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Branz et al.

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[45] **June 12, 1973**

[54] **GOLF PRACTICING APPARATUS**

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[73] Assignee: **Lectron Industries, Inc.**, Dallas, Tex.

[22] Filed: **Feb. 16, 1971**

[21] Appl. No.: **115,305**

[52] **U.S. Cl.** ..... **273/185 D**, 273/195 A

[51] **Int. Cl.** **A63b 69/36**

[58] **Field of Search** ..... 273/185, 176, 200, 273/197, 184, 284, 285; 73/379 TB, 380 A, 381 G

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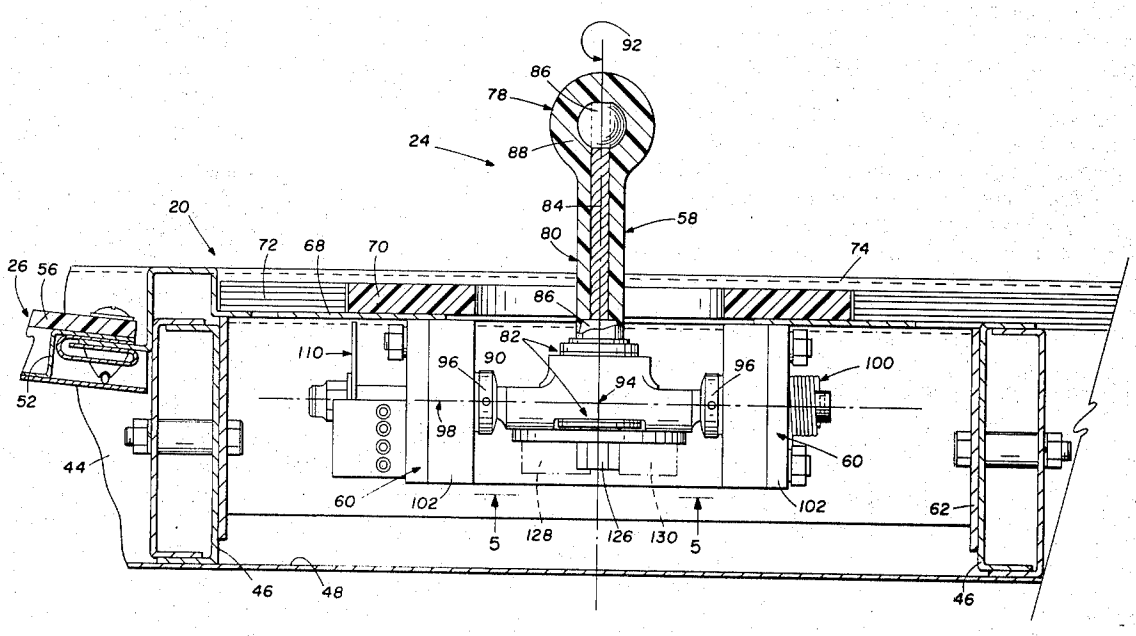
Primary Examiner—George J. Marlo

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[57] **ABSTRACT**

A golf practicing apparatus includes a platform; a target mounted on the platform for receiving practice of golf shots; a display panel for indicating distance information, hook-slice information, and push-pull information; and electronic circuitry responsive to movement of the target for actuating the display panel. The target comprises a simulated golf ball and a stem which are supported for rotation about a first axis extending through the ball and the stem, a second axis extending perpendicularly to the first axis, and a third axis extending perpendicularly to the second axis and in the plane of the first axis. In operation, the speed of rotation of the target about the second axis is sensed to provide distance information, the direction and amount of rotation of the target about the first axis is sensed to provide hook-slice information, and the direction and amount of rotation of the target about the third axis is sensed to provide push-pull information. Rotation of the ball and stem about the first axis is detected by an assembly including a cam and conventional automobile breaker point assemblies. Rotation about the second axis is detected by a system including a lamp assembly, a phototransistor, and a rotatable opaque shutter including two spaced apart holes which permit two sequential light pulses to reach the phototransistor. Rotation about the third axis is detected by a system including a lamp assembly and a rotatable opaque shutter which uncovers one or more phototransistors arranged in a V-shaped array.

