United States Patent

[11] 3,610,619

[72] Inventors **John J. Matcovich**
65–15 318th Ave., Woodisde, N.Y. 11377;
John E. Magee, 191 Forest Blvd., Ardsley, N.Y. 10502

[21] Appl. No. **786,255**
[22] Filed **Dec. 23, 1968**
[45] Patented **Oct. 5, 1971**

[54] **METHOD AND APPARATUS FOR RECORDING POSITIONAL STATUS OF BOWLING PINS**
16 Claims, 6 Drawing Figs.

[52] **U.S. Cl.** ..... **273/54 C,** 235/61.12 R, 235/92 GA, 340/323, 346/33 R
[51] **Int. Cl.** **A63d 5/04**
[50] **Field of Search** ..... 273/54 C; 346/33; 235/92; 340/323

[56] **References Cited**

UNITED STATES PATENTS

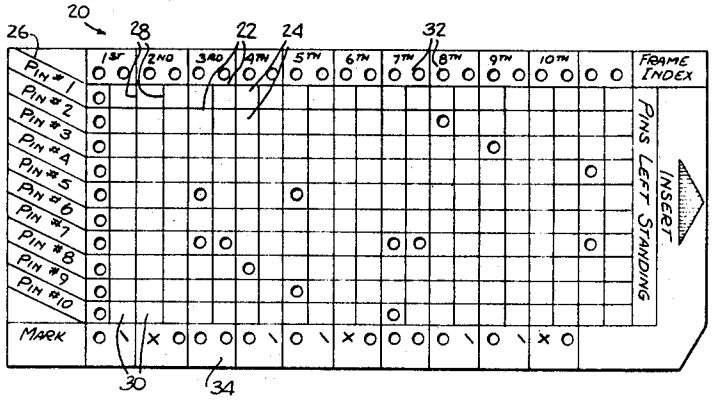
866,923	9/1907	Eichenberger	273/54 C UX
3,440,956	4/1969	Miller	273/54 (C) UX
3,516,665	6/1970	Danielson	273/54 C
2,590,444	3/1952	Millman et al.	273/54 (C) UX
3,435,120	3/1969	Cornell et al.	273/54 C

FOREIGN PATENTS

162,602	9/1905	Germany	273/54 C

Primary Examiner—Anton O. Oechsle
Attorney—Ward, McElhannon, Brooks & Fitzpatrick

ABSTRACT: A method of and electromechanical 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.



