APPARATUS FOR AUTOMATIC RECORDING OF SUCCESSIVE MEASUREMENTS SUCH AS BOWLING PIN STATUS

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ABSTRACT

An electro-mechanical apparatus for transferring and permanently recording data indicating specific bowling pins left standing, and conversely those bowling pins knocked down, following the roll of each ball in a bowling game; this data is recorded in punched card form and is then adaptable for either manual or machine totalization.

14 Claims, 6 Drawing Figures
APPARATUS FOR AUTOMATIC RECORDING OF SUCCESSIVE MEASUREMENTS SUCH AS BOWLING PIN STATUS

This application is a division of application Ser. No. 786,255, filed Dec. 23, 1968, now U.S. Pat. No. 3,610,619.

This invention relates to a bowling scoring method, recorder and score card therefor, permitting permanent recording of the specific pins left standing and their relative position or location identity after each roll of the ball during the game. The resultant score record is readily adaptable for manual totalization of the cumulative and final score or for machine totalization and statistical processing.

Presently in the game of bowling, it is customary to use scoring charts provided by proprietors or operators of bowling alleys for score keeping. It is generally customary for either the bowler, himself, or persons designated for this purpose to keep score. Various bowling machine totalizers have been suggested which automatically totalize and score the results of the game from its beginning to end, but these machines are found commercially unacceptable for many reasons. The main reason that these bowling machine totalizers are found unacceptable, is that they produce a quantitative record as opposed to a qualitative record. Stated another way, these known scoring machines provide a nonpermanent cumulative score and eventually a final or total score without attempting to permanently record the identity and number of pins knocked down or left standing during each phase of the game. Also, the inherent variables or options in a bowling game dictate considerable complexity in known score totalizers for "on line" totalizing as to make commercial acceptability problematical.

The present invention provides a bowling recording procedure, apparatus and record which lack relative complexity as compared to those attendant prior art totalizers and which are more readily acceptable commercially and afford a more meaningful record of the participant's individual performance.

It is an object of the present invention to provide an exact and permanent record of a participant's performance in a game of bowling.

It is a further object of the present invention to provide such record in a form readily acceptable to statistical analysis by data processing machinery, singly or in combination with similar records of the same bowler or like records of other bowlers, such as in team play.

It is also an object of the present invention to provide an exact and permanent record of a bowler's performance in a less complex and less expensive manner than afforded by prior art systems.

In the practice of the present invention, use is made of the momentary pin-status indication currently provided by commercial pinspotter machines during the "standing pin" portion of their full cycle of operation. Electrical signals corresponding to this pin-status indication is transmitted to the approach end of the bowling alley, and is utilized as an input to the recorder of the present invention. The recorder acts to punch a score card blank in order to provide a record of each pin left standing after each roll of the bowling ball during the game. The record is arranged so as to appropriately identify each pin left standing in regard to pin number and frame number, and is constructed of a flexible blank cut for automatic data processing, such as the commonly utilized IBM card. The resultant punched record, constitutes a permanent record of each pin fall during the game and thus of the cumulative and final game score. Of course, a printed record, as opposed to the preferred punched record may also be utilized in accordance with the present invention.

In accordance with one aspect of the present invention, the recorder constructed in accordance with the present invention includes means for defining a recording area where the score card is marked, and positioning means for selectively placing the card in this recording area during the bowling game. The recorder also includes input means for coupling electrical signals indicating the positional status (e.g., those pins which remain standing), of the various bowling pins after each roll of the bowling ball; and also includes recording means arranged in the recording area for marking the score card in response to these electrical signals to provide a record of the status and identity of each of the pins during the game. Control means are utilized for changing the relative positional relationship between the recording means and the score card after each roll of the bowling ball whereby the recorder provides a qualitative record of the status and identity of each pin throughout the game and serves to indicate the cumulative and final quantitative score of the game.