29 Claims, 14 Drawing Figures



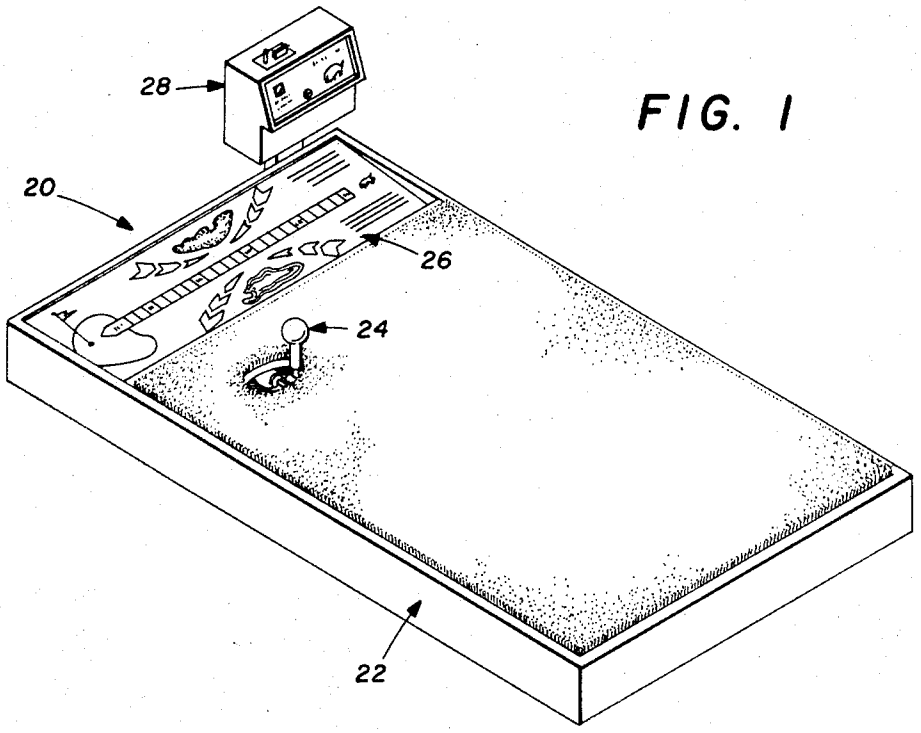


FIG. 1