PATENTED OCT 5 1971

3,610,619

SHEET 1 OF 5

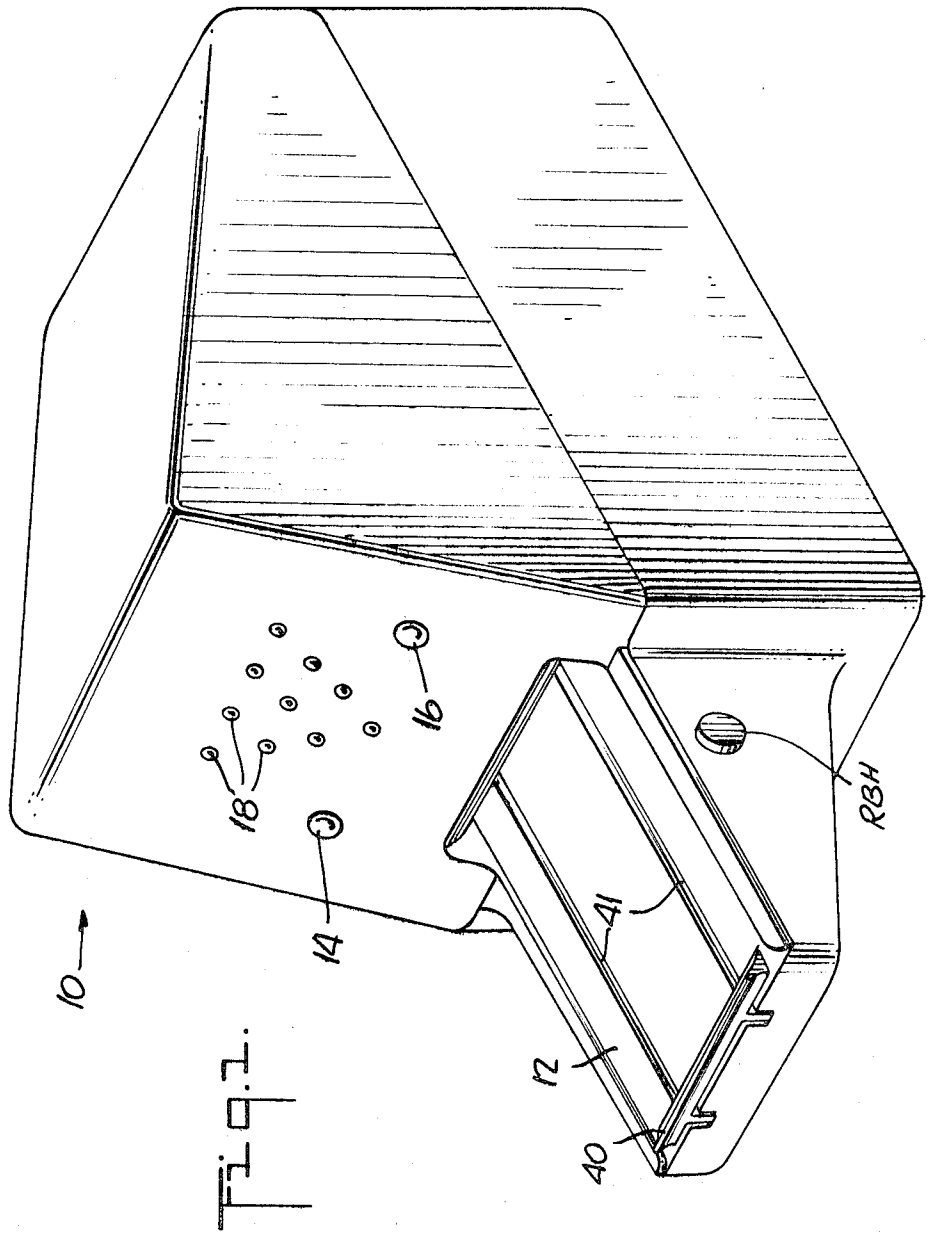


Fig. 1.

INVENTORS
JOHN J. MATCOVICH
BY JOHN E. MAGEE