In accordance with another aspect of the present invention, the recording means of the recorder includes indexing means for providing the score card with an indexing mark each half-frame of the game; and the recorder has a control means, responsive to the presence of an indexing mark within the recording area, for changing the relative positional relationship between the recording means and the score card so that the card is relatively positioned in the recording area for recording the succeeding half-frames of the game. In addition, circuit means, responsive to the input signals, are preferably provided for detecting the occurrence of game strikes and for operating the control means to change, upon the occurrence of a strike, the positional relationship between the recording means and the score card to a position corresponding to the first half of next succeeding frame of the game.

In its preferred embodiment, the recording means includes means for marking the score blank in such a manner that it is machine readable by automatic data processing equipment; and the positioning means of the recorder includes a carriage for carrying the score card to the recording area. In this preferred form, the control means includes means for shifting the carriage relative to the recording means after each roll of the bowling ball. Also, means may be provided in the recorder for marking the score card every time all of the bowling pins have been knocked down thereby providing a separate record on the score card indicating the strikes and spares made during the game as well as the specific frame in which they occur.

There has thus been outlined rather broadly the more important features of the invention in order that the detailed description thereof that follows may be better understood, and in order that the present contribution to the art may be better appreciated. There are, of course, additional features of the invention that will be described hereinafter and which will form the subject of the claims appended hereto. Those skilled in the art will appreciate that the conception upon which the disclosure is based may readily be utilized as a bases for
the designing of other structures for carrying out the several purposes of the invention.  

A specific embodiment of the invention has been chosen for purposes of illustration and description, and is shown in the accompanying drawings forming a part of the specification wherein:  

FIG. 1 is a perspective view of a recorder constructed in accordance with the present invention, and shows the exterior features thereof;  

FIG. 2 shows one side of a score card utilized in the recorder of FIG. 1, and arranged to be processed by automatic data processing machinery;  

FIG. 3 shows the reverse side of the score card shown in FIG. 2, and indicates the manner in which the cumulative and final total score is manually realized;  

FIG. 4 is a sectional view of the recorder shown in FIG. 1 with the outer cover removed and taken through the punching head of the recorder;  

FIG. 5 is a side view of the recorder shown in FIG. 1 with the outer cover removed and certain parts shown broken away to show details; and  

FIG. 6 is a schematic wiring diagram of control circuitry for use in the recorder shown in FIG. 1.  

Referring now to the drawings in detail, and specifically to FIG. 1, there is shown a recorder 10 constructed in accordance with the present invention. The recorder 10 is preferably adapted to be positioned near the approach end of a bowling alley so as to be readily accessible by the bowler during and immediately after the bowling game. The recorder 10 has a stationary card tray 12 for receiving and holding a score card (FIGS. 2 and 3) during the recording process which occurs during the game. The recorder 10 is provided with a green indicator light 14 which operates in a manner more fully disclosed hereinafter to indicate that the recorder is properly set and ready to receive bowling data; and a red indicator 16 is provided for indicating when bowling data is being recorded and that the score card should not be removed from the recorder. In addition, a removal button RBH is provided in the shelving of the stationary card tray 12 for actuating the recorder 10 in a manner more fully discussed below so that the score card may be removed during any portion of the bowling game. Indicator windows 18 arranged in the conventional pattern in which the bowling pins are initially set during a bowling game, are provided for indicating the specific pins standing during the last previous roll of the ball.  

Referring to FIGS. 2 and 3, it will be observed that a score card, shown generally at 20, for use with the recorder 10 is a standard size data processing card, such as the commonly utilized IBM card. As shown in FIG. 2, one side of the score card 20 is arranged with ruled lines 22 which extend along the length of the card, to define a plurality of rows 24 corresponding in number to the number of bowling pins utilized in the game. Preferably these rows 24 are identified as at 26 by indicia specifically indicating each conventional pin number to which the rows 24 correspond. The score card 20 is also arranged with ruled lines 28 extending parallel to one another and across the width of the card to define the card into a plurality of columns 30, each corresponding to a half frame of the bowling game.  

