

Feb. 6, 1962

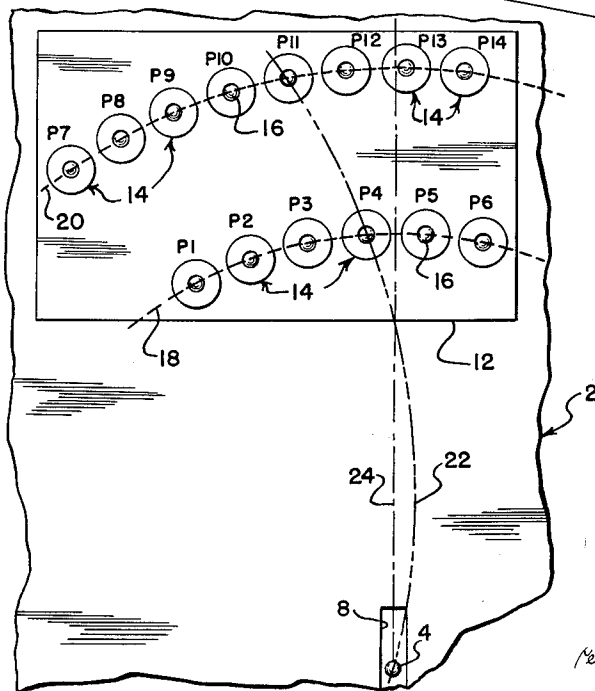
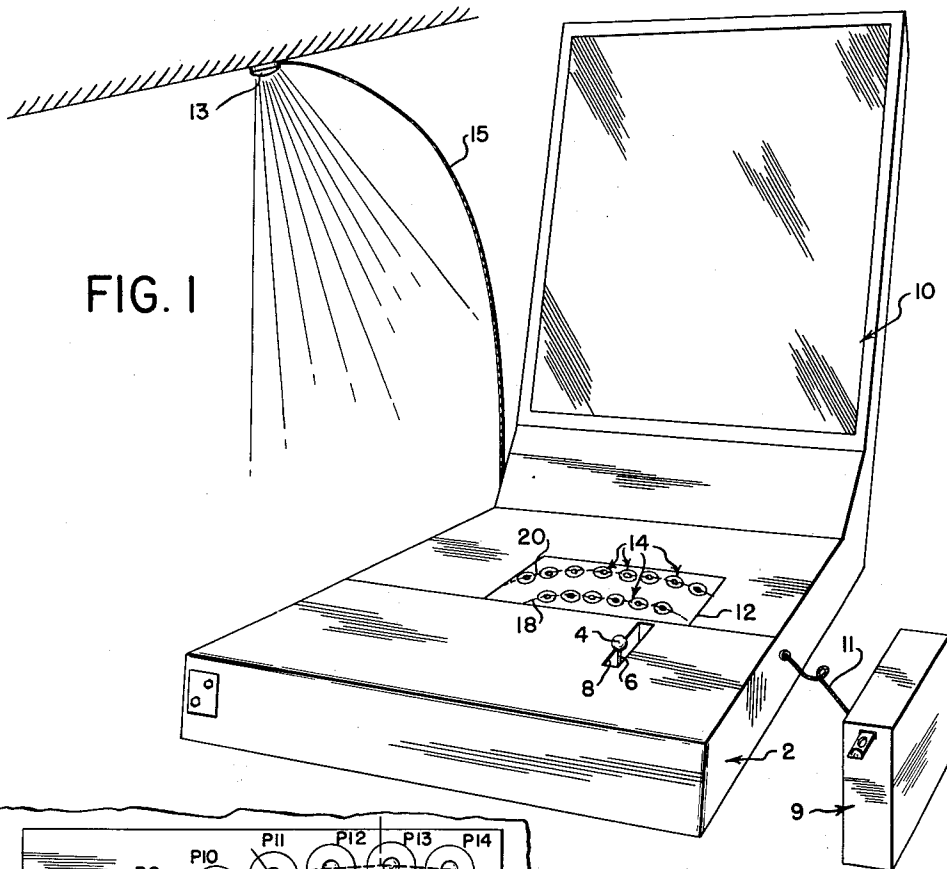
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3,020,049

GOLF PRACTICE APPARATUS

Filed Oct. 31, 1957

9 Sheets-Sheet 1



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GOLF PRACTICE APPARATUS

Filed Oct. 31, 1957

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FIG. 4

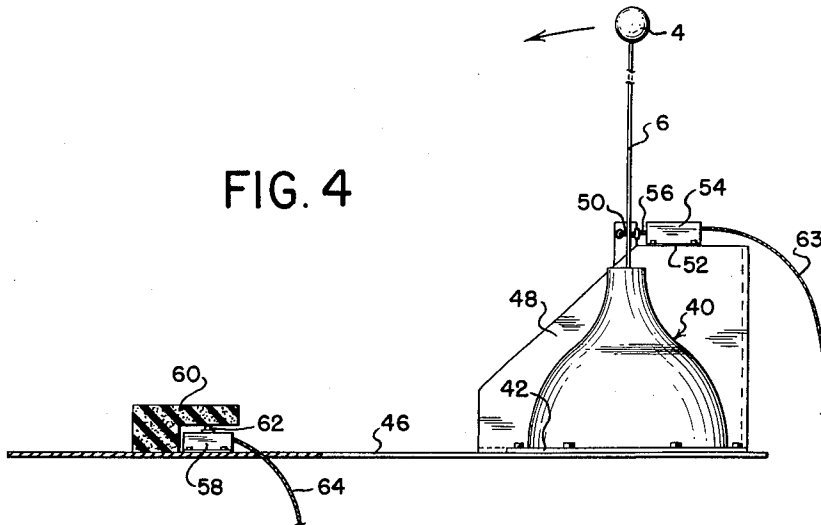


FIG. 3

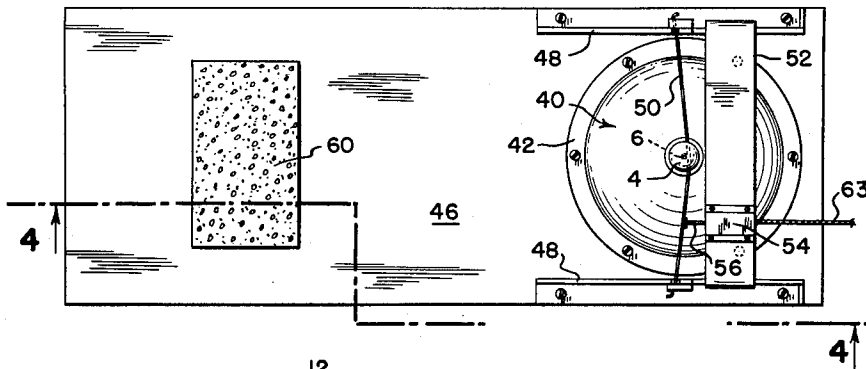
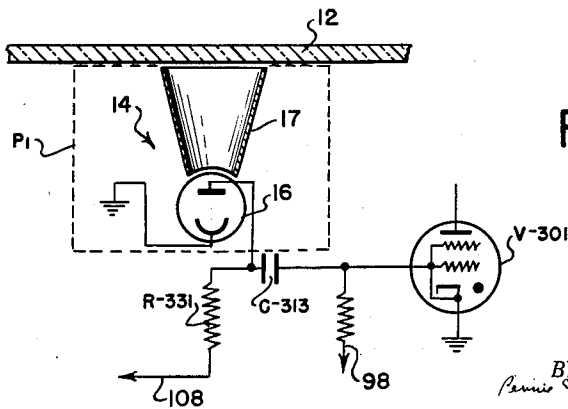


FIG. 5



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FIG. 6

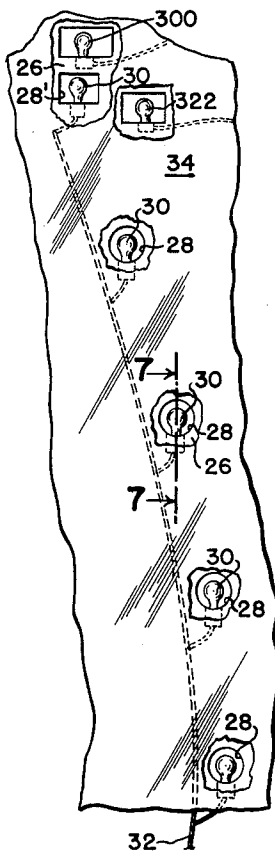


FIG. 7

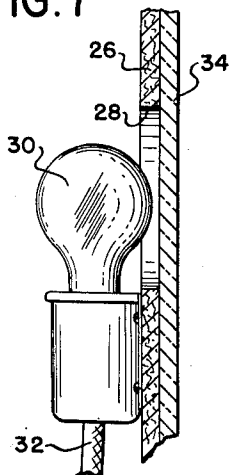
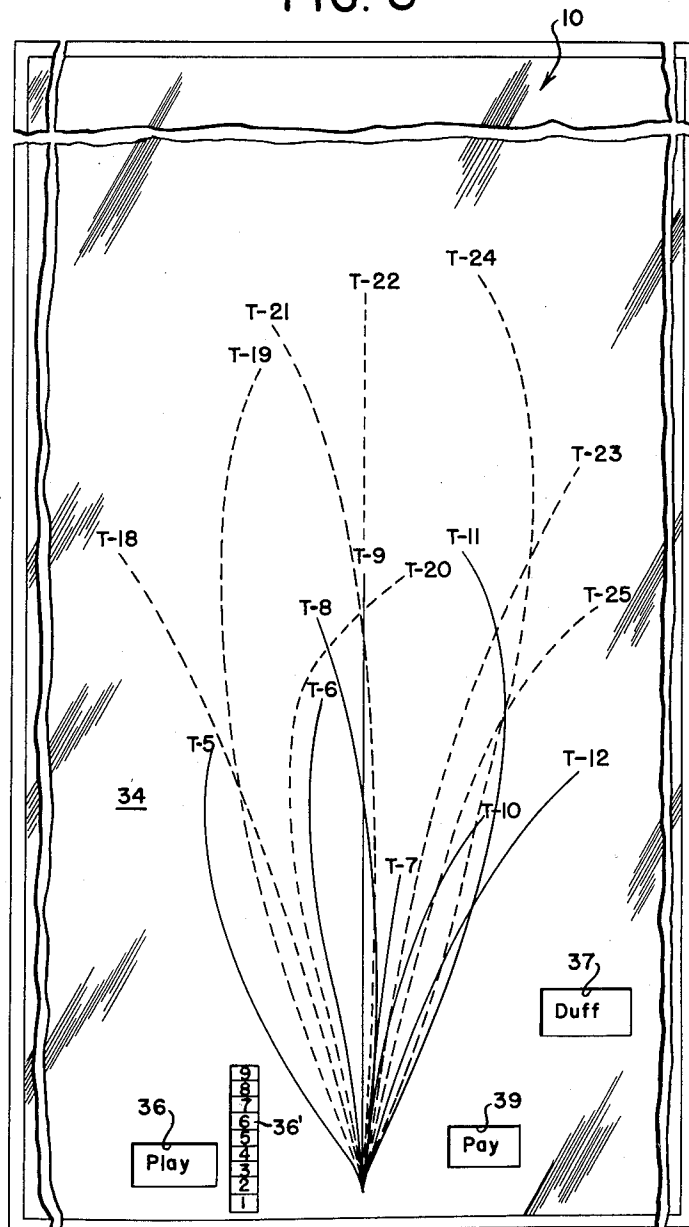