Ward, McElhannon, Brooks & Fitzpatrick
ATTORNEYS

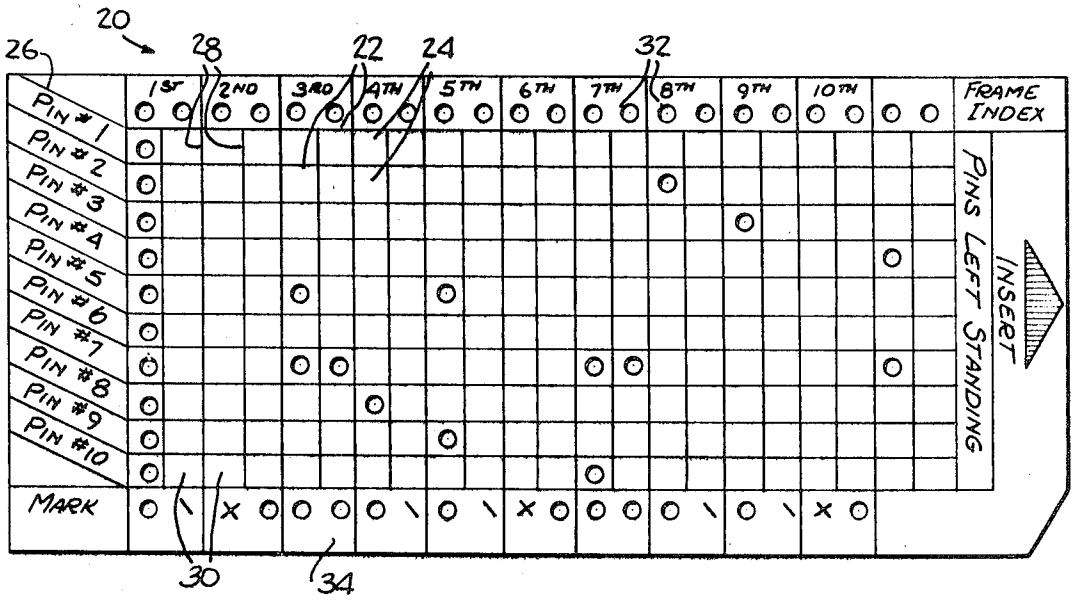
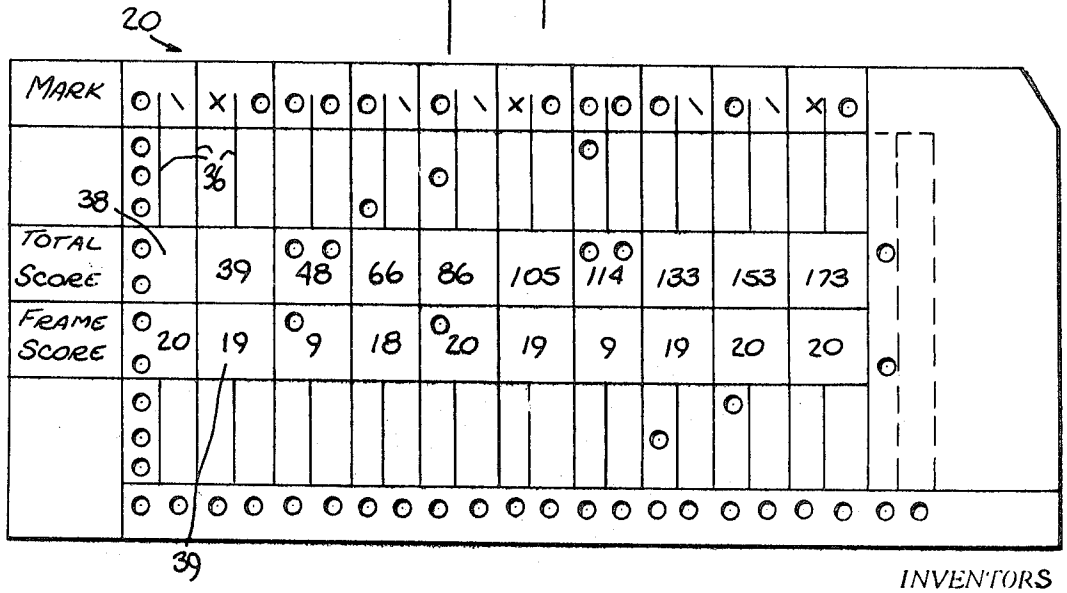