The score card 20 includes a row 32 extending across the length of the card 20 for accommodating frame index marks in a manner more particularly described below. Also another row 34 extends across the length of the score card 20 and is pre-marked with indicia “X” and “\” representing strikes and spares, respectively, the strikes indicia being pre-printed at all odd columns corresponding to first half-frames of the bowling game, and the spare indicia being pre-printed at all even columns corresponding to the second half-frames of the bowling game. As shown in FIG. 3, the reverse side of the card 20 may be marked with ruled lines 36 to define on that side the columns 30 of the other side. In addition, a total score row 38 and a frame score row 39 intersected by alternate ruled lines 36 may be defined to provide a place on the score card for recording the cumulative and individual frame scores, respectively.

Returning now to the features of the recorder 10, it will be seen from FIGS. 1 and 5 that the stationary card tray 12 is slotted as at 41 to allow passage therealong of a score card retainer 40 pivotally fastened through the slot 41 to a carriage 42 (FIG. 5). The carriage 42 is arranged to slide below and parallel to the stationary platform 12. As shown in FIG. 5, the card retainer 40 pivots about the carriage 42 under “toggle” action through the provision of a leaf spring 44. Thus, as shown in the dotted outline of FIG. 5, in operation, the card retainer 40 is pulled back as far as the carriage 42 permits and is bent downwardly against the bias of leaf spring 44 to permit the insertion of the card 20 on the stationary tray 12. Then the card retainer 40 is returned and placed around the edge of a card, as at 46, to retain the card on the stationary shelf 12 and hold same while the carriage 42 is moved parallel to the shelf 12. As the carriage is moved inwardly the card is confined at its top by toe guides 48, and at its rear by fingers 50 provided at the rear of carriage 42.

The carriage 42 is provided with a plurality of teeth RB, RA, R10, R10, etc. (FIG. 5) which override a carriage locking pawl 52 suitably secured in the recorder as at 54, and biased against the teeth by tension spring 56. The teeth and the pawl 52 are arranged so that any inward movement of the retainer 40 and carriage 42 from the outlined position shown in FIG. 5, causes the teeth to override the locking pawl 52 and be retained in position by an opposing force provided by a carriage return spring 58.

As shown in FIG. 5 snap action switches CIM and CCM are arranged in the recorder 10 to be operated by the square and cut corners respectively, of the score card 20 when the latter is properly inserted in the recorder. The purpose of the switches CIM and CCM will become more apparent hereinafter. As shown in FIGS. 4 and 5 a detent solenoid DTS is provided in the recorder to prevent insertion of the carriage 42, and thus the card 10, when signal input is provided by the pin detection system. To this end, a moving solenoid plunger 60 is arranged to engage a recess 62 provided in the carriage 42 when the carriage 42 is in its extended position and the solenoid DTS is energized.

As best shown in FIG. 4, the recorder 10 has a perforated plate 64 extending thereacross to define a work platform for marking the score card. A marking mechanism, shown generally at 66, is provided directly above the support plate 64 for carrying out the marking process. The marking mechanism 66 includes a stationary guiding 68 fixed relative to the support plate 64 and comprising perforated plates 70 and 72 which function to guide punches 74 extending therethrough. A punch head 76, slideable on guides 77 provided on opposite sides of the recorder, is positioned directly above the
stationary guide 68 and functions to drive the punches 74 through the perforations in the stationary guide 68 and support plate 64 to thus mark the score card 20 interposed therebetween. The punch head 76 is driven downwardly by a solenoid PRS which controls an arm and roller arrangement shown generally at 78 in FIG. 4. Bias springs 79 are provided to oppose the downward movement of the punch head and return same to its quiescent position upon deactivation of the solenoid PRS.