FIG. 8



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GOLF PRACTICE APPARATUS

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FIG. 10

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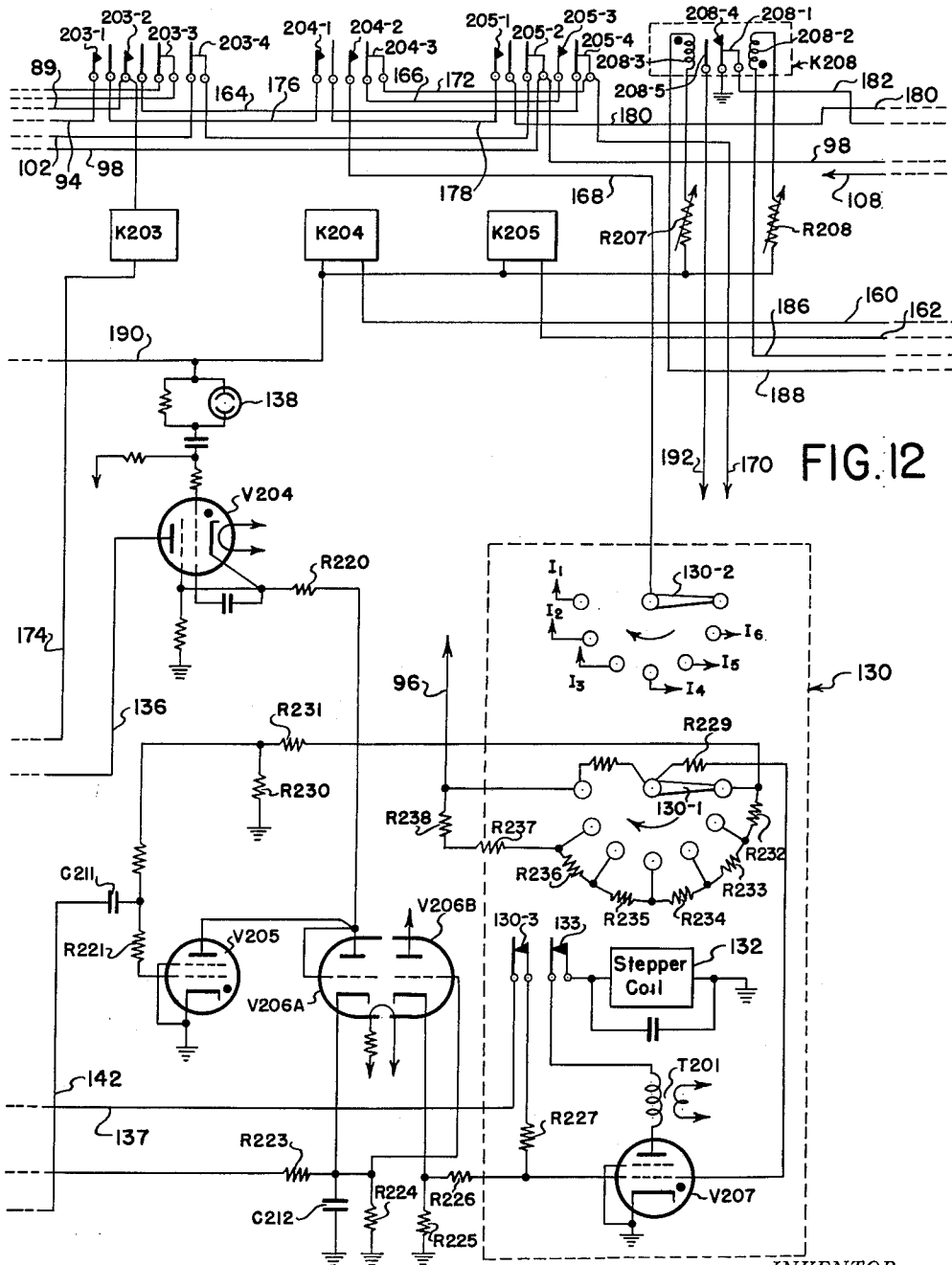
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GOLF PRACTICE APPARATUS

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9 Sheets-Sheet 6



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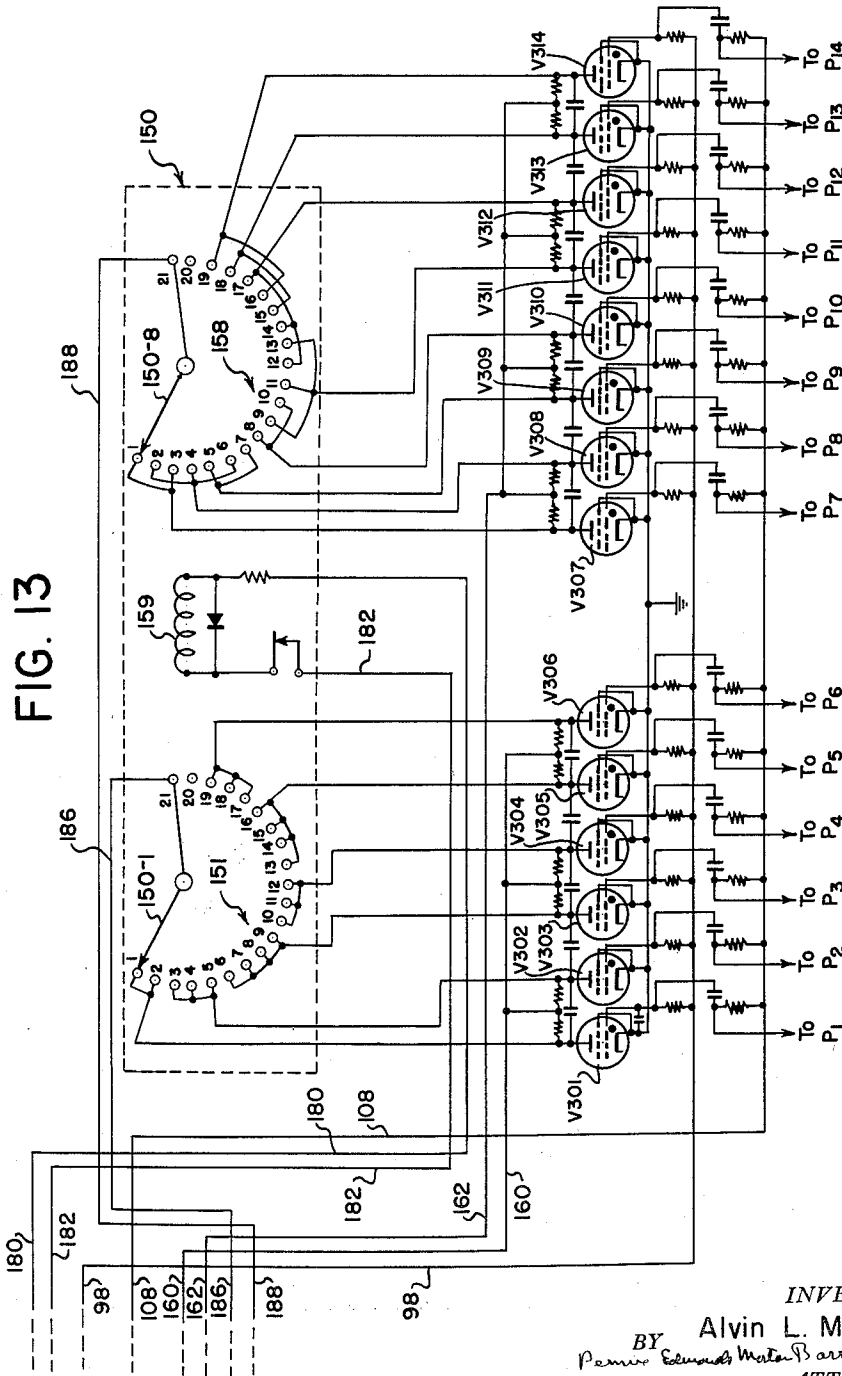
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Filed Oct. 31, 1957

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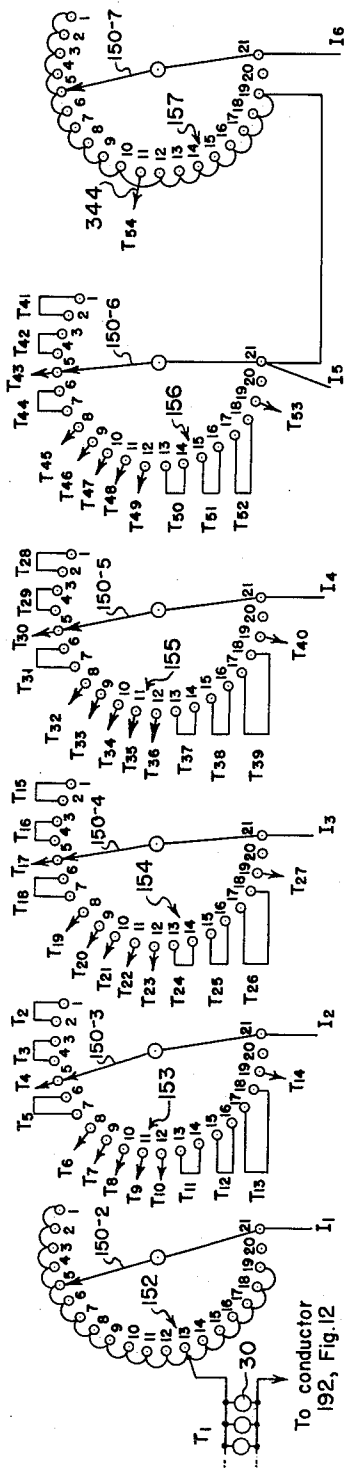
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GOLF PRACTICE APPARATUS

