BOWLING SCORING DEVICE
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This invention relates to a bowling scoring device capable of duplicating the various mental and manual steps involved in bowling score-keeping.

The development of bowling equipment has accomplished a significant advance in pin and ball handling equipment and in score sensing and indicating equipment but has not as yet solved the problems of score tabulating. While numerous devices are available for independently totaling, storing and printing bowling scores, the cost and size of such units to perform these functions is commercially prohibitive. Consequently, the automation of bowling is presently limited to the aspects of pin spotting and indicating with the record of bowling scores being accomplished as it has been for the past several decades.

Accordingly, it is one object of the present invention to provide a bowling scoring device capable of automatically displaying, totaling and printing the frame-by-frame and line-by-line bowling score in a manner compatible with existing practice and equipment.

It is a further object of invention to provide a bowling scoring device operable by a minimum number of driving signals.

It is another object of invention to provide a single bowling scoring computer of simple, compact and inexpensive construction.

Objects and attainments of the present invention will become apparent to those skilled in the art upon a reading of the following detailed description when taken in conjunction with the drawings in which there is shown and described an illustrative embodiment of the invention; it is to be understood, however, that this embodiment is not intended to be exhaustive nor limiting of the invention but is given for purposes of illustration in order that others skilled in the art may fully understand the invention and the principles thereof and the manner of applying it in practical use so that they may modify it in various forms, each as may be best suited to the conditions of a particular use.

The foregoing objects of the present invention are accomplished through the use of the combination and physical arrangement of simple counter units having raised numerals. Numbers of these units may be selectively coupled, driven and decoded to count-totize, visually display and, by a common printing mechanism, permanently record bowling scores.

In the drawings:
FIGURE 1 is a perspective of an exemplary form of the assembly of the invention.
FIGURE 2 is an elevation of the assembly of FIGURE 1 taken along lines 2—2.
FIGURE 3 is a time-sequence diagram of the scores occurring during a typical line of bowling play included to further an understanding of the operation of the invention.
FIGURE 4 is a schematic diagram of electrical and mechanical connections of the apparatus of the invention.
FIGURE 5 is an elevation of the control linkages of one of the counter units employed in the invention apparatus.
FIGURE 6 is a top fragmentary view of the structure of FIGURE 5.

Referring generally to FIGURE 1, a bowling scoring unit is shown resembling in size and shape a desk calculator. It is contemplated that one such unit may be placed in a position convenient to each two adjacent alleys directly behind the player bowling position. Each unit may be shared by the parties of adjacent alleys during individual play and by two teams during team play. It is to be understood that limited player devices are feasible by merely abbreviating the structure shown herein.

With a view to achieving the objective of presenting a scoring record similar to that presently accomplished by bowler tabulated scores penciled upon scoring sheets, the assembly of the invention contemplates the use of individual or team scoring sheets wherein player or team identification may be written in along the left portion followed by lines of frame blocks including mark squares. The face of the assembly of the invention, as indicated in FIGURE 1, includes player identification slots adjacent to frame slots carrying counter wheels capable of depicting the frame scores in a manner similar to that of the commonly used scoring pad. Following completion of bowling play the individual and team scores carried by the counters of the unit may be printed to form a permanent record comparable to the score sheet presently sanctioned by bowling regulations.

Referring more particularly to FIGURE 1, there is included a housing 20 connected by a cable 22 in turn connected to a suitable power source and to ball and pin scoring equipment located in the alley pit area. A variety of physical arrangements of the unit of FIGURE 1 are possible, but the arrangement included is preferred for the reason that it is similar in visual appearance to present bowling score sheets. The housing 20 includes a face 24 defining player identification slots 26, team identification slots 28, line slots 30 and team total slots 32. Within each line slot are ten frame slots 34 for framing one through ten and a separate player or line total slot 36; the latter being optional. Included further on the housing face 24 are various controls, here shown as buttons. The control 38 represents an override control included to permit individual line selection by buttons 46, adjacent each line, in the event that a player should pass his turn or, for any other reason that might cause a deviation from standard sequence of play. The controls 41 represent alley selectors and are provided so that pin fall signals from equipment in the pit area may be routed to the proper counter during normal play, which, as is known, alternates from alley to alley consecutively during team play. Element 42 represents a reset control which is operable to reset all counters to zero following completion of a game.