Twelve punches 74, i.e. 74a, 74b, 74c, 74d, 74e, 74f, 74g, 74h, 74i, 74j, 74k, 74l, are utilized in the preferred embodiment. The end punch 74a functions to provide an index mark every half frame of the bowling game while the other end punch 74b functions to provide a perforating mark to eliminate the pre-printed spare and strike indicia provided in the card 20 described above. The remaining punches 74c, 74d, 74e, 74f, 74g, 74h, 74i, 74j, 74k, and 74l are arranged to coincide with the rows 24 defined on the score card 20 and are related to the specific pin designations found at 26 thereon (FIG. 2). As shown in FIG. 4, the punch head 76 is provided with a recess 80 which permits the complete downward movement of the punch head 76 without moving punches 74c, 74d, 74e, 74f, 74g, 74h, 74i, 74j, 74k, and 74l. On the other hand, the recess 80 is arranged, as at 82, so that the punch head 76 when depressed always moves the punch 74a downward through the perforated plates 64 and 72. As best shown in FIG. 5, pin interposers 84 are provided adjacent punches 74c, 74d, 74e, 74f, 74g, 74h, 74i, 74j, 74k, and 74l, and are arranged to project into the recess 80 of the punch head 76 upon actuation of operatively connected solenoids IPSc, IPSd, IPSf, IPSg, IPSh, ISPi, ISPj, ISPk, and ISP,l respectively. The recess 80 and the pins 84 are relatively arranged so that when the interposer pins are positioned within the recess and the punch head 76 is moved downwardly, the punch head will selectively drive those punches 74 having their corresponding interposer pins actuated. The interposer pins 84 are returned to their quiescent position shown in FIG. 5 upon the deactivation of the interfering solenoids by return springs 86 connected to each.

As shown in FIGS. 4 and 5, the recorder 10 includes a sensing yoke 88 arranged to move along guide 90 provided on the side of the recorder and constructed to house a sensing pin 92. The sensing yoke 88 is arranged to raise, under the operation of solenoid SRS, the sensing pin 92 against the underface of the score card 20 to sense for the presence of indexing marks provided by the punch 74a. If no index mark is present, the sensing pin 92 urges against the rear surface of the score card under the bias provided by spring 94 included with the sensing yoke 88. If, however, an index mark is present, the sensing pin 92 projects therethrough and in doing so raises its lower end to actuate a microswitch SM held in closed position by spring 96. The switch SM, when actuated, controls the movement of the carriage 42. To this end, and as shown in FIG. 5, an actuating solenoid PWS is actuated upon the closure of the microswitch SM to rotate a pawl arm 98, carrying an index pawl 100 pivotedly arranged on the arm pawl 98, as at 102, and spring biased to pin stop 104 by a tension spring 106. The index pawl 100 is arranged upon actuation of solenoid PWS to disengage pawl 52 from carriage 42 and simultaneously engage one of the teeth of carriage 42. Upon the deenergization of solenoid PWS, the index pawl 100 is returned to the pin stop 104 releasing the carriage 42 from engagement with the index pawl 100 and allowing the carriage to move outwardly one tooth length under the urging of spring 58 to reengage pawl 52.

As best shown in FIG. 5, contacts C1a, C1b, . . . C1o and C1b are staggered arrayed on the carriage 42 and positioned adjacent each tooth thereof except at teeth RA and RB. A common contact Ck is provided which always engages each of the named contacts, C1a, C1b, . . . C1o; and in addition, two other contacts, CEV and COD, are arranged to alternately contact the aforementioned contacts C1a, C1b . . . C1o provided on the carriage 42. Specifically, the contact CEV is arranged to contact all even contacts, i.e. C1b, C2b, etc., and the contact COD is arranged to contact all odd contacts on the carriage 42, i.e. C1a, C2a, etc.

The control relay circuitry for operating the various above described solenoids and switches and sensing mechanisms is shown generally at 108 in FIGS. 4 and 5, and specifically in FIG. 6. The specifics of the control circuitry 108 are best noted by considering their operation in conjunction with the previously described electromechanical structure of the recorder during the various phases of a typical bowling game.

Although the symbols used in FIG. 6 are self-explanatory to those skilled in the art, a full understanding may be expedited by pointing out certain conventional symbols. All circuits are shown therein with contacts in their positions when all corresponding relays are deenergized, i.e. with no power supplied. All solenoids utilized for mechanically actuating purposes are designated with the suffix "S." Mechanically actuated contacts of snap-action type switches are shown diagrammatically with an extension and a roller symbol, and are designated in the specification and drawing with a final letter "M." The rectifiers shown in the several circuits of FIG. 6 are blocking rectifiers and function to prevent feedback, such as where contacts are used to energize more than one circuit. Timed relays are distinguishable from other relays shown by their associated capacitors and resistors which provide the necessary time constants. Contacts associated with specific electromechanical relays carry the relay coil designation with a particular identifying number appended thereto. It will be noted that certain of the relay contacts serve electrical interlock purposes only and that certain repetitive circuits have been omitted for simplification.