Fig. 2.

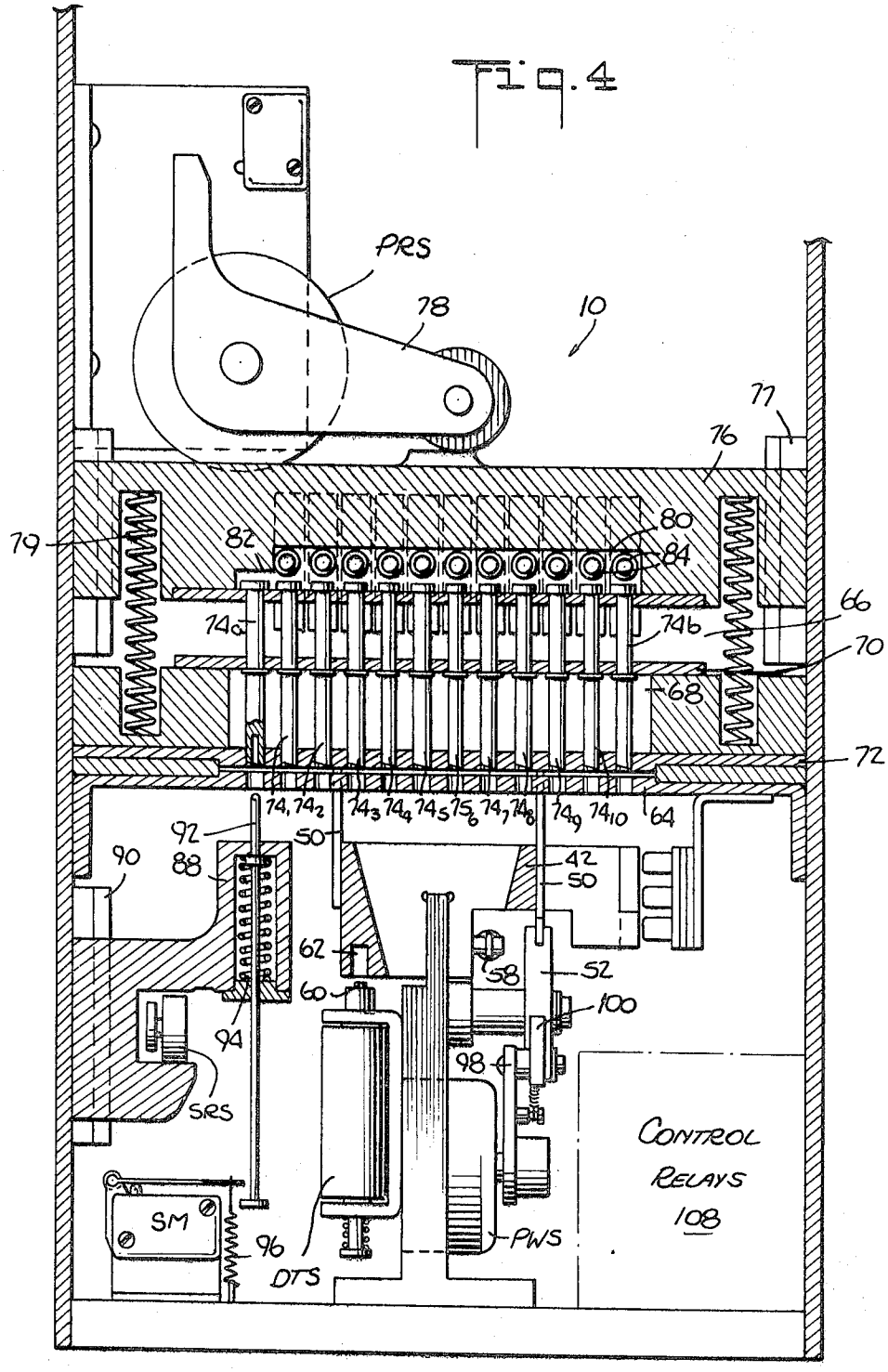
Fig. 3.