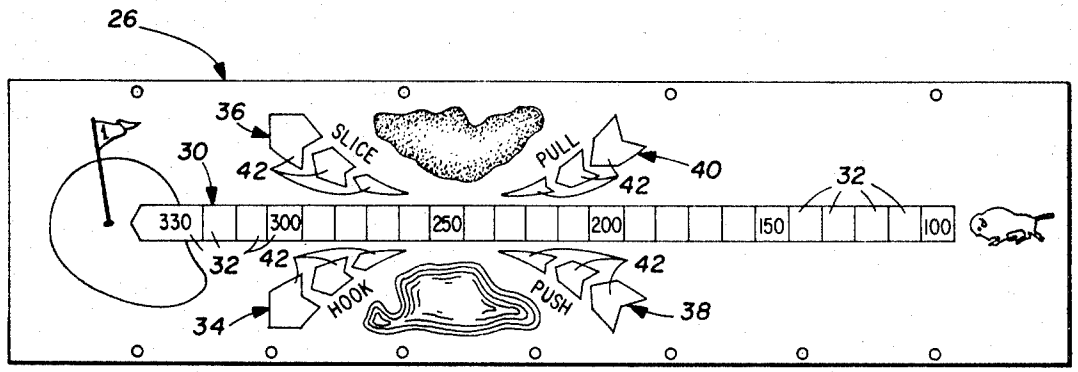


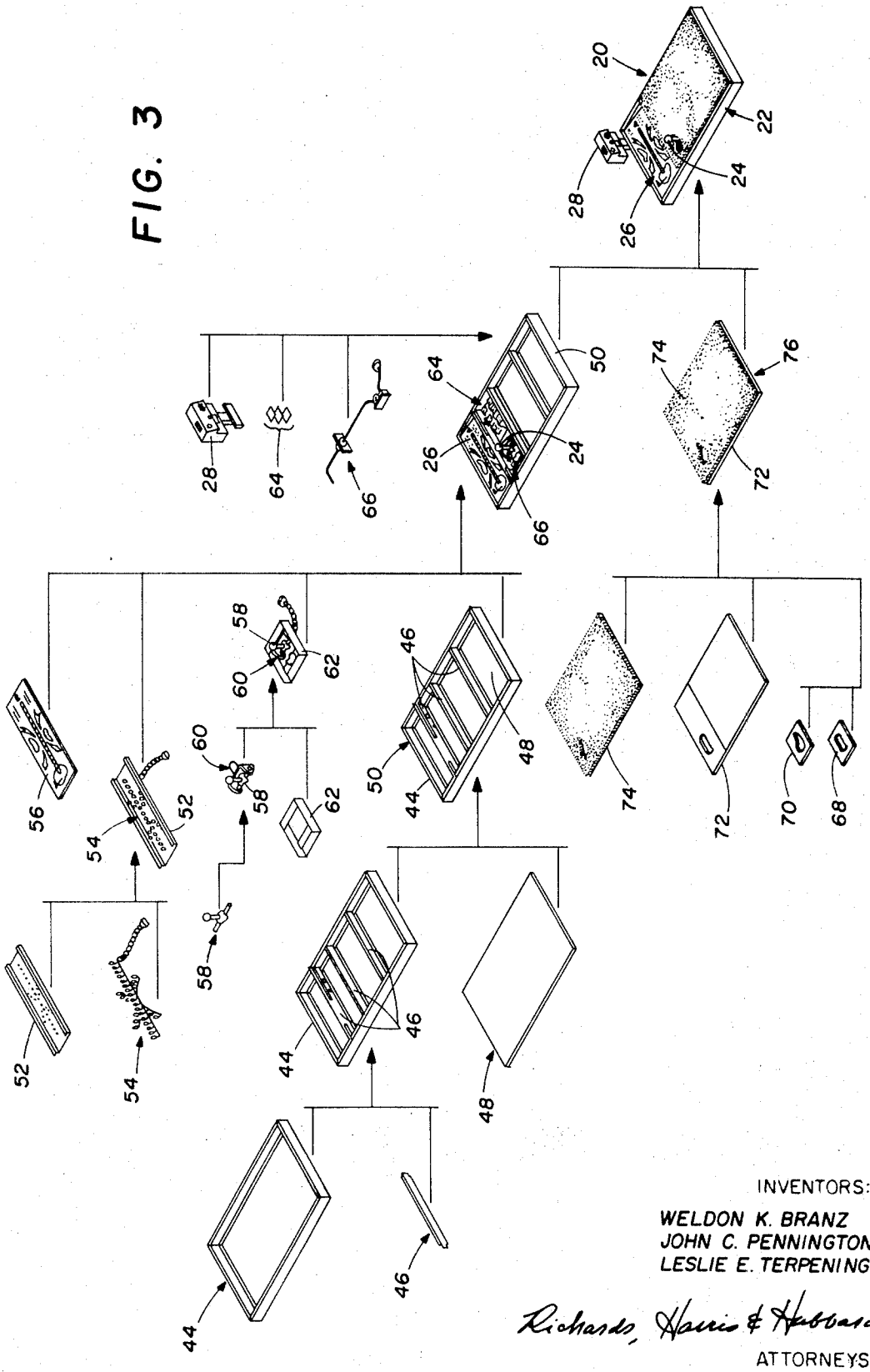
FIG. 2