As previously pointed out, signal input for the recorder 10, and thus for the control circuitry shown in FIG. 6, may be taken from the short-time illuminated indicators currently used in conjunction with commercial automatic pinspotting machines, such as for example, the short-time indicator shown in FIG. 6 of U.S. Pat. No. 2,590,444 to I. Millman et al. Alternatively, such short-time indication signals may be taken from a photoelectric detection system positioned near the pins or could be taken from a system such as shown in U. S. Pat. No. 651,601 to F. X. Ganter. Regardless of the type of signal input used, it is to be understood that the indicating period, preferably about 5 seconds, will be reflected in the closed status of contacts W of FIG. 6; and specific pin standing indication information will be transferred to the recorder 10 and be reflected therein by the closed status of each of the contacts in the group 1z through 10z of FIG. 6, each of which has a numeral prefix corresponding to specific pin interposers 84 controlled thereby. Thus, for example, the
closed status of contacts W may correspond to the closed status of contacts 412d in the above-mentioned Millman et al. patent (FIG. 6); and the closed status of contacts 12 through 102 may correspond to the operational status of indicator lights 1–10 shown in FIG. 6 of the Millman et al. reference.

In operation, the score card 20 is inserted on the stationary shelf 12 and retained thereon by the toggle action of the card retainer 40. Force is then exerted on the card retainer 40 to move the carriage 42 against the action of spring 58 and to position the card under the marking mechanism 66 at the position corresponding to the row thereof related to the first half of the first frame. If, however, a signal input to the recorder is present while the carriage 42 is extended from the recorder, the solenoid DTS is actuated by the presence of this signal input to prevent the insertion of the carriage 42 into the recorder. Normally, however, forward pressure on the card retainer 40 will cause the carriage 42, carrying the score card with it, to advance inwardly with its teeth RB, RA and R10B, R10A, etc. overriding the carriage locking pawl 52 to the full-in position where the locking pawl 52 engages the carriage indexing tooth R1A. If the score card orientation is proper, i.e., proper end forward and proper face upward, the uncut corner thereof will actuate the C1M snap-action switch, described above, to close same; and the cut corner will leave the snap-action switch CCM, also described above, in its closed status. As shown in FIG. 6, the closed status of switches C1M and CCM permits operation of relay CO which becomes self-holding by the operation of its contact CO1 until subsequent manually initiated release by the operation of the button RBH. The operation of relay CO closes contacts CO1 to actuate sensing solenoid SRS described above. The actuation of sensing solenoid SRS raises the sensing yoke 88 (FIGS. 4 and 5) along the guide 90 and permits the sensing pin 92 to bear against the underface of the score card. In addition, the operation of relay CO closes contacts CO2 and permits green light 14 (FIG. 6 and FIG. 1) to indicate readiness to bowl. At this time, since contacts CO2 are closed, the operation of relay OD is carried out through the connection of commutator contact CK to contact C1A through the contact C1A provided on the carriage 42.

Assuming that as a result of the initial ball rolled, all of ten pins are left standing. Upon detection and indication of this result, signal input contacts W and all the Z contacts will close. The related S relays, S through 10S, thereupon operate and, in turn, each causes, through the closure of related contacts Sn, operation of its counterpart IPS pin interposer solenoid, IPSn through IPSn_pr (FIGS. 4 and 5) mounted on the punch head 76 and advances its counterpart pin interposer 84 in preparation for the punching operation. As shown in FIG. 6, the closing of any contacts 1S, . . . 10S also permits the actuation of mark interposer solenoid IPS (FIGS. 4 and 5), which similarly advances its counterpart mark interposer 84.