Included in FIGURE 1 but not critical to an understanding of the present invention are frame cover members 43 which cover the face of each frame counter prior to the time a given frame is played. Cover members 43 may be sequentially opened by a common solenoid having individual cam members for each frame cover and operated by frame signals.

Located at a convenient position at the bottom of the unit 20 is a print control knob 44 which may be manually operated to cause the frame and total scores registered on the counters of the unit to be printed. The embodiment shown here contemplates a narrow diameter roller connected to the arm 46 and arranged to be driven across and beneath the housing face 24 covering an area defined by the points X—X and Y—Y shown therein. The roller may be mounted at each end in guide members (not shown) running parallel to the control knob slot 48 and disposed at the bottom and top of unit 20 beneath and parallel to face 24.

FIGURES 2—2B clarify the printing mechanism contemplated by the invention. In FIGURE 2, a score sheet
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3. guide member 50 is secured to the unit 20 and includes slots 52 and 54 of a width such that single or team play scoring sheets extend the full width of the slots and individual or non-team play sheets extend approximately a half slot width. Guide members 58 are provided including an upper member slotted at each player identification slot and a lower member, both extending into slots 52 and 54. In the normal sequence of operation a scoring sheet 56 is inserted in slot 54 as indicated in FIGURE 2A. The scoring sheet by reason of the upper plate of member 58 will be guided beneath the counter mechanism 60 leaving a portion disposed beneath the slots 26–28 as modulated in FIGURE 1. Player and team identification may be written upon the sheet through the slots 26–28.

Upon completion of play, the scoring sheet 56 may be withdrawn and inserted in slot 52 to assume the position shown in FIGURE 2B in contact with the counter mechanism 60. Operation of knob 44 will draw roller 62 across the face of the scoring sheet, pressing the sheet against raised numerals on each column, thereby printing the scores registered thereon. By employing National Cash Register print-through paper, the counter numerals thereby printed will appear on the score sheet in the proper sense. The resulting printed record will be similar in appearance to the present penciled record.

Prior to the counter mechanism of the invention, a brief discussion of the method of scoring control will be given relative to the time-sequence diagram shown in FIGURE 3. As is well understood, the actual score written in any one frame is accomplished at three possible times, namely, at the end of a frame if less than a spare or strike is obtained, following the first ball of the next frame if a spare is obtained and following the next two balls if a strike is obtained in the frame under consideration. On a frame basis, the score for a given frame (consider frame No. 1) must be written by at least the frame after the next frame (at the end of frame No. 3) if the maximum effect of three consecutive strikes is obtained. On a ball basis, the score for a given frame must be written following at least the second consecutive ball after the initial ball of the given frame, considering the maximum effect of a single strike. Following a spare in any given frame, the score for the given frame is written following the first ball after the given frame. Following a "no-mark" (the lack of a strike or spare), the score is written at the end of the frame.

The reason for the foregoing is that the score for a frame wherein a strike is obtained is modified by the scores achieved by the next two balls. A "spare" frame is obtained from the score from the next ball and a "no-mark" frame is not modified by succeeding ball scores. As will be apparent from the description relative to FIGURE 3, the time of writing scores may be related to the number of balls, the frame number and the existence of strike, spare and no-mark. Furthermore, the addition and multiplication necessary to achieve a proper score for each frame may be related to the time of writing scores.

The present invention utilizes the foregoing events to selectively drive and decouple individual counters for each frame and to selectively cause counters to, in certain instances, double or triple the pin count in a succeeding frame to perform the necessary addition and multiplication for proper scoring.