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FIG. 14



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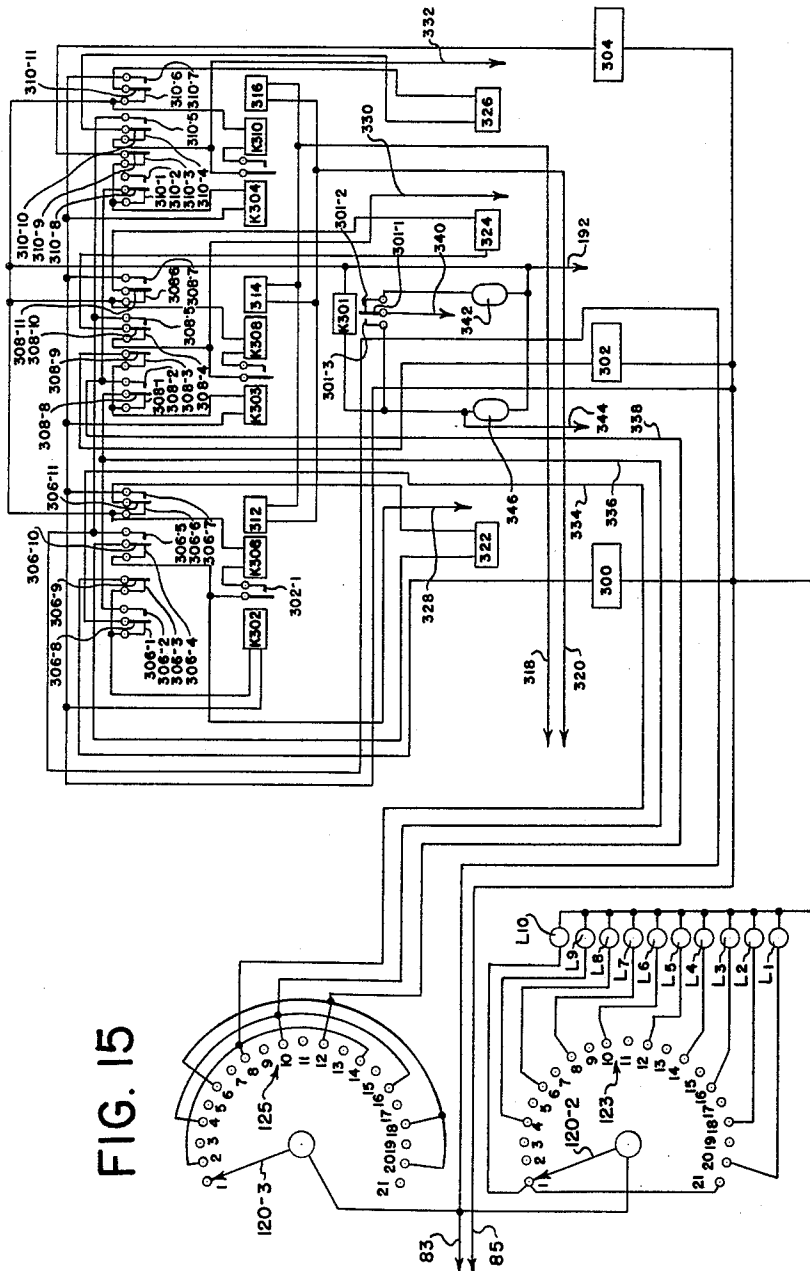
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FIG. 15



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GOLF PRACTICE APPARATUS

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Filed Oct. 31, 1957, Ser. No. 693,670

4 Claims. (Cl. 273—186)

This invention relates to golf practice apparatus and more particularly to such apparatus of simplified form capable of giving to the user thereof a visual indication representative of the distance, direction and quality of his stroke, i.e., of the distance to which, the direction in which, and straightness with which an actual golf ball might have been driven by his stroke.

In accordance with the invention a captive golf ball or "ball simulation" is provided to be struck by the player with a golf club. Electrical apparatus associated with this ball measures the impact with which it is struck. This impact is a measure of the maximum distance to which a free golf ball struck with such impact might travel. Associated with the impact measuring apparatus, in suitably spaced relation to the captive ball, there are provided means to develop signals representative of the direction and shape of the player's swing. Signals thus representative of the direction and shape of the swing are then combined with the impact signals in electrical apparatus to select on a display board a visual display which is energized to indicate to the player the nature of his stroke.

In contrast with various proposals heretofore made for inferring the range, direction of flight, and hook or slice component in a golf stroke by means of a dummy ball supported with separate degrees of freedom for each of these attributes of the stroke and by means of sensing apparatus responsive to the motion of the dummy ball in each of these degrees of freedom, the present invention employs for the ball simulation a simple form of mounting which measures impact only. The direction in which and the straightness with which the golfer's stroke would drive an actual ball are, in accordance with the present invention, judged by signals developed by the club head during portions of its swing other than that occupied by contact with the ball simulation. The signals representative of the shape of the swing are employed in display signal selecting circuits to select one or another display signals in accordance with the departure of the shape of the swing so measured from an optimum shape and from a normally preferred direction.

The invention will now be further described with reference to the accompanying drawings in which:

FIG. 1 is a perspective view of one form of golf drive practice apparatus according to the invention;

FIG. 2 is a fragmentary plan view of the platform in the apparatus of FIG. 1 on which the player stands to strike the ball, showing the arrangement with respect to the ball of the means for measuring the direction and shape of the player's swing;

FIG. 3 is a plan view of the captive ball and of associated elements disposed within the platform of FIG. 1 for developing signals representative of the impact with which the ball is struck;

FIG. 4 is a sectional view taken on the line 4—4 of FIG. 3;

FIG. 5 is a diagrammatic view in section of one of the swing measuring elements seen in plan in FIG. 2;

FIG. 6 is an enlarged fragmentary view of the display board of the apparatus of FIG. 1;

FIG. 7 is a sectional view taken on the line 7—7 of FIG. 6, shown at an enlarged scale;

FIG. 8 is a fragmentary diagrammatic view of the dis-

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play board of the apparatus of FIG. 1 showing the form of certain of the display circuits therein;

FIG. 9 is a diagram indicating the relation to each others of FIGS. 10, 11, 12 and 13; and

FIGS. 10 to 15 together form a schematic wiring diagram of the electrical components of the apparatus of FIG. 1.

The golf practice apparatus of FIG. 1 comprises a platform generally indicated at 2, above which appears a ball simulation 4, supported on and fastened to a stem 6. The stem is mounted on and fastened to a resilient support as illustrated in FIG. 4 and extends up through a slot-like opening indicated at 8 in the upper surface of the platform. The user of the apparatus stands upon the platform 2 and strikes the ball simulation with a golf club, exactly as in the manner of actual play.

A display board generally indicated at 10 in FIG. 1 gives to the user of the apparatus, substantially as soon as he has struck the ball simulation, a visual indication of the power and quality of his stroke, by means of a combination of mechanical and electrical elements hereinafter to be described. After a suitable time interval this indication is extinguished, and the entire apparatus is prepared for the making of another stroke. Apparatus according to the invention may, for example, be provided in places of public amusement, where a coin apparatus generally indicated at 9, connected to the platform 2 by a cable 11, permits a player to purchase a specified number of strokes in return for a coin inserted into the apparatus 9.

There is further seen in FIG. 1 a plate 12 set into the upper surface of platform 2 and over which the head of the user's golf club passes during the follow-through portion of his swing after striking the ball simulation 4. The plate 12, seen in plan in FIG. 2, is of transparent or partially transparent nature and accordingly permits the casting by the club head of a shadow on one or more of a plurality of light sensitive devices 14 disposed in two linear arrays 18 and 20 within the platform 2 beneath the plate 12. These light sensitive devices 14 each comprise, in a presently preferred embodiment of the invention, a photocell 16 with a surrounding opaque light reflecting cone 17, as indicated in FIG. 5. The cone 17 is provided to enlarge, beyond the size which would be specified by the dimensions of the light sensitive electrode in the photocell, the cross-sectional area or column of space between the platform and a bright lamp 13, disposed above the platform 2, interception of which by the club head will generate a signal in the photocell. Lamp 13 is connected to platform 2, and more particularly to a complex of electrical apparatus housed in the rear thereof and presently to be described, by means of a cable 15. While the perspective of FIG. 1 prevents its being so shown, lamp 13 is preferably disposed directly over the plate 12.

As indicated in FIG. 2, the light sensitive elements 14 are disposed in two linear arrays or rows 18 and 20, advantageously arcuate in shape, and so positioned with respect to the rest position of the ball simulation 4 (also shown in FIG. 2) that on a normal swing by the golfer employing the apparatus, a signal will be generated by one of the light sensitive elements in each of the two rows 18 and 20. The two light sensitive elements thus excited to produce signals are a measure of the quality of the golfer's swing, in particular of the initial direction of flight which an actual ball in the position of the ball simulation 4 would follow on leaving the "tee" comprising platform 2 and also of the straightness or trueness with which the ball would have traveled in such direction, as indicated by the shape and curvature of the projection onto the plane of the platform of the path followed by the club head during the golfer's follow-through swing.

The cones 17 (FIG. 5) are so dimensioned and the light sensitive devices 14 containing them are so spaced apart in each of the arcuate rows 18 and 20 that the shadow cast by the golfer's club head during the initial follow-through portion of his stroke (e.g., until the club head rises to the level of the player's waist) will obscure illumination of the photocell in one and only one of the elements 14 of such row sufficiently to generate a signal, which will trigger into conduction an electronic circuit into which such photocell is coupled. One such circuit, presently to be described, is provided for each of the elements 14.

In this fashion two signals are generated, representative of the positions at which the club head shadow crosses rows 18 and 20. These signals together, by reference to the rest position of the ball 4, provide information on the direction in which an actual ball would have been driven by the stroke being evaluated and also of the quality of that stroke.