Shortly following initiation of signal input, a relay GST (FIG. 6), timed in operation and in release relative to the signal input, actuates its contacts. Thus, upon operation of relay GST, its contacts GST1 thereby open to release sensing solenoid SRS (FIGS. 4 and 5) dropping the sensing yoke 88 away from the score card 20, and retracting the sensing pin 92 therewith. Also, the actuation of relay GST closes its contacts GST2 to energize the rotary punch solenoid PRS (FIG. 4) to rotate the actuating cam to force the punch head 76 downwardly on guides 77 against the force of the bias springs 79. This movement of the punch head 76 causes the index punch 74A, mark punch 74B and all ten pin punches 741, . . . 7410 to penetrate the score card at its first half of first frame column (FIG. 2).

Upon termination of the input signals (after about five seconds), each of contacts W and Z open, and each of related relays 1S through 10S drop out. Shortly thereafter, the timed GST relay will also drop out. In addition, all pin interposer solenoids are deenergized and are returned to their initial position by return springs 86.

At this stage contacts GST1 return to their normally closed position and actuate the sensing solenoid SRS to raise the sensing pin 92 through the newly punched index hole in the score card, thus permitting the further end of the sensing pin to actuate the snap-action switch SM (FIGS. 4 and 5). As shown in FIG. 6, the contacts SM1 of the switch SM cause actuation of relay SMT, which is delayed in its release by capacitor CS. Upon actuation of relay SMT, contacts SMT1 open to deenergize solenoid SRS and drop the sensing pin 92 away from the score card thus opening relay contacts SM again. Also, upon actuation of relay SMT, contacts SMT2 close to energize carriage indexing solenoid PWS (FIGS. 4 and 5), which through the arm 98 advances the carriage indexing pawl 100. This actuation of indexing solenoid PWS initiates a one step escapement action of the carriage from the locking pawl 52 by dislodging the locking pawl 52 from the tooth R1A.

Upon release of the relay SMT, following by solenoid PWS release, the index pawl 100 is returned to stop 104 through the urging of the return spring 106. By this carriage movement the locking pawl 52 is in engagement with the carriage tooth R1B; and the record card, transported by the movement of carriage 42, is positioned under the marking mechanism so that its second half-frame column is now positioned under the punching head (FIG. 1). Also, this movement causes contact CK to contact CEV through C1A thus dropping relay OD (FIG. 6) and permitting actuation of relay EV followed by actuation of related relay EVT.

Release of relay SMT also permits its contacts SMT1 to again energize sensing solenoid SRS to raise the sensing yoke 88 and sensing pin 92 to contact the repositioned score card. Since no indexing pole exists in the score card at this new position, i.e., the second half of the first frame, indexing pin 92 travel is restricted by the card and the contact SM remains open.

It will be appreciated that the recorder 10 is now prepared to accept scoring results for the next ball to be rolled. Assume now that all bowling pins left standing in the initial half frame are knocked down by the second ball rolled, — for a spare —, no S relays (FIG. 6) will be energized, and consequently no IPS solenoids will be actuated to position pin interposers 84 in the recess 80 of the punching head. Also, since none of the pin interposer solenoids are actuated, mark interposer solenoid IPS, will not be energized. Accordingly, punch action in this case, would cause card penetration only for the index punch 74A. Thus, in this case the pre-printed spare symbol of the score card would not be punched out, thereby leaving indicia indicating that a spare has been made. Following punch release and index sensing, the newly punched index hole per-
mits full travel of the sensing pin 92 to again initiate the next step of escapement of the carriage 42 moving the score card in a manner such that the column corresponding to the first half of the second frame is positioned under the punching head. In this case, the commutator CK would move from C1₄ to C2₄, thus transposing from EV to OD relay actuation.