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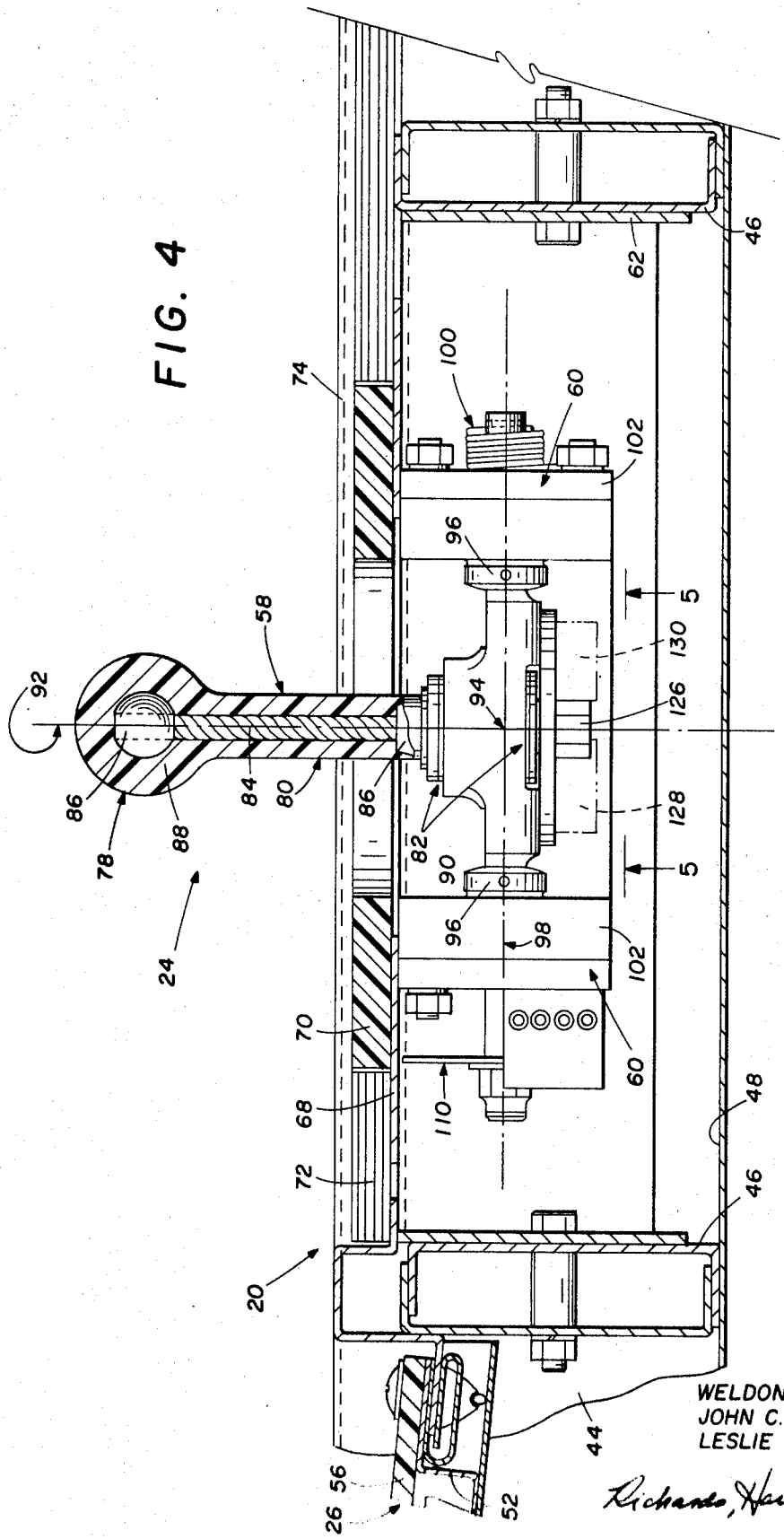
FIG. 3