A brief explanation of the above mentioned incidents relative to a typical line of bowling as shown in FIGURE 3, is included to further an understanding of the invention. Following a "no-mark" as in frame No. 1, the next two balls modify the score by an amount equal to the actual pin fall count; i.e. 9 + 9 = 18, 18 + 1 = 19. Following a single mark (strike or spare), the score in the mark frame is entitled to be modified by adding the pin fall count of the next fall of the next frame; i.e. 19 + 10 = 29. At the same time, due to the occurrence of the mark, the pin fall count occurring is added to the score of the preceding frame to establish the score of the succeeding frame; i.e. 29 + 10 = 39. The effect of this is that the score of frame No. 2 is modified by the addition of the pin fall count in frame No. 3 multiplied by one, the score of frame No. 3 is modified by the addition of the resultant to the pin fall count multiplied by two; i.e. the score of frame No. 4 becomes 19 + 10 × 2 = 39 and the score of frame No. 5 becomes 19 + 10 × 2 × 2 = 39. Following the scoring in this manner finds score of frame No. 3 being modified by the strike in frame No. 4 and the first ball of frame No. 5 to the effect of 39 + 10 and 49 + 9 = 58. The score of frame No. 4 at the same time is modified to the effect of 58 + $10 × 2 + 49 + 9 × 2 = 77$. It will be noted that the score of frame No. 5 during this time is 39 + 10 × 2 = 59 and 59 + $9 × 3 = 86$. The occurrence of two consecutive strikes enables frame No. 5 to, in effect, receive the benefits of its first ball pin fall count three times. Since the modification to which a frame may be entitled is either zero, the score from the next ball or the score from the next two balls, the multiplier used above is limited to one, two or three, respectively, no-mark, spare or strike.

In FIGURE 3, the horizontal portions of line 82 define the point in time wherein the score of a given frame becomes final and fixed. The occurrence of a frame if the no-mark situation occurs and following the next ball or two balls if a mark situation occurs.

In prior practice, it is at this time that a frame score is written. With the present invention it is at this time that a counter is decoupled from the pin counting mechanism. To achieve this the present invention includes a counter mechanism for each frame of a given line capable of multiplying the actual pin count by one, two or three and capable of being coupled and decoupled from a common driving means.

FIGURE 4 shows the drive and control mechanism of the invention. The assembly 90 represents ten counter units F1–F10 provided for each of the ten lines of unit 20. Each assembly 90 is provided with a common digit drive 92, a common digit pull mechanism 94 and a decouple mechanism 96 suitably linked by drive connections 98, 100 and 102 which may be gear operated push rods suitably geared to perform the desired function. Unit 92 comprises a single solenoid capable of mechanically impulse rotary drive 98 responsive to each electrical impulse with a spring enforced return. Unit 94 is a double driving coil solenoid capable of stepping the connection 100 forward or backward to one of three physical positions responsive to the other driving coil. Unit 94 may thereby set each counter to effectively multiply the actual count by one, two or three. As indicated the driving coils of unit 94 are connected to step up or add one responsive to operation of either the spare or the strike relay and to step back or subtract one responsive to the operation of unit 96.

The decoupling mechanism 96 is similarly a double driving coil solenoid modified to drive connection 102 forward only in ten steps to sequentially decouple frame counter units F1–F10 by reason of the staggered position of decouple arms 104 relative to each counter unit. The unit 96 includes a first arm driven forward to actuate 102 through the ten steps responsive to energization of one solenoid driving coil which is in turn actuated by a second arm driven by a second driving coil responsive to the no-mark, strike and spare relays 110, 112 and 114. The two arms are linked mechanically so that upon operation of the no-mark relay the decouple device decouples one frame counter and upon operation of the spare or strike relay the decouple device decouples one counter after the next one or two balls respectively.

The units 110, 112 and 114 comprise relays responsive to sensing equipment in the pit area to impulse the digit pull mechanism 94 and the decouple device 96. The
output of units 112 and 114 is fed through pulse multiplying units 116 and 118 which may comprise a solenoid and operated plunger arranged to sequentially close two and three contacts respectively to provide two and three pulses to the step back portion of unit 96. In this manner, the decoder mechanism may be controlled to delay for a period of one or two balls before operating to decouple a counter. This achieves the score modification due a given frame following a spare or strike as heretofore described.