Assume now that the roll of the first ball of frame two, knocks down all the pins, for a strike. For substantially the same reasons previously described in connection with the rolling of a spare, only an index hole will be punched in the score card and the preprinted strike symbol in the last row of the card would remain un-punched. Additionally, upon operation of relay OD, OD₁ contacts (FIG. 6) are closed and all S₁ contacts are closed so that relay XT is energized. The relay XT is timed in pull in and release, and is made self holding through its own contact XT₄ to remember the strike. Following punch release and sensing pin action in the manner described above, the carriage 42 is moved to place the score card in a position corresponding to the second half of the second frame. This movement causes the release of relay OD and the operation of relay EV followed shortly by the operation of relay EVT. As shown in FIG. 6 with XT and EV now energized, contacts XT₃ and EV₄ permit mark interposer, IPSM, to be energized. In addition, with contacts XT₃ closed, the closing of contacts EVT₃ permits operation in the punched solenoid PRS independent of the status of contacts GST₃. Accordingly, card punching operation will occur for the index hole and the mark hole only the latter to eliminate the pre-printed spare symbol which is not here applicable. Thus, the circuit arrangement of FIG. 6 automatically shifts the score card carried by the carriage 42 to the first half of the next frame when a game strike is made.

When the punch head 76 has completed its downward stroke, switch PMID is actuated (FIG. 4) and contacts PDM₁₂ are opened. The opening of these contacts interrupts the XT holding circuit as contacts EV₃ are already opened. Upon timed release of XT, punch solenoid PRS and mark interposer solenoid IPS₃₄ are released. This action releases switch PMID and causes contacts PDM₂ to close again to permit solenoid SRS to position the sensing pin 92 through the newly punched index hole in the card and thus initiate indexing of carriage and card to the first half frame position of the third frame.

It will be seen that under these conditions a strike is recorded and is immediately followed by punch out of both the next index point and the non-pertinent spare symbol, and that this is followed by advance of the carriage and score card to the first half of the frame following that to which a strike is made. If, however, a strike occurs in the tenth frame, double indexing will leave the card at tooth RA (FIG. 5), preparatory to recording results of an initial extra ball. The rolling of the initial extra ball is followed by another single indexing step to advance the carriage and score card to tooth RB for the final ball results. The indexing mark at each of these stations, i.e. RA and RB, serves as evidence for their scoring, even if each extra ball rolled left no pins standing. In addition, since as inferred above, relay OD is not active in stations RA and RB, no XT initiation of double indexing is possible if all the balls are knocked down.

Assuming now that following completion of the second frame of bowling, it is desired to remove the record card, such as for the use of the alley for another player or other reasons, pressure is made on button RBH (FIGS. 1 and 6) to result in repetitive action of relay FRT (FIG. 6) which is timed in operation and release and which is self interrupting through its FRT₄ contacts. Initial operation, with FRT₄ contacts open, interrupts the CO relay sustaining circuit thus isolating all circuits associated with punching action by reason of the CO₂ contacts being open; and since contacts FRT₃ are closed, the carriage indexing pawl 100 is operated by the solenoid PWS. As the relay FRT continues to alternate completely and interrupt the circuit to the PWS solenoid, the carriage 42 is sequentially moved to its full-out position under the action of carriage return spring 58. During this release, open CO₂ contacts ensure retracted status of the sensing pin 92.

At a later time, in preparation of the resumption of bowling by the participant, the card is reinserted completely in the recorder and causes the reestablishment of operation of relay CO. At each previously indexed punched half frame station, i.e., in this example those of the first two frames, relays SRS and SMT as well as Solenoid PWS would act to move the carriage 42 and the score card out one column 30 in the manner previously described. The carriage, and thus also the card, would then come to rest at the first column 30 of the score card which has no prior punched indexing hole. Card removal and later replacement is thus achieved while maintaining accurate continuity of score.

As shown in FIG. 6 light sources RO 1 through RO 10 (FIGS. 3 and 6) are actuated whenever a record card is actively being used, i.e., contact CO₂ closed, and are used in conjunction with the indicator windows 18 to indicate the particular pins left standing on the previous roll. Specifically, the light sources are positioned under the score card and selectively optically coupled via light guides "g" to the windows 18 through the punched holes of the last frame.

An inspection of the score card shown in FIGS. 2 and 3 for a typical completed game will indicate that an exact game record of strikes, spares, splits, singles or other pins left standing by each ball rolled is afforded by the punched record of the score card (FIG. 2). This recorded data permits manual totalization of frame and game total scores in the conventional manner (FIG. 3). In addition, the completed punched data processing card, i.e., an IBM card, is obviously readily adaptable for use as a computer input along with similar cards of the same bowler or with similar record cards of other bowlers such as for team totalizing or seasonal average determination.