Referring to FIG. 2, there is shown at a dash line 22 the path of the center of the shadow of the club head on a stroke such as would drive an actual ball, teed at the position of the ball simulation 4, in the "straight ahead" direction indicated by the line 24. This "straight ahead" direction is that which the golfer naturally strives to achieve, it being parallel to the sides of the platform 2 and generally perpendicular to the display board 10. It will be noted that the path 22 is curved, being substantially the projection onto the plane of the platform of the initial part of the follow-through portion of the player's stroke. In FIG. 2 the elements 14 are individually identified with reference characters P1 to P14, and it is seen that a "true," straight ahead stroke of whatever impact is the result of a swing whose follow-through produces signals at elements P4 and P11.

The apparatus of the invention distinguishes a large number of two-cell combinations which can be "triggered" by the club head, including one cell from each row. It distinguishes for example the combinations P4, P10 and P4, P12 as departures from the optimum stroke which triggers the combination P4, P11. In addition the apparatus distinguishes, among others, the combinations P3, P10; P3, P9; P3, P11 and the combinations P5, P12; P5, P11; P5, P13.

The board 10 is fragmentarily illustrated, in plan and sectional views, in FIGS. 6 and 7, and a further partial diagrammatic showing thereof is contained in FIG. 8. For clarity, FIG. 8 shows only the lower central portion of the board, and shows in that portion the displays associated with the lower values of impact only. The board comprises a large rectangular sheet of opaque material 26 pierced with a large number of holes 28. An electric lamp 30 is positioned behind the board at each of these holes to cast its light therethrough, and these lamps are connected together into a plurality of separately energizable circuits each containing a plurality of lamps, each lamp belonging to one circuit only.

The lamps of each circuit are positioned at holes in the board which make up a line extending, generally, from the midpoint of the lower edge of the board up the board a distance and in a direction generally representative of the stroke being represented according to the combined effect of the impact value measured and to the conformity of the follow-through portion of the stroke to an optimum follow-through swing pattern for a given direction as determined by the light sensitive elements in rows 18 and 20 (FIG. 2) triggered by the club head shadow.

Part of such a circuit or string of lamps is shown in FIG. 6, where all lamps 30 shown are energizable in parallel from a cable 32, shown in dashed lines in view of its representation in phantom in that figure.

As indicated in FIG. 7, the opaque sheet 26 may be overlaid with a transparent sheet 34 of glass or the like, on which a pictorial representation of a golf course or portions thereof may be applied. In this connection, the

lamp at the upper end of the string, or of certain of the strings, may be disposed behind an enlarged hole 28', to permit illumination thereby of a golf green painted on the transparent sheet 34.

The invention provides on the board 10 a number of distinct lamp circuits. In the presently preferred embodiment of the invention now being described, this number is substantially equal to the product of a plurality of distinguishable impact values or impact ranges and a number of distinguishable combinations of light sensitive elements among the elements P1 to P14 of FIG. 2. As will be further explained in conjunction with FIG. 8, the number of lamp circuits can be widely varied consistently with the invention.

The relationship to each other of the lamp circuits associated with a given range of impact values measured at the ball simulation and of these circuits with those associated with the adjacent range of impact values is illustrated in FIG. 8. FIG. 8 is a schematic view of the display board showing the lower central portion thereof and showing in that portion the shape and position of the strings of lamps 30 for two adjacent ranges of impact values. The circuits associated with the lower range of impacts are indicated at full lines identified by reference characters T5 to T12 while those associated with the higher range of impacts are indicated at dashed lines identified by reference characters T18 to T25. In the embodiment illustrated, all lamp circuits include lamps arranged in a pattern, line or "string" originating at the mid-point at the lower edge of the board and extending generally upward therefrom. Each of the circuits T5 to T12 and T18 to T25 is energized by a stroke having one or the other of the adjacent ranges of impact measured at the ball 4 and each will be energized by such a stroke, the follow-through portion of which generates signals at a particular combination of the light sensitive elements P1 to P14 as follows:

Combination of light sensitive elements 14	Display board lamp circuit	
	Lower range of impact values	Higher range of impact values
P2, P9.....	T5	T18
P3, P10.....	T6	T19
P3, P11.....	T7	T20
P4, P10.....	T8	T21
P4, P11.....	T9	T22
P4, P12.....	T10	T23
P5, P11.....	T11	T24
P5, P12.....	T11	T24
P5, P13.....	T12	T25
P5, P14.....	T12	T25

Still other combinations of the elements 14 are actuable by the player's club head after striking the ball 4, and their actuation leads, according to the impact value of the stroke, to the energization of still other lamp circuits on the board 10. These have however for clarity been omitted from FIG. 8.

For any given stroke, the element of row 18 which is actuated identifies generally the direction of flight which a free ball so struck would take, whereas the combination of elements in rows 18 and 20 indicates the straightness or trueness with which such a free ball would travel. More particularly, the elements P4, P11 together with the rest position of ball 4 define an arc which conforms to the projection onto the plane of platform 2 of the path of the club head when swung to produce a straight shot parallel to the edges of the platform. Hence in FIG. 8 the circuits T9 and T22 are straight and are oriented parallel to the vertical sides of the board. The combination P4, P10 however represents the arc of the projection of a club trajectory on a stroke with excessive effort or "snap" in the player's wrists. Such a stroke, applied to a free ball, would cause that ball to rotate

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counter-clockwise as seen from above and would hence produce a hooked shot. The corresponding lamp circuits T8 and T21 are accordingly laid out on the board 10 to represent hooked shots. Conversely the combination P₄, P₁₂ represents a stroke with insufficient snap in the wrists, the club head being "pulled" by the player. Such a stroke would cause clockwise rotation of a free ball as seen from above and would hence produce a sliced shot, and the corresponding lamp circuits T10 and T23 are laid out on the board in the curved shape of a sliced ball. The hook or slice quality of a golf stroke is thus according to the invention inferred from the trajectory of the club head, and is displayed to the player by a corresponding shaping of the display board lamp circuits. The direction of the shot is also displayed by an orientation on the board of the lamp circuits in accordance with the identity of the element in row 18 which produces their energization. It will thus be noted that the combination P₃, P₁₀ energizes the lamp circuits T6 or T19 disposed to the left of circuits T8, T9 and T10 or T21, T22 and T23 respectively, all of which are produced by photo-cell combinations including element P₄ in row 18.

The board 10 of FIG. 1 includes lamp circuits for still other ranges of impact values and combinations of photo-cells 16. It also includes certain auxiliary lamp circuits. One of these illuminates, when energized, a rectangular opening 36 at the lower edge of the board over which may be applied on the transparent sheet 34 the word "Play," this circuit being energized when the apparatus is ready for a stroke. Another of these illuminates a cutout 37 in sheet 26 over which is applied the word "Duff" or the like, indicating a stroke below passing grade, as when the player's follow through swing fails to actuate a light sensitive element in one of the two rows 18 or 20, or in both.

The board may incorporate still other lamp circuits.

A description will now be given of the components by means of which the board is energized at one of the lamp circuits thus far described. The impact measuring apparatus is illustrated in FIGS. 3 and 4. The stem 6 of the ball simulation, which in the assembled apparatus projects through the slot 8 in the platform 2, is supported and fixed at its lower end in a resilient elastic support 40. The support 40 comprises a hollow inverted body of rubber or the like, approximately conical in shape, which may be advantageously filled with elastic material in spongy form, for example the closed cellular plastic commonly known as styrofoam. The rubber member 40 is provided at its lower edge with a flange over which fits a metallic ring 42. Cap screws passed through the ring 42 and flange securely hold the flange to a base plate 46, fixed in position within the platform 2 of FIG. 1. The base plate prevents the contents of member 40 from being expelled therefrom, thus increasing the elastic resistance which member 40 presents to any deflection of stem 6 from a vertical position.

Two sides plates 48 are affixed to plate 46, one on each side of member 40, and a member 50 having tensile resiliency such as a strand of rubber is strung between them in stressed relation, with anchor points on the two side plates so positioned that with the ball simulation 4 at rest its stem 6 stretches the member 50 into a shallow V shape. A bar 52 between side plates 48 supports a microswitch 54 in such position that its actuating member 56 is engaged by resilient member 50 when the ball simulation is at rest, keeping the switch open in the particular embodiment of the invention being described. When the ball is struck, deflecting stem 6 from the vertical position shown in FIG. 4, strand 50 permits switch 54 to close, thus generating a signal.

In front of the ball simulation, in the sense in which it is supported in the platform 2, the base plate 46 supports a microswitch 58 beneath a pad 60 of resilient material. The actuating member 62 of switch 58 is ar-

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ranged to be actuated, to generate a second signal, whenever the pad 60 receives a blow from the ball 4, which is driven to a horizontal position when struck by the player's golf club, and which then whips back to the vertical. The time interval between the actuation of switches 54 and 58 is a measure of the impact with which the ball is struck. The pad 60 serves both to protect the switch 58 from excessive shock and to insure its actuation irrespective of the position at which the ball reaches the plane of pad 60, within a range of positions ample for the purpose.

The successive signals generated upon actuation of switches 54 and 58 are conveyed by cables 63 and 64 to the display board lamp circuit selecting apparatus, presently to be described. This apparatus is advantageously housed immediately in back of the display board, in an enclosure forming part of the display board structure. In view of the short time intervals involved and the use of these signals for the control of vacuum tubes, the cables 63 and 64 may advantageously be of coaxial type. In the embodiment of the invention here being described, switch 54 is closed when the ball simulation is struck by the player's club head, and switch 58 is closed when the ball simulation strikes pad 60.

There will now be described by reference to FIGS. 10-14 the electrical components of the apparatus of FIG. 1 by means of which the impact signals from the apparatus of FIGS. 3-4 and the signals from light sensitive elements P1 to P14 are combined to effect energization of a particular, appropriate one of the lamp circuits on board 10.

FIG. 10 is a diagram of a power supply provided for energization of the electrical components of the golf drive apparatus of FIG. 1. Also shown in FIG. 10 is the coin operated timer 9 of FIG. 1. The coin operated timer 9 includes a switch 66, adapted to be closed upon insertion of a suitable coin, and an electric motor 68. Motor 68 has coupled thereto a gear train which, after an interval of operation of motor 68 (for example of the order of a few minutes) operates to reopen switch 66. Switch 66 effectively governs energization of the entire apparatus so far as concerns its utility to the player or user. Coin timer 9 is connected to the remainder of the electrical system by cable 11.