The unit 122 represents a multiposition relay capable of closing circuit paths between the units 110, 112 and 114 and a solenoid drive connected to the mark wheels M, 124, of each counter unit FI-F10. Unit 122 is driven by frame signals from frame relay 120 in turn driven by sensing equipment in the pit area. Following a sequence of ten frames, a terminal signal will drive the unit 122 to a position that automatically resetting the unit to the normal position N as indicated. The circuit conductors between elements are to be considered as exemplary of signal paths, it being understood that suitable separate leads or circuit elements would be employed in any case wherein one path appears to be capable of driving a second device beyond the desired function explained herein.

Figure 90 of FIGURE 4 includes ten counter units F1-F10 exemplified by the structure shown in FIGURES 5 and 6. Each of the counters and associated linkages may be commonly mounted from a single bracket secured to the casing of the unit 20. The possible scores for each frame being limited to a maximum of 30, 60, 90 etc. permits the use of only units and tens wheels for frame 1-3 and units, tens and hundreds wheels for frames 4-10 and total. It is also possible to effect further die and material savings by providing only those digits necessary for the particular frame score for each counter frame. For example, the tens wheel for frame No. 1 need only have numerals 0, 1, 2 and 3 since the maximum score is 30. Similarly, the hundreds wheel of frame No. 4 need only have numerals 0 and 1 since the maximum score is 120. It is contemplated that a standard counter mechanism may be employed with the usual drive from an input gear to the unit wheel which in turn drives the tens wheel once for each ten units; the tens wheel similarly driving the hundreds wheel. It is contemplated that each counter will be provided with an automatic reset accomplished by a suitable connection with the common reset control on the face of the unit 20.

Coupled by a common linkage including an arm 130 having individual fingers 132 mounted to actuate the counter mechanism 134 by rotary movement as shown in FIGURES 5 and 6. The mechanism 134 includes an arm 136 having a normal position as indicated in FIGURE 5, maintained by a spring 138 mounted for arcuate movement about the shaft 140. At the free end of arm 136 is attached a pawl member 142 secured by a pin 144 and driven inwardly by a second spring 146 about the pin 144. The actuation of the digit drive 92 serves to operate each pawl mechanism of each counter responsive to each pin fall pulse through a mechanical linkage including arms 130 and 132, pin 144 and pawl member 142. After each rotary movement the digit drive mechanism and the pawl member return to the normal position shown in FIGURES 4 and 5. The mechanism 134 also returns to the normal position in the action of the member 136 under the force of spring 138. Suitable stop means (not shown) limit the movement of the pawl member 142 to the arc "a"-"c" as shown in FIGURE 5.

Also disposed on shaft 140 is a shudder member 150 shown in FIGURES 5 and 6 having a portion 152 disposed between the pawl member 142 and counter input gear 154 and a further portion 156 linked to the mark wheel 172. The shudder member 150 is driven by spring 158 in an arcuate movement and is held against such movement by teeth 158 disposed on the outer surface of the member in cooperation with gear 169 in turn held by movement against gear 162, their respective shafts 164 and 166 and the gear member 168. Rotation of shaft 166 drives gear 160 to effectively set the shutter 150 in any of the positions "a", "b", or "c". Withdrawal of gear 160 by operation of the decoupling device 96 through linkage 102 releases the shutter 150 which, by reason of spring 156, moves to position "d". In position "d" operation of the gear drive will not operate the counter because the pawl member 142 will ride over the shutter surface 152 and will not engage the teeth of gear 154.

The settings "a", "b", and "c" of the shutter 150 will effectively cause pawl member 142 to engage 3, 2 and 1 gear teeth respectively to input 3, 2 and 1 digits into the counter for each movement of arm 132. In this manner, the digit multiplication heretofore discussed is accomplished by each counter according to the setting of the digit pull mechanism 94 through linkage 100, shaft 166 and gears 160. Individual counter decoupling is accomplished by operation of arm 104 to withdraw gear 160, releasing shutter 150 to a position "d". The spring member 170 should be of sufficient strength as to maintain the gear 160 in cooperative contact with teeth 158 against the force of gear 166 but not against the force of 104.