INVENTORS
JOHN J. MATCOVICH
BY JOHN E. MAGEE

Waid, McCollough, Brooks & Fitzpatrick
ATTORNEYS

Fig. 4



INVENTORS
JOHN J. MATCOVICH
BY JOHN E. MAGEE

Wood, McEllarson, Brooks & Lightfoote
ATTORNEYS

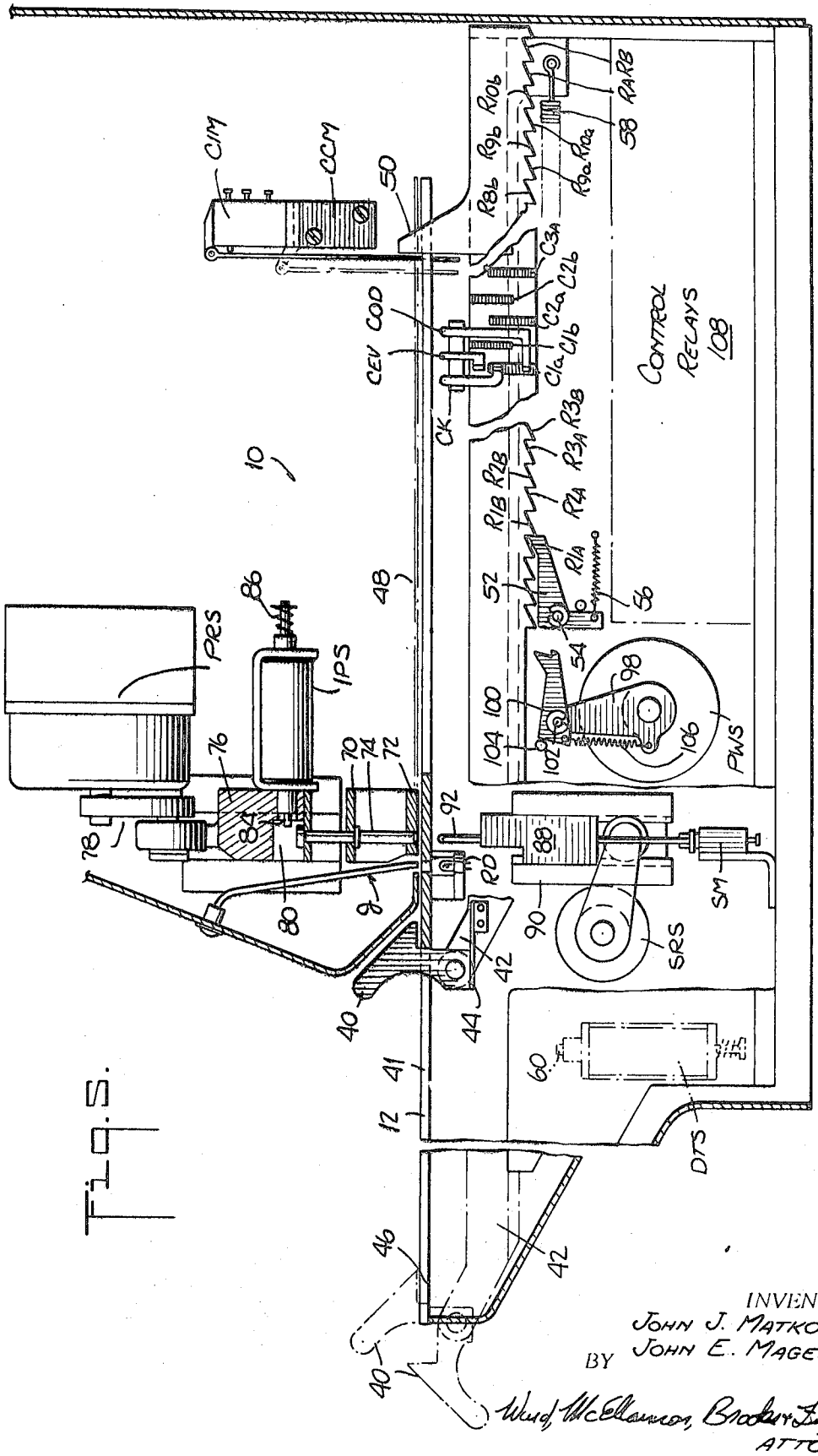
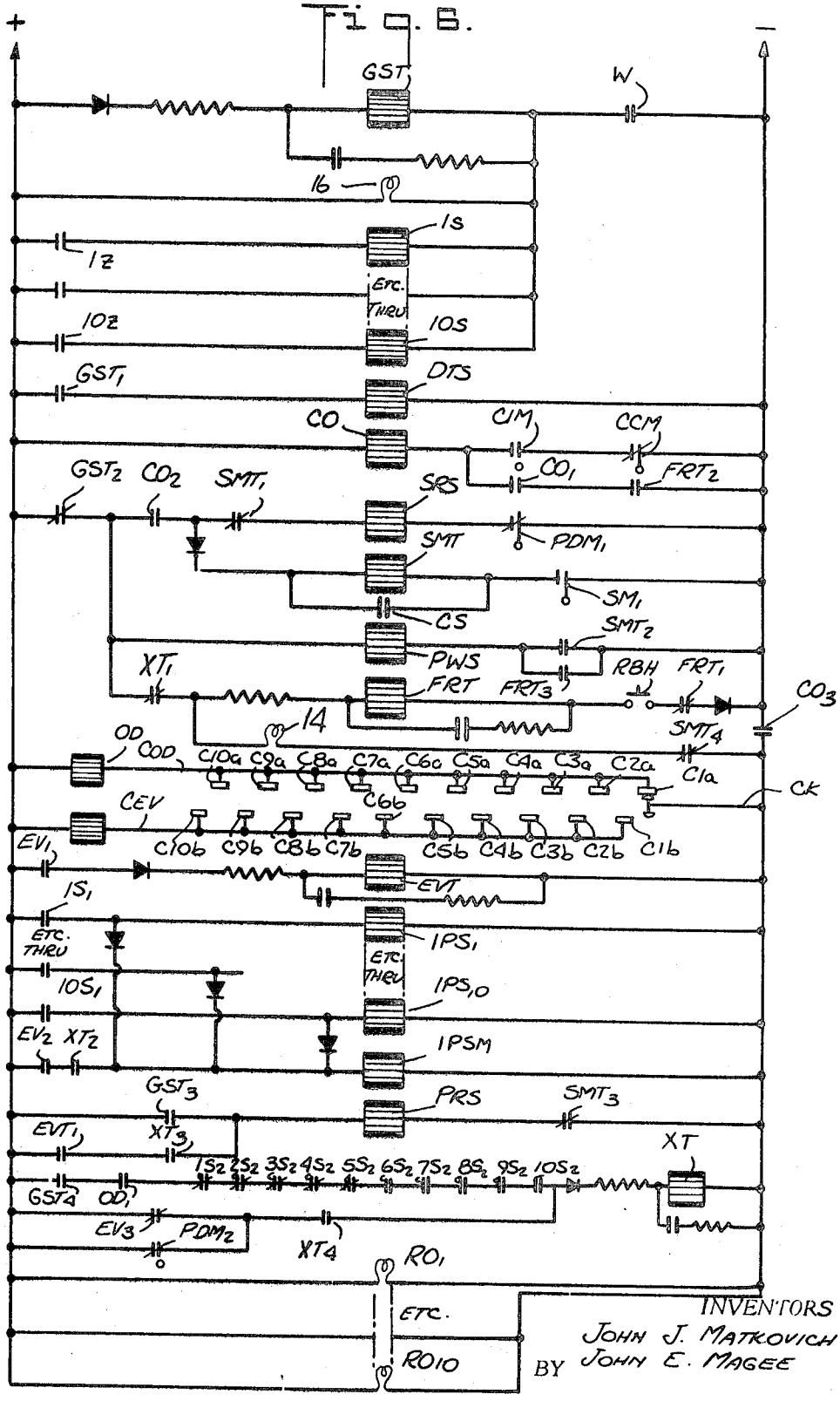