Input power to the entire electrical circuit may be derived from an ordinary 110 volt A.C. lighting circuit through conductors 70 and 72 and fuses 74. With conductors 70 and 72 energized, power is supplied to three transformers 80, 82 and 84. One winding 86 on transformer 80 energizes the filaments of all vacuum tubes in the system and also the coil of a thermal relay 87 through a normally closed contact 102-1 on a relay K102. When relay 87 operates, relay K102 is energized, opening its contact 102-1 and closing its normally open contacts 102-2 and 102-3.

Another winding 88 on transformer 80 provides voltage to conductors 89 and 90 and thence, via control and switching circuits presently to be described, to the lamp circuits on the display board. Transformer 80 includes another secondary winding 92 to which is connected a full wave rectifier 881 as shown. One of these provides a negative voltage to conductor 94 from which various negative bias voltages are developed at conductors 94, 96, 98, 100 and 102. The other provides, upon energization of relay K101, positive B+ voltage at conductor 104. Lower positive rectifier voltages are derived therefrom at conductors 106 and 108. Voltage regulator tubes may be provided as indicated in the drawing for stabilization of these voltages.

The voltage from transformer 82 is applied to the filaments of two hot cathode grid controlled gas rectifiers or "thyatron" tubes V203 and V204 (FIGS. 11 and 12). The voltage from transformer 84 is applied (via conductors 83 and 85) to a special circuit shown in FIG. 15

which indicates to the player the number of strokes remaining to him and which may have other functions.

Two conductors 110 and 112 connected through normally open contact 101-1 of relay K101 to conductors 70 and 72 constitute a reset circuit for restoring the apparatus to a condition preparatory to renewed play, when the allotted time runs out by operation of motor 68.

Energization of relay K101 opens the reset circuit at normally closed contact 101-1 and closes normally open contact 101-2, thereby completing the circuit for the rectifier 881 whose output conductor is shown at 104. Referring to FIG. 11, conductor 104 is seen to apply B+ voltage to a wiper arm 120-1 of a stepping switch generally indicated at 120.

Stepping switch 120 may have a plurality of banks of stationary contacts, one being indicated in FIG. 11 and two others being shown, in the embodiment illustrated, in FIG. 15. FIG. 11 shows a first bank of these contacts and the associated wiper arm 120-1. The stationary contacts of the bank shown in FIG. 11 are divided into odd and even numbered contacts, all odd numbered contacts being short-circuited together to a conductor 124 and all even numbered contacts being short-circuited together to a conductor 126. A total of twenty-one stationary contacts may be provided in each bank. For clarity, however, only one odd and one even contact are shown in FIG. 11.

Stepping switch 120 having been restored by its reset coil 123 and by conductors 110 and 112 via contact 101-1 in FIG. 10, wiper arm 120-1 rests on the number one stationary contact of the bank illustrated in FIG. 11, so that B+ voltage is applied from conductor 104 to conductor 124 and to a relay K211, energizing the same. The circuit of conductors 110, 112 and reset coil 123 is completed at a contact 129 mechanically linked to wiper arm 120-1 to be closed except when that arm is in its fully reset position. Resetting may take place upon energization of coil 128 through a mechanical spring and latch mechanism not shown, in accordance with the usual operating of stepping switches.

On relay K211 a normally open contact 211-1 is now closed, grounding a resistor R223 (FIG. 12) to permit discharge of a capacitor C212 whose function will be presently described. A normally closed contact 211-2 is opened by energization of relay K211, thus removing the short circuit to ground across a capacitor C201 in the grid circuit of a cold cathode gas tube V201.

In addition, energization of relay K211 opens a normally closed contact 211-3, disconnecting conductor 106 and its regulated stabilized positive voltage from a conductor 136 and from the plate of a thyatron tube V204 (FIG. 12). Lastly, energization of K211 grounds at a normally open contact 211-4 a conductor 137 and therewith the grid of a thyatron tube V207 through a resistor R227 and through a normally closed contact 130-3 on a second stepping switch generally indicated at 130, this contact being mechanically coupled to the rotating wiper arm 130-1 of that switch to be opened only when switch 130 is at reset position, as shown in FIG. 12.

With relay K211 energized, the control grid of V201 rises above ground as C201 charges through R201 and after a short time delay, which may be of the order of one second, this produces conduction in the tube V201 and consequent energization of a relay K201 whose coil is in the plate circuit of that tube. This closes a normally open contact 201-1 which completes the circuit for the stepping coil 121 on switch 120, shifting the wiper arm 120-1 thereof from an odd to an even numbered stationary contact. With this shift in the condition of relay 120, relays K201 and K211 de-energize and a further relay K202 is instead energized via conductor 126 from the even numbered stationary contact. Since stepping coil 121 is now open-circuited relay 120 remains stationary after a one step shift from an odd to an even stationary contact, relay K206 not having been energized.

On relay K202 a normally open contact 202-1 is now closed, completing, through a normally closed contact 203-3 on a de-energized relay K203 (FIG. 12) the 110 volt circuit from conductors 70 and 72 for an overhead light or projector 13 (FIG. 1) which illuminates the light sensitive elements 14 in platform 2 of FIG. 1. Closing of 202-1 also energizes the lamp of a "Play" sign 134 which may be provided in the display board at opening 36 (FIG. 8) or elsewhere, indicating to the user of the apparatus that it is ready for use. A second normally open contact 202-2 on relay K202 also closes and applies B+ voltage from conductor 104 to the plate of a thyatron type tube V203.

With relay K202 energized and positive voltage on the plate of tube V203, the system is ready to measure and to evaluate a practice golf stroke. Tube V203 is biased off on its grid with a low negative voltage from conductor 100 but is brought into conduction by means of a positive pulse produced when the golfer's club head strikes the ball 4. The instant when the club head strikes the ball may be referred to as time t_0 . At this instant microswitch 54 is shifted from the grounded position shown in FIG. 11 to a contact 55 at B+ and a positive pulse is thus generated and applied through cable 63 to a capacitor C206 in the grid of V203, causing that tube to conduct.

The ultimate effect of such conduction is to initiate conduction in a diode V206A (FIG. 12) to charge a timing capacitor C212 through a charge limiting resistor R220 in the cathode circuit of a thyatron V204 which is brought into conduction by conduction in V203 and which has applied to its plate a regulated positive voltage from conductor 106 through the now closed contact 211-3 on de-energized relay K211 and conductor 136.

More particularly, firing of tube V203 energizes a relay K209 to apply a regulated positive voltage from conductor 106 to the plates of two tubes V202A and V202B, each of which is connected in a modified Miller circuit for production of a delayed signal as will be presently described.

Firing of thyatron tube V203 additionally applies the positive voltage of conductor 104, reduced by the drop in that tube, to conductor 190 and through a neon glow tube 138 to the grid of a further thyatron tube V204. This tube is caused to conduct, it now having positive plate voltage applied thereto in view of the de-energized condition of relay K211. Regulated positive voltage is then communicated through tube V204 to the plate of a diode-connected tube V206A in whose cathode is contained the capacitor C212 which functions to measure the impact value of the stroke.

Firing of V203 also applies positive voltage via conductor 190 to relays K204, K205 and K208. These relays remain de-energized however inasmuch as the circuits for the actuating coils thereof remain incomplete in FIG. 13, these circuits being first completed by operation of a stepping switch 150 of that figure during the evaluation of the stroke by means of the light sensitive elements 14 of FIGS. 1 and 2.

Capacitor C212 charges in an exponential or approximately linear fashion until the ball simulation 4 strikes impact pad 60 (FIG. 4) and shifts the second microswitch 58 to its positive contact 59 (FIG. 11). This produces a second positive pulse which is conducted through cable 64 to a conductor 142 and thence through a capacitor C211 and resistor R221 (FIG. 12) to the grid of a further thyatron tube V205. V205 is biased off through resistors R230 and R231 and through a chain of resistors R232-R238 associated with the stationary contacts of one bank in stepping switch 130. Resistors R232-R238 lead to the negative bias supply at conductor 96.

The "stop" pulse produced at microswitch 58 thus initiates conduction in V205. It follows the "start" pulse of microswitch 54 with a time delay representative of the impact imparted to the ball. Conduction in tube V205 initiated by the stop pulse effectively grounds the plate of

diode 206A and consequently terminates the charging of capacitor C212. The interval between the start and stop pulses typically amounts to a few milliseconds, whereas the time constant of the discharge circuit for capacitor C212 provided by resistor R224 is long by comparison therewith and furthermore long by comparison with the actual operating time of the stepping switch 130. This stepping relay operates to assume an angular position representative of the initial charge value in capacitor C212 within the time short compared to the discharge time constant.

The voltage to which capacitor C212 is charged is reproduced across a resistor R225 in a cathode follower circuit comprising tube V206B. The voltage thus reproduced is applied to a network including resistor R226, the grid of a thyratron V207, R229, the wiper arm 130-1 of one bank on switch 130, and so many of resistors R232-R238 which lead to the negative bias at conductor 96 as are not by-passed by arm 130-1. In the absence of a positive voltage charge on C212 and a consequent positive voltage across R225, thyratron V207 is negatively biased beyond cutoff, even for the positive voltage excursions imposed on its plate by means of a transformer T201 whose secondary is inserted in series with the plate of that tube in a circuit including the actuating coil 132 of stepping switch 130. The primary of transformer T201 is fed with an appropriately proportioned alternating current voltage which may advantageously be the power line voltage as reduced in amplitude by transformer 86 of FIG. 10. In series with coil 132 there is provided a contact 133, coupled mechanically to wiper arm 130-1 to open at each step made by the latter.

The rest or reset position of stepping switch 130 is that illustrated in FIG. 12, in which the wiper arms 130-1 and 130-2 of its two banks are in the position shown in the drawing, arm 130-1 applying minimum negative bias to tube V207. With the positive voltage across R225 produced by the charge stored in C212, however, the bias on tube V207 is reduced to such an extent that the tube is caused to fire on the positive excursions of its plate. Accordingly, pulses of current are passed by tube V207 at power line frequency, and stepping switch 130 shifts its wiper arms one step for each such pulse until the increasing negative voltage tapped by the wiper arm 130-1 increases the negative bias on tube V207 to a point at which the tube no longer fires.