Associated with each counter mechanism is a mark wheel assembly having a wheel 172 including the symbols for no-mark 171, spare 173, and strike 175. The mark wheel symbols as well as the numerals on the counter wheels are raised as indicated to effect the printing operation as heretofore described. Each mark wheel assembly includes a self-fatching three position solenoid (not shown) capable of rotating wheel 172 in two distinct steps to a position wherein the spare and strike symbols may be viewed through slots 34 as described relative to FIG. 1. In the event of a no-mark in a given frame, the mark wheel solenoid will not be pulsed and the no-mark symbol will be displayed. Following a spare or a strike the mark wheel solenoid will drive wheel 172 to the appropriate position responsive to an input from relays 112 or 114 via units 116 or 118 and unit 122 over loads 123. As shown in FIG. 5 the shudder member 150 includes a portion 175 having three resiliently mounted pawl members 176. Upon rotation of wheel 172 to either the spare or strike position one of the pawl members 176 will engage teeth 180 of gear 174 and the shutter will thereby become locked against further clockwise movement. Gear 174 includes a relieved portion 182 permitting rotation of shutter 150 prior to operation of the mark wheel. In the counter digit multiplication may be accomplished in all counters except the counters registering completed frames. In the event that a no-mark is obtained, the counter will be decoupled and therefore the counter will not need to be blocked against shudder movement. On the other hand, when 150 is locked in spare and strike cases, it will operate through 178 to block the shutter teeth 158 and will lock gear 162 and gear 160. To permit all other counters to be set the gear 162 is provided with a simple overload release clutch mechanism including a spring member 167 secured to shaft 166 and resiliently linked to gear 160 by stops 169. The spring 167 will upon application of a given force depress to permit shaft 166 to turn while gear 162 is locked but upon application of lesser forces will coact with stops 169 to drive gear 162 against the force exerted by members 160 and 150 during non-blocked operation.

The foregoing structure permits the selective multiplication of pin fall pulses by one, two or three by a common drive with each counter of a frame scoring a mark blocked from increasing its multiplier.

In order to further explain the operation of the invention, the above described circuit and mechanism will
be described relative to the scoring procedure shown in FIGURE 3. Prior to the first ball of the first frame the counters of assembly 90 are each set to indicate zero; the unit 94 is set on position “1” and the units 96 and 122 are set on position “N.” Each counter shutter 150 is positioned on “c” to cause each counter to register one for each operation of the digit drive device 92. As per FIGURE 3, the first ball scores 9 and each of the counters F1–F10 are impulsed 9 times to each register 9. As heretofore indicated, the covers 43 will remain closed over all counters except that of frame No. 1 which will be opened. The second ball of frame No. 1 scores a zero which leaves counters F1–F10 in the same position as at the end of the first ball. The next two balls drive counters F2–F10 to 18 and then to 19 responsive to nine and one input pulses respectively. A spare being scored in frame No. 2 entitles frame No. 2 to the score of the next ball. To accomplish this, unit 120 operates unit 122 to position 2 thereby connecting the output of relay 112 to drive the mark wheel solenoid of frame No. 2 to register a spare and at the same time operate the blocking arm 178 to prevent the counter of frame No. 2 from registering additional impulses. A second output from relay 112 acts to thereafter operate the step-up portion of unit 94 to set each of the counters F3–F10 to the position “b” and, via pulsing device 116 delay the decoupling mechanism 96 from operating until after the next ball. At this point counter F1 registers 9 and is decoupled, counters F2–F10 register 19 and are coupled. The next ball, the ball of frame No. 3, scores a strike driving counters F1–F10 to 39. Operation of the strike relay 114 via unit 122 operates the arm 178 of counter No. 3 to block the shutter 150 from adding digits and operates the digit pull unit 94 to set the shutters of counters No. 4–10 to multiply each succeeding count by three. The counter of frame No. 2 is then decoupled by unit 96, providing an output to unit 94, stepping each of the counters back one; counter F3 thereafter multiplying the count by one, counter F4–F10 multiplying the count by two. The next ball, the ball of frame No. 4, registers another strike to operate in the above fashion to step counter F3 to 49 and counters F4–F10 to 59. The first ball of frame No. 5 steps counter F4 to 58, counter F5 to 77 and counters F6–F10 to 86 since the digit control following the strikes of frames No. 3 and No. 4 left the counters F3, F4 and F5 set to multiply the count by one, two and three digits. In this manner the counters of the assembly are driven to register the frame by frame scores of a given line of bowling. Upon the conclusion of the last line to be bowled in a given game the scores registered on each frame counter may be printed as heretofore described. Following printing each counter may be reset either electrically by an automatic reset of the type present in a number of commercially available counters or by any suitable mechanical means. The mark wheels may be reset by providing a current of reverse polarity to each mark wheel solenoid. Reset of the counter shutters may thereafter be accomplished by a common reset solenoid connected to rotate each shutter to position “c.” Release of the decoupling mechanism will then permit all gears 162 to reengage the teeth of each shutter mechanism thereby locking each shutter in the proper position.