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FIG. 4



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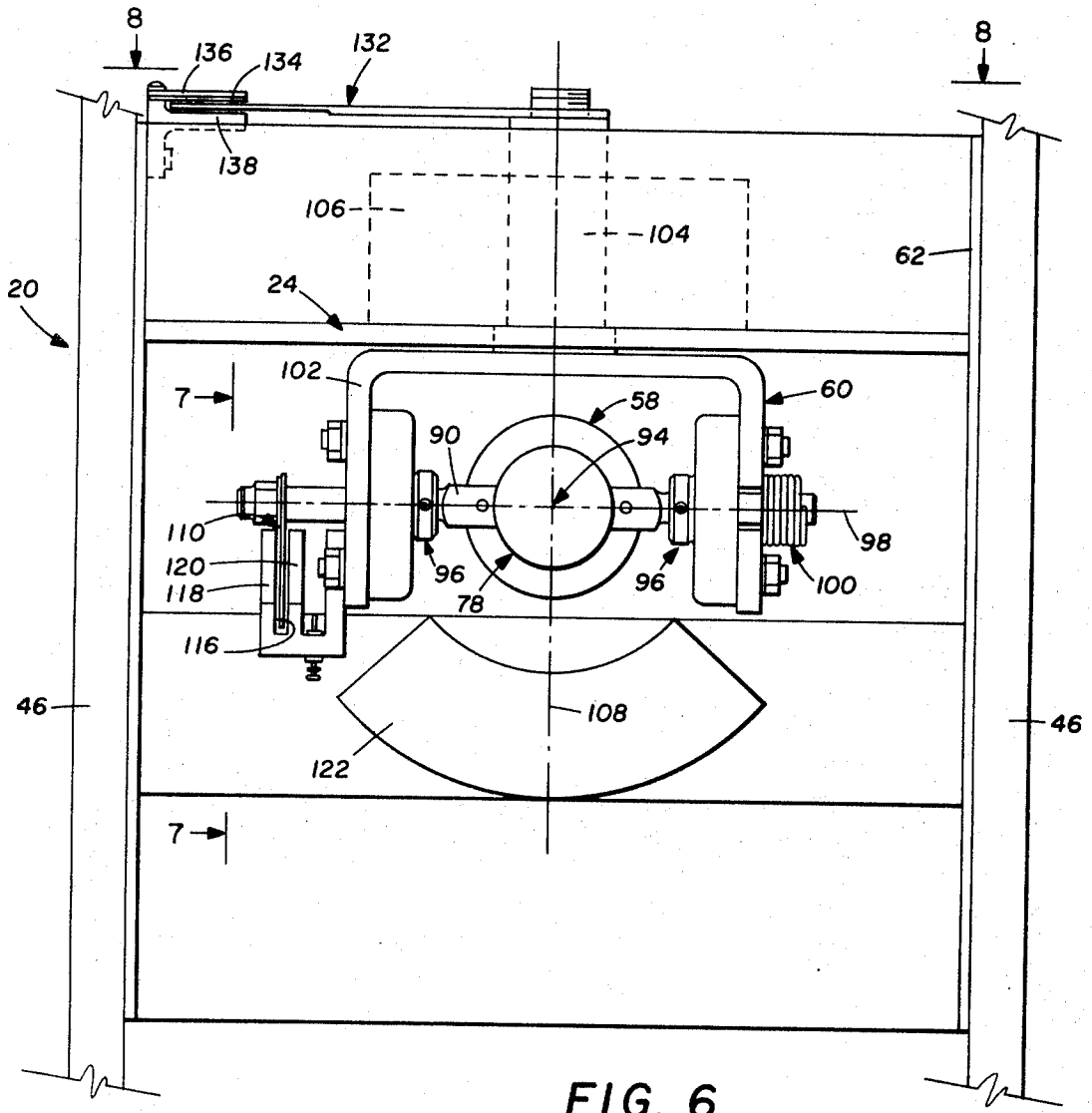