The second bank of contacts on relay 130 includes stationary contacts connected to a plurality of "impact lines" or conductors I₁-I₆ which are connected respectively to the wiper arms 150-2 to 150-7 of the second to seventh banks 152-157 (FIG. 14) of a stepping switch 150 shown in FIG. 13. It is through the stationary contacts of these banks that are energized the various lamp circuits on the display board such as the circuits T5 to T12 and T18 to T25 of FIG. 8. The wiper arm 130-2 of stepping switch 130 is connected via conductor 168 to a normally open contact 204-2 in relay K204 and, upon closure of that contact and energization of relays K203 and K205, to a conductor 89 of the lamp circuit transformer winding 88, conductor 90 being grounded (FIG. 11).

With maximum impact the interval between the start and stop pulses is a minimum and the charge stored during that interval in C212 is also a minimum. Consequently, stepping relay 130 will move through a minimum number of steps in response to such a stored charge, so that the line of maximum impact I₆ in the second bank of stepping relay 130 is that corresponding to a single step for that relay away from the rest position shown in the drawings. Conversely, the minimum impact line I₁ corresponds to a maximum number of steps of that relay.

The impact of the stroke having been measured, there now remains for the apparatus of the invention to evaluate the direction and quality of the stroke or swing

shape in order to select on the display board a lamp circuit representative of the combined factors of impact, direction and quality. The components illustrated in FIGS. 12, 13 and 14 together with those already described, cooperate to this end.

Each of the photocells 16 of the array of light sensitive elements 14 of FIG. 2 is, as shown in FIG. 5, provided with a grounded cathode and with an anode connected through a current limiting resistor R331 to a source of positive voltage at conductor 108. In addition the anode is connected through a capacitor C313 to the grid of one of the thyratron tubes V301-V314 of FIG. 13, all of which are biased off at conductor 98. FIG. 5 illustrates this connection between the element P1 and V301. The photocells of light sensitive elements P1 to P6 of row 18 in FIG. 2 are thus connected to thyratrons V301 to V306 respectively in FIG. 13, whereas those of elements P7 to P14 are similarly connected to thyratrons V307 to V314 respectively.

When the head of the golfer's club passes over the row 18 of photocell units in FIG. 2, the illumination from the lamp 13 is substantially cut off from one of the photocells in that row and conduction therein is momentarily extinguished or sharply reduced. This produces a positive pulse of voltage which is communicated to the corresponding one of thyratrons V301-V306. This tube is then brought into conduction. Conduction in any of tubes V301-V306, whose cathodes are grounded, completes via a conductor 160 the circuit for relay K204. Energization of K204 closes a normally open contact 204-1 on that relay. This extends, via conductors 176 and 178, from open contact 203-1 on relay K203 to open contact 205-1 on relay K205, a circuit which, when completed by energization of relays K203 and K205 will energize stepping switch 150.

Energization of relay K204 also closes a normally open contact 204-2 which connects the wiper arm 130-2 on the second bank of stepping relay 130 to a normally open contact 205-3 on relay K205. Upon closure of contact 205-3 the lamp circuit for the display board will be completed, except for an open contact 203-2 on relay K203, from conductor 89 (FIG. 11) to wiper arm 130-2 and the lamp circuit selector bank of stepping relay 150 to which arm 130-2 is connected by one of lines I₁ to I₆. This connection is made by a conductor 164 between 203-2 and 205-3, a conductor 166 between 205-3 and 204-2, and conductor 168 between K204-2 and wiper arm 130-2.

When the club head intercepts the light incident on one of the photocell units in the second row indicated at 20 in FIG. 2, the corresponding one of the thyratron tubes V307-V314 is energized, completing the circuit for energization of relay K205 via a conductor 162. When this relay is energized, a first normally open contact 205-1 thereon is closed to complete the driving circuit for the actuating coil 159 of stepping switch 150 from conductor 94 in FIG. 11 to ground at a normally closed contact 208-1 on relay K208 except for the open contact K203-1 on relay K203.

Simultaneously, a normally closed contact 205-2 is opened to isolate the negative bias line conductor 98 from the less negative bias line 102 in the power supply. This increases the negative bias applied by conductor 98 to the unfired thyratron tubes in the series V301 to V314 in order to prevent energization of any additional ones of those tubes when the shadow of the club head sweeps back across the arrays of photocells as the club head rises above the player's waist on the follow-through, or when he returns the club head to the vicinity of the ball 4.

A further normally open contact 205-3 on relay K205 is closed upon energization of that relay to connect the lamp circuit conductor 164 from relay K203 via conductor 166 back into relay K204 where, if relay K204 has been energized, it will be completed via conductor

168 into the wiper arm 130-2 in stepping switch 130. The normally closed contact 205-4 on relay K205 connects conductor 164 to a conductor 176 for illumination of the "duff shot" cutout 37 on the display board as an indication of a bad or incomplete stroke. It will be observed that by the provision of a conductor 172 between normally closed contacts 204-3 and 205-4, provision is made for energization of the "duff shot" conductor 170 upon energization of K203 in place of the conductor 168 leading to the lamp circuits T1 to T54 in the event that either K204 or K205 or both should fail to be energized by the player's follow-through swing.

Assuming a signal to be generated at a light sensitive element 14 in each of rows 18 and 20, one thyatron in each of the groups V301-V306 and V307-V314 will have been brought into conduction, and both of relays K204 and K205 will be energized, all within a space of time no more than some 25 or 50 milliseconds after t_0 , the time of first contact of the club head with the ball simulation 4. The lamp circuit on the display board representative of the impact value, direction and quality of the player's stroke has been potentially identified, the impact value in terms of the charge on C212 and the direction and quality in terms of the particular combination among the thyatron tubes V301-V314 which has been brought into conduction. Within a time of the order of 100 or 150 milliseconds after t_0 , relay 130 has evaluated the charge on C212 in terms of a particular final angular position for wiper arm 130-2, connecting conductor 168 to a particular one of lines I_1 to I_6 .

The energization of the lamp circuit on the display board is next effected by stepping relay 150 upon the energization of relay K207 when conduction in tube V202-B reaches the threshold of excitation of that relay. Tube V202-B is typically adjusted to energize relay K207 within some 500 milliseconds after time t_0 , i.e., well after switching relay 130 has come to rest. When relay K207 energizes, it produces energization of relay K203 by grounding conductor 174 at contact 207-1. Contact 203-1 then closes and completes the driving circuit for stepping relay 150 from conductor 94 through contact 203-1, conductor 176, contact 204-1, conductor 178, contact 205-1, conductor 180, actuating coil 159 of relay 150, conductor 182 and contact 208-1 to ground. Contact 203-2 also closes and completes the lamp circuit from conductor 89 to conductor 168. Opening of normally closed contact 203-3 extinguishes the projector lamp 13 and "Play" sign 134, while opening of normally closed contact 203-4 opens the connection of the low negative bias conductor 102 into 205-2.

Stepping switch 150 now commences to rotate its wiper arms. This relay comprises a plurality of banks of stationary contacts. All wiper arms in switch 150 move together and occupy the same angular position with respect to the stationary contacts of their banks. In the embodiment illustrated in the drawings, there are a total of eight banks, each containing twenty-one contacts, the first and last being generally indicated at 151 and 158 in FIG. 13. The stationary contacts in banks 151 and 158 are connected in combinations as shown in FIG. 13 to the plates of tubes V301 to V314, the contacts of bank 151 being associated with tubes V301 to V306, whereas the contacts of bank 158 are associated with tubes V307 to V314. Wiper arm 150-1 of bank 151 is connected by a conductor 186 to one of the actuating coils 208-2 of relay K208, the other terminal of that actuating coil connecting through an adjustable resistor R208 to conductor 190 which leads to the cathode of V203. Similarly, wiper arm 150-8 is connected by a conductor 188 to the second actuating coil 208-3 of relay K208, the other terminal of this coil connecting through adjustable resistor R207 to conductor 190. The armature 208-4 of relay K208 is so adjusted by means of resistors R207 and R208 that conduction is required in both of coils 208-2 and 208-3 be-

fore contact 208-1 will open and before contact 208-5 will close.

In connection with the stationary contacts of banks 151 and 158 to tubes V301-V314, the arrangement is such that for each of the angular positions to which the wiper arms of switch 150 can move, there is one and only one pair of thyatron tubes (each such pair including a tube from the group V301-V306 and one from the group V307-V314), for which the wiper arms 150-1 and 150-8 of both of banks 151 and 158 will be connected to ground by conduction in tubes of the series V301-V314. Relay 150 will accordingly move stepwise until this condition is arrived at, its wipers, which move together, beginning from the stationary contacts where the relay was left by previous operation and moving counterclockwise in FIG. 13. When wiper arms 150-1 and 150-8 are both grounded through conducting tubes in the series V301-V314, both of coils 208-2 and 208-3 carry current, and relay K208 will energize. Opening of contact 208-1 breaks the circuit for the stepping coil 159 of relay 150, and the wiper arms accordingly move no further.

Normally open contact 208-5 closes when relay K208 energizes, and in closing grounds a conductor 192 in the common path of all of the display board lamp circuits. This is indicated for a typical lamp circuit in FIG. 14.

Referring now to FIG. 14, there are generally indicated at 152 to 157 the six intermediate banks of stationary contacts of stepping switch 150, together with the wiper arms 150-2 to 150-7 thereof. Each of these wiper arms is connected to one of the conductors I_1 to I_6 of FIG. 12. The stationary contacts on banks 152-158 are connected into a plurality of lamp circuits T1 to T54 on the display board. One of these is shown at T1, one terminal of the circuit T1 connecting to all stationary contacts in bank 152 and the other terminal connecting (as with all of circuits T1 to T54) with conductor 192 of FIG. 12 for grounding when relay K208 energizes. The other lamp circuits T2 to T54 are indicated in FIG. 14 only by reference to the stationary contact or contacts of banks 152 to 157 at which they respectively begin. It is also seen in FIG. 14 that by connection of all but one of the stationary contacts in bank 157 to the wiper arm of bank 156, strokes of impact value resulting in selection of line I_6 at relay 130 energize the same display board lamp circuits as strokes which generate signals at the same combinations of light sensitive elements 14 (FIG. 2) but with the next lower range of impact values, except in the case of the "perfect" shot or stroke which produces signals at elements P4 and P11 and which consequently brings stepping switch 150 to rest with its wiper arms on their eleventh stationary contacts. In this case, a separate board lamp circuit T54 is energized. This may comprise the board lamp circuit T48, brought into conduction by a relay which is energized by circuit T54, plus a number of additional lamps lengthening the "string" on the board 10.