FIG. 5

INVENTORS
JOHN J. MATKOVICH
JOHN E. MAGEE
BY
Ward, McElhannon, Brooks & Fitzpatrick
ATTORNEYS

Fig. 6.



INVENTORS
JOHN J. MATKOVICH
BY JOHN E. MAGEE

Ward, McElhannon, Brooks & Fitzpatrick
ATTORNEYS

METHOD AND APPARATUS FOR RECORDING POSITIONAL STATUS OF BOWLING PINS

This invention relates to a bowling scoring method, recorder and scorecard 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 scorekeeping. 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 of 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 scorecard 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 an aspect of the present invention, the recorder constructed in accordance with the present invention includes means for defining a recording area where the scorecard 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 scorecard 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 scorecard 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 scorecard 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 scorecard 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 scorecard 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 scorecard 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 scorecard every time all of the bowling pins have been knocked down thereby providing a separate record on the scorecard 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 basis 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 scorecard 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 scorecard 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 scorecard (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 scorecard 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 scorecard 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 scorecard, 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 scorecard **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 scorecard **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 scorecard **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 scorecard **20** and is premarked with indicia "X" and " " representing strikes and spares, respectively, the strikes indicia being preprinted at all odd columns corresponding to first half frames of the bowling game, and the spare indicia being preprinted at all even columns corresponding to the second half frame 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 scorecard 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 scorecard 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, $R10_b$, $R10_a$ 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 scorecard **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 scorecard. 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 guide **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 scorecard **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. **74***a*, **74***b*, 74_1, 74_2...74_{10}, are utilized in the preferred embodiment. The end punch **74***a* functions to provide an index mark every half frame of the bowling game while the other end punch **74***b* functions to provide a perforating mark to eliminate the preprinted spare and strike indicia provided in the card **20** described above. The remaining punches 74_1...74_{10} are arranged to coincide with the rows **24** defined on the scorecard **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 74_1...74_{10} and **74***b*. On the other hand, the recess **80** is arranged, as at **82**, so that the punch head **76** when depressed always moves the punch **74***a* downward through the perforated plates **64** and **72**. As best shown in FIG. **5**, pin interposers **84** are provided adjacent punches 74_1...74_{10} and **74***b*, and are arranged to project into the recess **80** of the punch head **76** upon actuation of operatively connected solenoids IPS_1...IPS_{10} and IPS_m, 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 interposing 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 scorecard **20** to sense for the presence of indexing marks provided by the punch **74***a*. If no index mark is present, the sensing pin **92** urges against the rear surface of the scorecard under the bias provided by spring **94** included within 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** pivotally 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 C1*a*, C1*b*...C10*a* and C10*b* are staggeredly 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, C1*a*, C1*b*...C10*b*; and in addition, two other contacts, CEV and COD, are arranged to alternately contact the aforementioned contacts C1*a*, C1*b*...C10*b* provided on the carriage 42. Specifically, the contact CEV is arranged to contact all even contacts, i.e. C1*b*, C2*b*, etc. and the contact COD is arranged to contact all odd contacts on the carriage 42, i.e. C1*a*, C2*a*, 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 respective ones of 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 412*d* in the above-mentioned Millman et al. patent (FIG. 6); and the closed status of contacts 1z through 10z may correspond to the operational status of indicator lights 1–10 shown in FIG. 6 of the Millman et al. reference.

In operation, the scorecard 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 scorecard 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 scorecard orientation is proper, i.e., proper end forward and proper face upward, the uncut corner thereof will actuate the CIM 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 CIM and CCM permits operation of relay CO which becomes self-holding by the operation of its contact CO_1 until subsequent manually initiated release by the operation of the button RBH. The operation of relay CO closes contacts CO_2 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 scorecard. In addition, the operation of relay CO closes contacts CO_3 and permits green light 14 (FIG. 6 and FIG. 1) to indicate readiness to bowl. At this time, since contacts CO_3 are closed, the operation of relay OD is carried out through the connection of commutator contacts CK to COD through the contact C1*a* provided on the carriage 42.