What is claimed and desired to be secured by letters patent is:

1. Apparatus for successively recording a plurality of successive measurements in spaced positions on a record card comprising means for generating electrical signals representative of each of said measurements, means responsive to said signals for marking said card with marks corresponding to said signals and with a mark indicating the generation of said signals and means responsive to said mark for producing relative stepping movement between said card and said marking means for thereby moving said card to a position for receiving marks corresponding to subsequent signals.
2. Apparatus as set forth in claim 1, wherein said means for producing relative stepping movement comprises means responsive to the generation of predetermined electrical signals for modifying the relative movement between said card and said marking means.

3. Apparatus as set forth in claim 2, wherein said means modifies said relative movement by increasing the relative stepping of said card and said marking means.

4. Apparatus as set forth in claim 1, wherein said means are the number of bowling pins struck during each roll of a ball in a bowling game and said means for generating signals generates signals corresponding to the number of pins left standing after a roll of the ball.

5. Apparatus as set forth in claim 4, wherein said means for producing relative stepping movement comprises means responsive to the absence of any pins left standing for increasing the number of relative steps between said card and said marking means.

6. Apparatus as set forth in claim 4, wherein said means for producing relative stepping movement comprises means responsive to the generation of signals corresponding to the absence of any pins left standing after a predetermined number of said marks indicating the generation of said signals have been made on said card for further moving said card and said marking means relative to each other.

7. Card punch apparatus comprising carriage means for receiving a card to be punched and advancing it stepwise in a first predetermined direction, electrical signal input means for receiving electrical signals representative of the information to be recorded by punching holes in said card, electrically actuable punching means connected to said input means, said punching means comprising a plurality of punches mounted adjacent said carriage means and spaced from each other in a second direction transverse to said first direction, one of said punches being operated to punch a hole in said card each time that a signal is received by said input means and the other of said punches being selectively operated by said signals to punch a hole in said card dependent upon the signals received, and means for controlling the advance of said card and said blank having perforations therethrough in said further row to indicate said strikes and spares.

8. Apparatus as set forth in claim 7, wherein said means comprises an electrically movable pin mounted adjacent said carriage means in a position to engage the portion of the card which is punched by said one punch, said pin being movable into a first position in the absence of a hole in said card punched by said one punch in the portion thereof adjacent said pin and being movable into a second position in the presence of a hole in said card punched by said one punch in said portion thereof adjacent said pin and means controlled by said pin for advancing said carriage means following the time said pin reaches said second position and for stopping the advance of said carriage means when said pin is in said first position.

9. Apparatus as set forth in claim 2, wherein said input means has a plurality of inputs, one for each signal to be received, each of said inputs being connected to the actuating means of a different one of said punches.

10. Apparatus as set forth in claim 9, further comprising a plurality of electric switches, one for each of said inputs, and means connecting each of said switches to a different one of said inputs.

11. In combination with the apparatus of claim 7, a card formed of flexible material and having a plurality of intersecting rows and columns thereon, one of said rows being disposed to be punched by said one punch in each column and each of the other rows being disposed to be punched by one other punch.

12. The combination as set forth in claim 11, wherein the number of rows corresponds to the number of pins utilized in a bowling game plus one and the number of columns corresponding to the number of half frames in said game.

13. A score card for use with an automatic recorder for scoring a bowling game comprising a flexible blank constructed to be used with said recorder and having a plurality of intersecting rows and columns defined therein, the number of said rows corresponding to the number of pins utilized in said bowling game plus one additional row and the number of columns corresponding to the number of half frames in said game, said blank having perforations therethrough in columns corresponding to completed half frames which indicate the status of the bowling pins after the completion of a half frame and having perforations therethrough in said additional row which indicate the number of completed half frames.

14. A score card as in claim 13, wherein said blank includes at least one further row, said further row having predisposed indicia therein for alternately representing strikes and spares, said indicia indicating strikes being disposed adjacent odd ones of said columns and said indicia indicating spares being disposed adjacent even ones of said columns and said blank having perforations therethrough in said further row to indicate said strikes and spares.