A large number of possibilities exist for the selection and arrangement of such lamp circuits. In the embodiment illustrated in FIG. 14, all of the stationary contacts in bank 152 connect to the single lamp circuit T1, this being a lamp circuit not shown in FIG. 8. This means that if the player strikes the ball 4 so feebly that maximum time is required between the production of start and stop pulses at microswitches 54 and 58, the signal displayed on the board, to indicate minimum performance, is made without discrimination as to either direction or quality of swing. If the ball is struck hard enough to result in selection of impact lines I_2 at relay 130, any one of twelve lamp circuits T2 to T14 may be selected on the display board according to the angular position to which relay 150 moves before being brought to a halt by the energization of a particular combination of tubes in the series V301-V314. Of these, circuits T5 to T12 are shown in FIG. 9, lamp circuits T2, T3, T5, T11, T12,

and T13 being each energized for two angular positions of relay 150.

In similar fashion impact values corresponding to impact lines I_3 , I_4 and I_5 permit illumination on the display board of any one of three groups of lamp circuits T15 to T27, T28 to T40 and T41 to T53.

The lamp circuit so energized on the display board continues illuminated until conduction in tube V202-A rises to the threshold level of relay K206 in the cathode thereof. When this relay is energized, its contacts 206-1 complete the circuit for the stepping coil 121 in stepping relay 120, shifting the wiper arm 120-1 thereof from an even contact (number two, in case only a single "play" has been had) to the next succeeding odd numbered stationary contact. This shift de-energizes relay K202 with consequent extinction of tube V203, and de-energization of relay K209 and of all the remaining relays and thyatrons in the system, while relay K211 becomes energized. Stepping switch 130 is thereby reset to its zero or "number one" stationary contact position by conventional mechanical elements (not shown) forming part thereof. Relay 150 is not reset but remains in the position to which it was moved by the stroke whose display has just ended.

Approximately one second later V201 is brought to conduction again with energization of relay K201, and relay 120 is shifted once more to an even contact. This results in relighting of the projector lamp 13, and the system is again ready for another stroke.

The last even numbered stationary contact in the first bank of switch 120 is isolated from relay K202, so that the player has a limited number of strokes for his coin. With the completion of the time interval established by the gear train coupled with the timer motor, switch 66 is opened, whether or not all plays have been completed, and K101 is deenergized. This opens the B+ circuit of conductor 104 and prevents further operation of the equipment. At the same time, the circuit for the reset coil of switch 120 is completed at contact K101-1 and stepping switch 120 is restored to its "zero" position in which the wiper arm is on the number one contact.

There will now be described, with reference to FIG. 15, still other features forming a part of the invention in the preferred embodiment thereof.

The components already described provide a completely operative golf practice apparatus according to the invention, and when the wiper arm 120-1 of stepping switch 120 reaches the last stationary contact thereon, which is not connected to conductor 126, the apparatus is effectively disabled until reset by timer motor 68.

It is, however, advantageous to give to the player a running count of the number of strokes which he has taken, or of which remain to him to be taken. Moreover, the interest in the apparatus can be heightened by designating, for successive strokes, particular ones among the display board lamp circuits as targets or objectives to be achieved. Components suitable to these ends are schematically illustrated in FIG. 15.

In FIG. 15 there are shown at 120-2 and 120-3 the wiper arms of the second and third banks of contacts on stepping switch 120. These banks are generally indicated at 123 and 125 respectively. Associated with each of these wiper arms are a plurality of stationary contacts, twenty-one in the embodiment illustrated, and the wiper arms are shown on the first stationary contacts of their respective banks, all these wiper arms 120-1, 120-2, 120-3 moving together upon operation of stepping switch 120. The even numbered stationary contacts in bank 123, beginning with the fourth, are seen to be connected to one terminal of a plurality of lamps L9 to L1, while the first and last (twenty-first) contacts are connected to one terminal of a lamp L10 which may illuminate a "Pay" sign 39 on the board 10 (FIG. 8). Wipers 120-2 and 120-3 are connected to conductor 83 of transformer 84, while the opposite terminals of lamps

L1 to L10 are all connected to the other conductor 85 of that transformer.

When the entire apparatus is reset by de-energization of relay K101, restoring wipers 120-2 and 120-3 to the positions shown therefor in FIG. 15, and also when they engage their twenty-first or last stationary contacts, lamp L10 is lighted.

With a suitable coin inserted into the timer, the wiper arms of switch 120 shift to their second stationary contacts upon energization of relay K201. The player, in the example being described, now has ten strokes to make, or to "go." Upon his striking the ball 4, tube V202-A measures off a time interval during which the board is illuminated with a display representative of the stroke just made, and when relay K206 energizes switch 120, it advances its wiper arms to their third stationary contact. Again a short delay is imposed by tube V201 until relay K201 energizes, and stepping relay 120 advances to its fourth numbered stationary contacts. The apparatus is now set up for the next stroke, and lamp L9 is lighted, indicating that there are nine strokes to go. Thus, each time wiper arm 120-2 shifts to an even numbered stationary contact the apparatus is set up for a stroke, and the number of strokes remaining to be taken is indicated to the player: After the tenth stroke has been taken, and also after the apparatus is reset, the "Pay" lamp L10 is lighted. For this purpose lamps L1 to L10 may advantageously be provided in the display board itself, for example, at an aperture 36' out of the area occupied by the lamp circuits T1 to T54.

Bank 125 of stepping relay 120 and the other components illustrated in FIG. 15 supply the apparatus of FIG. 1 with the other optional features now under consideration, which may for convenience be termed a "challenge circuit or circuits."

On the board, and advantageously adjacent the ends of a plurality of selected ones of the lamp circuits T1 to T54 representative of balls fairly hit with adequate impact, there may be provided "challenge" or target lamps or combinations of lamps 300, 302 and 304 (FIG. 15). One of these is also shown at 300 in FIG. 6. One terminal of each of these is connected to conductor 85. The other terminals of these lamps are connected via movable -9 contacts respectively to normally closed contacts 306-3, 308-3 and 310-3 of three relays K306, K308 and K310 respectively. These relays are provided with mechanical latches which latch the movable contacts thereof in the position opposite that shown in the drawing when energized, and they are provided respectively with reset or release windings 312, 314 and 316, all connected in parallel to conductors 318 and 320 which, as indicated in FIG. 11, connect to the opposite terminals of reset coil 128 on stepping switch 120.

Display board 10 is provided with additional lamps or lamp combinations 322, 324, 326 (FIG. 15) which may be disposed immediately adjacent lamps 300, 302 and 306 respectively, but arranged to be distinguishable therefrom. Thus lamps 300, 302 and 304 may be positioned behind transparent sheet 34 of board 10 to illuminate representations of golf greens, whereas lamps 322, 324, and 326 when lighted illuminate representations of flags. Lamps 322, 324 and 326 have each one terminal connected to a movable -10 contact engageable with either a normally closed -4 contact or with a normally open -5 contact on relays K306, K308 and K310 respectively, and the other terminal connected to a movable -11 contact engageable with either a normally closed -6 or a normally open -7 contact on those relays respectively.

Further, for each of lamps 300, 302 and 304, conductors 328, 330 and 332 respectively lead from a normally closed -4 contact on relays K306, K308 and K310 respectively to the stationary contact or contacts of banks 152 to 157 of stepping relay 150 (shown in FIG. 14) of the display board lamp circuits with which the "challenge" circuit of lamps 300, 302 and 304 are respectively

associated. Thus if the lamp circuit illustrated in FIG. 6 is T31, with which challenge lamp 300 and flag lamp 322 are associated, conductor 323 connects to the sixth and seventh stationary contacts of bank 155 in FIG. 14. Conductors 328, 330 and 332 also connect respectively through normally open contacts 302-1, 303-1 and 304-1 on relays K302, K303 and K304 with the actuating coils of relays K306, K308 and K310 respectively. Relays K302, K303 and K304 have their actuating coils connected between conductor 85 on the one hand and both of the -1 and -3 normally closed contacts on relays K306, K308 and K310 respectively.

Further conductors 334, 336 and 338 lead respectively to movable contact blades -8 on relays K306, K308 and K310 respectively, these contact blades being engageable with normally closed -1 and with normally open -2 contacts of those relays in respectively, in their de-energized and energized states respectively. Moreover, conductor 336 connects with normally open contact 306-2. Similarly, conductor 338 connects with normally open contact 308-2.

Conductor 334 is connected to the second, eighth and fourteenth stationary contacts in bank 125, and conductor 336 to the fourth, tenth and sixteenth, and conductor 338 to the sixth, twelfth and eighteenth and twentieth. Accordingly, when stepping relay 120 advances its wiper arms to the second stationary contact in each of its banks, conductor 334 will be energized.

Application of voltage to conductor 334 results in energization of relay K302 via contact 306-1 on relay K306. It also lights the target or challenge lamp 300 via contact K306-3. The operator of the apparatus now makes his stroke. If he is successful in the objective manifested by lighting of lamp 300 he will cause relay 150 to select for energization on the display board the lamp circuit T31. Energization of this, and only this, lamp circuit applies voltage to the conductor 328 in FIG. 15. This produces energization of relay K306 via the now closed contact 302-1. When relay K306 is energized, it latches and its movable contacts 306-10 and 306-11 effect illumination of the flag lamp 322, indicating to the player that he has succeeded, and, as it were, made a hole in one. Energization of relay K306 moreover extinguishes challenge lamp 300 and de-energizes relay K302.

Advance of stepping relay 120 to its fourth numbered stationary contact for the next stroke produces at bank 125 energization of conductor 336 with a similar sequence of events respecting challenge or target lamp 302 and flag lamp 324 in case the player achieves selection of the particular lamp circuit on the display board to whose contact or contacts among the stationary contacts of banks 152-157 conductor 330 is connected. Similarly, preparation in stepping relay 120 of the third stroke by advance of its wiper arms to their sixth stationary contacts produces energization of conductor 338 with lighting of target lamp 304.