Assuming that as a result of the initial ball rolled, all of 10 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, 1S through 10S, thereupon operate and, in turn, each causes, through the closure of related contacts S_1, operation of its counterpart IPS pin interposer solenoid, IPS_1 through IPS_{10} (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 $1S_1$...$10S_1$ also permits the actuation of mark interposer solenoid IPS_M (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 GST_2 thereby open to release sensing solenoid SRS (FIGS. 4 and 5) dropping the sensing yoke 88 away from the scorecard 20, and retracting the sensing pin 92 therewith. Also, the actuation of relay GST closes its contacts GST_3 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 10 pin punches 74_1...74_{10} to penetrate the scorecard at its first half of first frame column (FIG. 2).

Upon termination of the input signals (after about 5 seconds), each of contacts W and Z open, and each of related relays $1S_1$ through $10S_1$ 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 GST_2 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 scorecard, thus permitting the far end of the sensing pin to actuate the snap action switch SM (FIGS. 4 and 5). As shown in FIG. 6, the contacts SM_1 of the switch SM cause actuation of relay SMT, which is delayed in its release by capacitor CS. Upon actuation of relay SMT, contacts SMT_1 open to deenergize solenoid SRS and drop the sensing pin 92 away from the

scorecard thus opening relay contacts SM again. Also, upon actuation of relay SMT, contacts SMT_2 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, as described above.

Upon release of the relay SMT, followed 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 $C1_b$ 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 SMT_1 to again energize sensing solenoid SRS to raise the sensing yoke **88** and sensing pin **92** to contact the repositioned scorecard. Since no indexing hole exists in the scorecard 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, the mark interposer solenoid IPS_M, 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 preprinted spare symbol of the scorecard 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 permits full travel of the sensing pin **92** to again initiate the next step of escapement of the carriage **42** moving the scorecard 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 $C1_B$ to $C2_A$, 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 scorecard and the preprinted strike symbol in the last row of the card would remain unpunched. Additionally, upon operation of relay OD, OD_1 contacts (FIG. 6) are closed and all S_2 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 XT_4 to remember the strike. Following punch release and sensing pin action in the manner described above, the carriage **42** is moved to place the scorecard 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 XT_2 and EV_2 permit mark interposer, IPSM, to be energized. In addition, with contacts XT_3 closed, the closing of contacts EVT_1 permits operation of the punch solenoid PRS independent of the status of contacts GST_3. Accordingly, card-punching operation will occur for the index hole and the mark hole only, the latter to eliminate the preprinted spare symbol which is not here applicable. Thus, the circuit arrangement of FIG. 6 automatically shifts the scorecard 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 PDM is actuated (FIG. 4) and contacts PDM_2 are opened. The opening of these contacts interrupts the XT holding circuit as contacts EV_3 are already opened. Upon timed release of XT, punch solenoid PRS and mark interposer solenoid IPS_M are released. This action releases switch PDM and causes contacts PDM_1 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 nonpertinent spare symbol, and that this is followed by advance of the carriage and scorecard to the first half of the frame following that to which a strike is made. If, however, a strike occurs in the b 10th 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 scorecard 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_1, 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 held 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 FRT_1 contacts. Initial operation, with FRT_2 contacts open, interrupts the CO relay sustaining circuit thus isolating all circuits associated with punching action by reason of the CO_3 contacts being open; and since contacts FRT_3 are closed, the carriage indexing pawl **100** is operated by the solenoid PWS. As the relay FRT continues to alternately complete 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 CO_2 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 scorecard 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 scorecard 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 CO_3 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 scorecard and selectively optically coupled via light guides *g* to the windows **18** through the punched holes of the last frame.

An inspection of the scorecard 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 scorecard (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. A method of automatically scoring a bowling game in which there are successive rolls of a ball and the positional status of the pins is dependent upon the pins struck by the ball comprising providing electrical signals indicating the rolling of a ball and indicating the positional status of each of the various bowling pins after each roll of the ball, marking a record after each roll of the ball in response to said signals to indicate both the positional status of each of the pins after each roll of the ball and the rolling of a ball, said record having space thereon for receiving markings for a plurality of rolls of the ball, and changing the position at which the same record is marked after each roll of said ball in response to said signals to provide and retain a cumulative record of the status of each of said pins after each roll of the ball whereby said record is a qualitative record of the positional status of said pins and indicates the score of the game.