1. A bowling scoring device including a housing carrying lines of counter assemblies; each assembly including a counter mechanism for each frame of a line, a counter drive means and a counter control means common to each counter mechanism; each counter mechanism including means responsive to said drive means to register frame scores and means responsive to said drive means and means responsive thereto for blocking the effect of said drive means in accordance with successive frame scores; each counter mechanism further including means for registering frame marks and means responsive thereto for blocking the effect of said control means to modify said drive means; each of the means for registering frame scores and marks including raised symbols aligned in a common plane at their point of registration; a printing means including a guide member for guiding a score sheet into contact with said raised symbols in said plane and roller means operable to press a score sheet against said symbols to print scores and marks registered thereon.

2. A bowling scoring device including arrays of frame scores and mark indicators; digit input means connected to drive said score indicators responsive to impulses representative of pins downed in a given frame; control means connected to said score indicators to increase or decrease by multiplication the inputs thereto in accordance with scoring incidents; blocking means linking each score indicator and each mark indicator and operable to block said control means from increasing inputs to said score indicators; decoupling means operable to release a portion of said control means to effect a block of inputs to said score indicators following scoring in corresponding frames; said decoupling means including means responsive to the occurrence of a mark in a given frame to effectively delay operation of said decoupling means to permit score indicators to receive inputs occurring in succeeding frames.

3. A bowling scoring device including a plurality of line assemblies each having a frame unit operable to register and display individual frame scores and each assembly including a digit drive linked to each frame unit for supplying impulses representative of downed pins, a digit control unit operable to increase or decrease the effect of said digit drive impulses to each frame unit responsive to the occurrence of frames and scores per frame and a decoupling unit operable to sequentially block each frame unit from responding to said digit drive impulses following scoring for a given frame; each frame unit including a digit and a mark counter, the digit counter including a digit pawl responsive to said digit drive, and a shutter responsive to said digit control unit capable of regulating the effect of said pawl in driving said digit counter, the said shutter including a portion linking said mark counter so as to lock against increasing the effect of said digit drive impulses responsive to the occurrence of a mark.

4. A bowling scoring device including in combination a housing having a face plate having at least one player aperture and one line of frame apertures, means disposed within the housing for registering bowling scores for each said frame aperture including means aligned with the frame apertures for displaying scores so registered, and means for driving a score sheet against the means for displaying scores to effectively print scores registered thereon, and means disposed within the housing having sheet guide members capable of guiding scoring sheets in either a first path beneath player apertures and beneath
the registering means or in a second path into contact with the score displaying means.

5. A bowling scoring device including in combination a housing having a face plate having at least one player aperture and one line of frame apertures, means disposed within the housing for registering bowling scores for each said frame aperture including means aligned with the frame apertures for displaying scores so registered, and means for driving a score sheet against the means for displaying scores to effectively print scores registered thereon, the said driving means comprising a roller supported in the housing for transverse movement across the face of the displaying means.

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