FIG. 15 illustrates a particular detail in the embodiment illustrated to which reference has already been made. The optimum form of stroke is that which in the array of light sensitive elements of FIG. 2 produces signals at elements P4 and P11, and this results in advance of stepping relay 150 to its eleventh numbered stationary contact in all banks. For a stroke of impact value identified with conductor I_5 of stepping relay 130 this produces energization of the lamp circuit T48 on the display board. This circuit includes a plurality of lamps connected between the eleventh stationary contact in bank 156 of relay 150 and conductor 192 of FIG. 11 exactly in the manner illustrated in FIG. 13 for lamp circuit T1. In addition, however, there is shown in FIG. 15 a conductor 340 which is connected at one end to the eleventh stationary contact in bank 156 of FIG. 14, i.e., at the end of lamp circuit T48 opposite conductor 192. Conductor 340 is connected at its other end to the

movable contact 391-1 of a relay K301. In the de-energized condition of this relay a blade 301-1 thereof engages a stationary contact 301-2. Contact 301-2 connects to one terminal of a lamp or combination of lamps 342, the other terminal of which is connected to conductor 192 of FIG. 12. Lamp 342 illuminates on display board 10 a yardage marker, for example, one reading "270 yards" to indicate to the player that he has made a very good stroke. Lamp 342 is thus a supplement to circuit T48, illuminated when the latter is energized from impact line I_5 .

If, however, the stroke to be displayed produces signals at the same light sensitive elements P4 and P11 but with even higher impact which causes relay 130 to step only to the impact line I_6 of highest impact, it will be wiper 150-7 in bank 157 of FIG. 14 which is energized for illumination of a lamp circuit on the display board. Consequently, voltage will be applied to the eleventh stationary contact of bank 157, this contact being that which produces energization of lamp circuit T54.

Lamp circuit T54 comprises a conductor 344 shown in FIG. 14 and the continuation of which is shown in FIG. 15. Conductor 344 connects at one terminal with a lamp or lamp combination 346, the other terminal of which connects with conductor 192. It also connects with one terminal of the actuating coil of relay K301, the other terminal of that actuating coil also connecting with conductor 192.

Consequently, upon application of voltage to conductor 344 relay K301 is energized and its movable contact 301-1 engages a normally open contact 301-3 thereon to which conductor 344 is also connected.

In consequence, application of voltage to conductor 344 energizes the lamp circuit T48, via conductor 340, and, in addition, the yardage marker lamp 346 which may, for example, be labeled "300 yards."

It will be seen from the foregoing that the invention provides golf practice apparatus comprising, among other components, a captive ball 4, displaceable means 6 to support the ball in a rest position, first and second micro-switches 54 and 58 arranged to be actuated successively by said support means upon striking of the ball with a golf club swung thereat, a capacitor C212 connected in series with a resistor R220, with a third switch constituted by tube V204 and with a source of direct current voltage at conductor 136. The invention further provides in tube V203 means to close that third switch in response to actuation of switch 54 and in tube V205, means to open that third switch in response to actuation of switch 58. The invention also provides a first stepping relay switch 130 having a plurality of contacts in each of two banks, a first electron discharge device V207 having a cathode, anode and control grid and having its anode-cathode path connected in series with the stepping coil 132 of that stepping switch and with a source of alternating current voltage at transformer T201. The invention further provides a plurality of resistors R232 to R236 connected in series with the contacts of one of those banks, these resistors being connected in series with a source of direct current voltage at conductor 96 and with a further resistor R225 to bias said device V207 to cut off. The invention further provides in tube V206B means to apply a voltage representative of the charge on capacitor C212 as an unbiasing signal to the control grid of device V207 whereby the stepping switch 130 will take up a position representative of the value of that charge. The invention further provides a display board 10, a plurality of lamp circuits T1 to T54 arranged in groups on that board, and a plurality of first supplementary lamp circuits 300, 302 and 304 and second supplementary lamp circuits 322, 324 and 326 arranged on that board in association with certain of said first named lamp circuits, e.g. with circuits T31, T48 and T35. The invention further provides a second stepping relay switch 120 having a plurality of banks of contacts and having odd

and even numbered contacts of one bank thereof connected together respectively. The invention further provides in relay K211 means operable by said second stepping switch to permit charge of said capacitor C212 upon actuation of said first switch when said second stepping switch is on an even numbered contact and to discharge said capacitor when said second stepping switch is on an odd numbered contact. The invention further provides two linear arrays 18 and 20 of photoelectric sensing elements 14 extending transversely of the path of the shadow of the club head on the plane of platform 2 in position to be traversed successively by that shadow, the elements being arranged for the generation of a signal at one element in each of those arrays by that shadow. The invention further provides (in tubes V301-V314) an electron discharge tube for each of the elements 14, these tubes having an anode, a cathode and control grid, means coupling each of elements 14 to the control grid of one of tubes V301-V314, and two sources of negative bias voltage of unequal values at conductors 98 and 102. The invention further provides at resistor R103 means applying the lesser of said bias voltages to the control grids of those tubes, and at relay K205 means responsive to the generation of a signal in an element of the array 20 later traversed by the club head shadow to apply the greater of said bias voltages to tubes V301-V314. The invention further provides a third stepping relay switch 150 having as many banks of contacts 152 to 157 as there are groups of lamp circuits on the board and having two further banks of contacts 151 and 158, the lamp circuits of each of said groups being connected to the contacts of a separate one of the banks 152 to 157 on stepping switch 150. The invention further provides at conductors I₁ to I₆ means connecting the contacts of a second bank of contacts on said first stepping switch 130 to the wiper arms of the banks 152 to 157 on said third stepping switch to whose contacts said lamp circuits are connected, means connecting the contacts of said two further banks 151 and 158 on said third stepping switch 150 to the plate-cathode conduction paths of the electron discharge tubes V301 to V314 which are coupled to the sensing elements 14 of the two arrays 18 and 20 respectively such that each position of said third stepping switch 150 connects the wiper arms of its said two further banks 151 and 158 to a unique pair of the tubes V301 to V314. The invention further provides a relay K203 having normally closed contacts 208-1 in circuit with the stepping coil 159 of said third stepping switch 150, said relay having two actuating coils 208-2 and 208-3 through both of which current must flow to operate that relay, the wiper arms of said two further banks 151 and 158 being connected in series with said last named coils respectively. The invention further provides at conductors 334, 336 and 338 means connecting selected even numbered contacts on a second bank 125 of said second stepping switch 120 to said supplementary lamp circuits for energization thereof via the wiper arm of said last named bank, and in relays K306, K308 and K310 it provides means responsive to selection of said associated lamp circuits T31, T48 and T35 by said first and third stepping switches to de-energize said first supplementary lamp circuits 300, 302 and 304 and to energize said second supplementary lamp circuits 322, 324 and 326.

The invention is however not limited to the details set forth in the preceding paragraph nor to the structures which have been illustrated and described hereinabove. Numerous modifications may be made therein without departing from the scope of the invention, which is set forth in the appended claims.

I claim:

1. Golf practice apparatus comprising a captive ball, displaceable means to support said ball in a rest position, means to generate a signal representative of the time of passage of said ball between said rest position

and a displaced position on being struck with a golf club swung thereat, two linear arrays of photo-electric sensing elements extending transversely of the path of the projection of the head of said club onto a plane, said elements being arranged for the generation of a signal at one element in each of said arrays by the shadow of said swung club head, a plurality of groups of electrically energizable indicating means, the indicating means of each of said groups being associated with a range of values for said first named signal and each indicating means within each of said groups being associated with signals generated at a combination of said sensing elements, separate movable power distributing means for each of said groups, means responsive to said first-named signal to energize one of said distributing means, and means responsive to signals from said one elements to set said one distributing means to a position effecting energization of the indicating means associated with said one elements.

2. Golf practice apparatus comprising a captive ball, displaceable means to support said ball in a rest position, means to generate a signal representative of the time of passage of said ball between said rest position and a displaced position on being struck with a golf club swung thereat, two linear arrays of photo-electric sensing elements extending transversely of the path of the projection of the head of said club onto a plane, said elements being arranged for the generation of a signal at one element in each of said arrays by the shadow of said swung club head, a plurality of groups of electrically energizable indicating means, a switching circuit for each of said elements closable in response to the generation of a signal at such element, a stepping relay switch having a bank of contacts for each of said groups, the indicating means of each group being connected to the contacts of such bank, means to select for energization the wiper arm of one of said banks according to the value of said first named signal, said stepping switch having two further banks the contacts of each of which are connected to the switching circuits of the sensing elements of one of said arrays such that each position of said stepping switch connects the wiper arms of said further banks to a unique pair of said switching circuits, a relay having normally closed contacts in circuit with the stepping coil of said stepping switch, said relay having two actuating coils through both of which current must pass to operate said relay, the wiper arms of each of said further banks being connected in series with one of said last-named coils, whereby the circuit for said stepping coil is interrupted at said relay when the arms of said stepping switch are connected to the switching circuits of the sensing elements at which signals are generated by said swung golf club.

3. In a golf practice apparatus including a captive ball, a plurality of groups of electrically energizable indicating means and means to develop on a capacitor a charge representative of the impact delivered to said ball when struck with a golf club, means to select for energization among said groups in accordance with the value of said charge, said last-named means comprising a stepping relay switch having a plurality of banks of contacts, an electron discharge device having a cathode, anode and control grid and having its anode-cathode path connected in series with the stepping coil of said stepping switch and with a source of alternating current voltage, a plurality of resistors connected in series between the contacts of one of said banks, said resistors being connected in series with a source of direct current voltage and with a further resistor to bias said device to cutoff, and means to apply a voltage representative of said charge as an un-biasing signal to the control grid of said device, whereby said stepping switch will take up a position representative of the value of said charge.

4. A golf practice apparatus comprising a captive ball, displaceable means to support said ball in a rest position,

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a plurality of electrically energizable indicating means, two linear arrays of sensing elements extending transversely of the path of the head of a golf club swung to strike said ball in position to be traversed successively by said club head, said elements being arranged for the generation of a signal on one element in each of said arrays, an electron discharge device for each of said elements, each of said devices including an anode, a cathode and a control grid, means coupling each of said elements to the control grid of one of said devices, two sources of negative bias voltage of unequal values, means applying the lesser of said voltages to the control grids of said devices, means responsive to the generation of a signal in any of the elements of the one of said arrays later traversed by said club head to apply the greater of said

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bias voltages to said devices, and means to connect a source of voltage to combinations of said indicating means in response to the application of unbiasing signals to combinations of said electron discharge devices.

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