2. A method of automatically scoring a bowling game as in claim 1 wherein said electrical signals indicate the specific bowling pins left standing after the roll of the bowling ball.

3. Apparatus for automatically qualitatively scoring a bowling game in which there are successive rolls of a ball and the positional status of the pins is dependent upon the pins struck by the ball comprising input means for coupling electrical signals indicating the rolling of a ball and indicating the positional status of each of the various bowling pins after each roll of the ball, recording means for marking a record in response to said signals to indicate both the positional status of each of the pins after each roll of the ball and the rolling of a ball, to provide and retain a record of the status of each of said pins after each roll of the ball, said record having space thereon for receiving markings for a plurality of rolls of the ball, and control means responsive to said signals for changing the position at which said record is marked after each roll of said ball.

4. Apparatus for automatically scoring a bowling game on a single record blank comprising means in said apparatus defining a recording area for marking said blank, positioning means for placing said blank in said recording area, input means for coupling electrical signals indicating the positional status of each of the various bowling pins after the roll of the bowling ball and indicating the rolling of a ball, recording means arranged in said recording area for marking said blank in response to said signals to provide a record of the status of each of said pins nd to provide a record of the rolling of the ball, and control means responsive to said signals for changing the relative positional relationship between said recording means and said blank after each roll of the bowling ball whereby said scoring apparatus provides a qualitative record of the status of the pins during the game and indicates the quantitive score of the game.

5. Apparatus for automatically scoring a bowling game as in claim 4 wherein said recording means includes perforating means for punching said blank to provide a perforated record of the positional status of each pin after the roll of the ball.

6. Apparatus for automatically scoring a bowling game as in claim 4 wherein said recording means includes means for marking said blank in indicia readable by automatic data processing machinery.

7. Apparatus for automatically scoring a bowling game as in claim 4 wherein said positioning means includes a carriage for carrying said blank in said recording area and wherein said control means includes means for shifting said carriage relative to said recording means after each roll of the bowling ball.

8. Apparatus for automatically scoring a bowling game as in claim 4 wherein said recording means includes means for marking said blanks when all of said pins have the same predetermined positional status thereby providing a separate record indicating the strikes and spares made during the game.

9. Apparatus for automatically scoring a bowling game as in claim 4 wherein said apparatus includes means responsive to said input signals for detecting the occurrence of game strikes, said last-named means being coupled to said control means and arranged to actuate same.

10. Apparatus for automatically scoring a bowling game on a record blank comprising means defining a recording area in said apparatus for marking said blank, positioning means for placing said blank in said area for recording the first half frame of said game, input means for coupling electrical signals indicating the positional status of the various bowling pins after the roll of the bowling ball, recording means for marking said blank in response to said signals to provide a record of the status of each of said pins, said recording means also including indexing means for providing said record with an index mark and control means responsive to the presence of an index mark within said recording area for changing the relative positional relationship between said recording means and said blank so that said blank is relatively positioned in said recording area for sensing and recording of the succeeding half frame.

11. Apparatus for automatically scoring a bowling game as in claim 10 wherein said apparatus includes circuit means responsive to said input signals for detecting the occurrence of game strikes, said last-named means automatically operating said control means to change the positional relationship between said recording means and said blank to that corresponding to the first half of the next succeeding frame.

12. Apparatus for automatically scoring a bowling game as in claim 11 wherein said circuit means is coupled to said recording means for actuating same to automatically mark said blank with an index in the next successive half frame whereby said control means sequentially changes the relative position between said recording means and said blank to that corresponding to the first half of the next succeeding frame.

13. Apparatus for automatically scoring a bowling game as in claim 10 wherein said recording means includes means for marking said blank with perforations.

14. Apparatus for automatically scoring a bowling game as in claim 10 wherein said recording means includes means for marking said blank in indicia readable by an automatic data processing machinery.

15. Apparatus for automatically scoring a bowling game in claim 10 wherein said positioning means includes a carriage for carrying said blank to said recording area and wherein said control means includes means for shifting said carriage relative to said recording means after each roll of said bowling ball.

16. Apparatus for automatically scoring a bowling game as in claim 10 wherein said recording means includes means for marking said blank when all of said pins have the same predetermined positional status thereby providing a separate record indicating the strikes and spares made during the game.