected to said current-ball indicator for timed actuation to the next player position in the cycle upon bowling of a strike, spare, or no-mark second ball, and said player programming means having connections with said inputs, registers, memories and programming means for making selective operative connections therebetween for scoring and registering the score bowled by each player on his own register.

5. A bowling scorekeeping machine as characterized in claim 3, wherein said pinfall counter includes a self-cycling step switch connected for advancing said current ball indicator step switch as aforesaid, said self-cycling step switch having a contact connected to and arranged to energize said first ball indicator, and said self-cycling step switch having another contact connected to said current-ball indicator step switch for directing a pulse there-through to said accumulator to enter the pinfall count therein.

6. A bowling scorekeeping machine as characterized in claim 3, wherein said programming means includes a multi-level step switch and a plurality of terminals in each level providing connections to the several pre-set programming circuits, and selector contacts in said last-named step switch engaging said terminals thereof and being connected to and energized by said memory unit.

7. A bowling scorekeeping machine comprising, an accumulator having a low electro-magnet, a high electro-magnet, a 1-6 electro-magnet, a 2-7 electro-magnet, a 3-8 electro-magnet, and a 4-9 electro-magnet, and functioning to store a unit, 2, 3, and 4 count upon energizing of the low and 1-6, 2-7, 3-8 and 4-9 electro-magnets respectively, and a 5 count upon energizing the low electro-magnet alone and a 6, 7, 8 and 9 count upon energizing of the high and 1-6, 2-7, 3-8 and 4-9 electro-magnets respectively; a step switch having at least two levels having at least ten terminals each and selector contacts engaging said terminals, means displacing said selector contacts to terminals 1 to 10 corresponding with the pinfall count for each ball rolled; terminals 1, 2, 3, 4, and 5 of a first level of said step switch being connected to said low electro-magnet; terminals 6, 7, 8 and 9 of said first level being connected to said high electro-magnet; terminals 1 and 6 of a second level of said step switch being connected to said 1-6 electro-magnet; terminals 2 and 7 of said second level being connected to said 2-7 electro-magnet; terminals 3 and 8 of said second level being connected to said 3-8 electro-magnet; terminals 4 and 9 of said second level being connected to said 4-9 electro-magnet; and a ten count memory relay being connected to terminal 10 of one level of said step switch.

8. A bowling scorekeeping machine comprising, an accumulator having a units input, a 10 input, a 20 input, and a 30 input; a pinfall counter operable to indicate the frame-accumulator pinfall count for each ball rolled; a memory unit connected to store strike and spare information; and programming means connected to said accumulator, memory unit, and pinfall counter and having pre-set programming circuits for each of the following seven scoring situations viz.:

- First—No mark;
- Second—Strike following two strikes;
- Third—First ball following two strikes;
- Fourth—No mark following a strike;
- Fifth—Spare following a strike;
- Sixth—Strike following a spare; and
- Seventh—First ball following a spare.

9. A bowling score keeping machine as characterized in claim 8 wherein said programming means includes a step switch having levels connected to provide individual outputs for said second to seventh scoring situations; and said memory unit includes a plurality of strike relays and a spare relay energized by said counter and functioning according to the various combinations of energization of

31

said relays and said counter to select the various levels of
said programming step switch.

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