FIG. 6

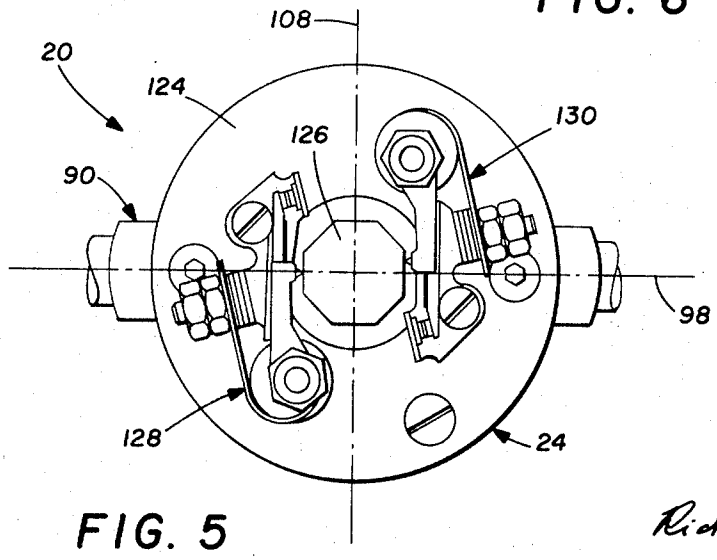


FIG. 5

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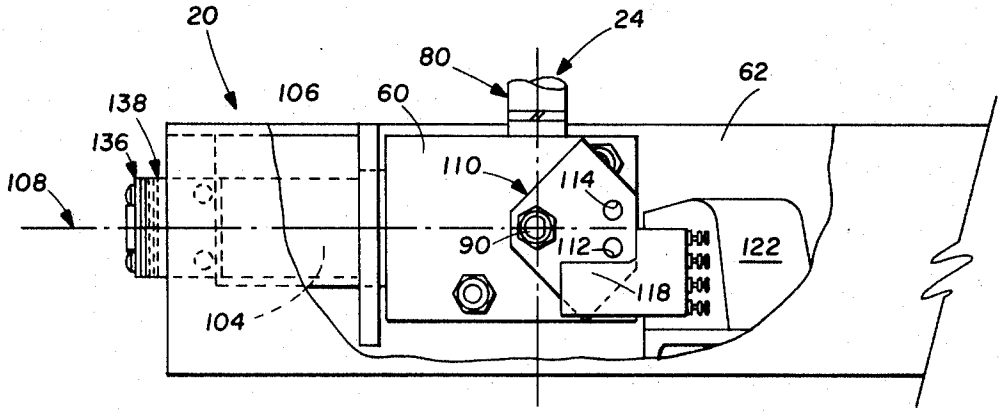


FIG. 7

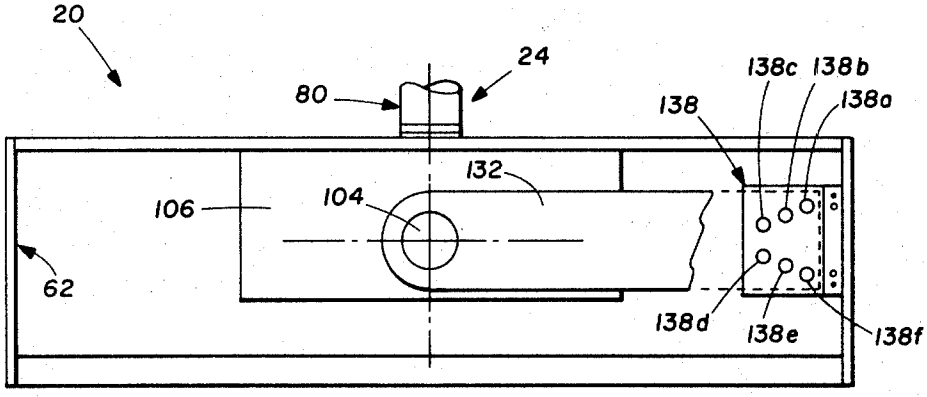


FIG. 8

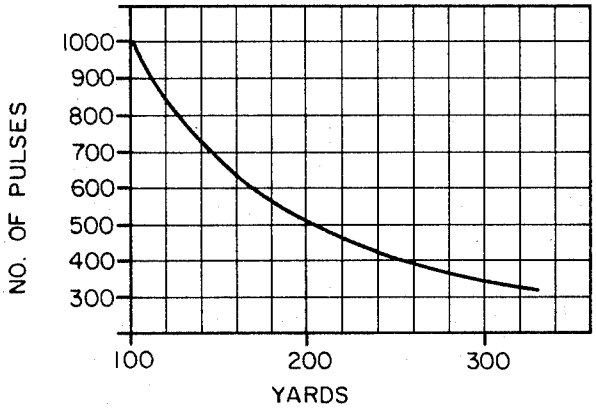


FIG. 12

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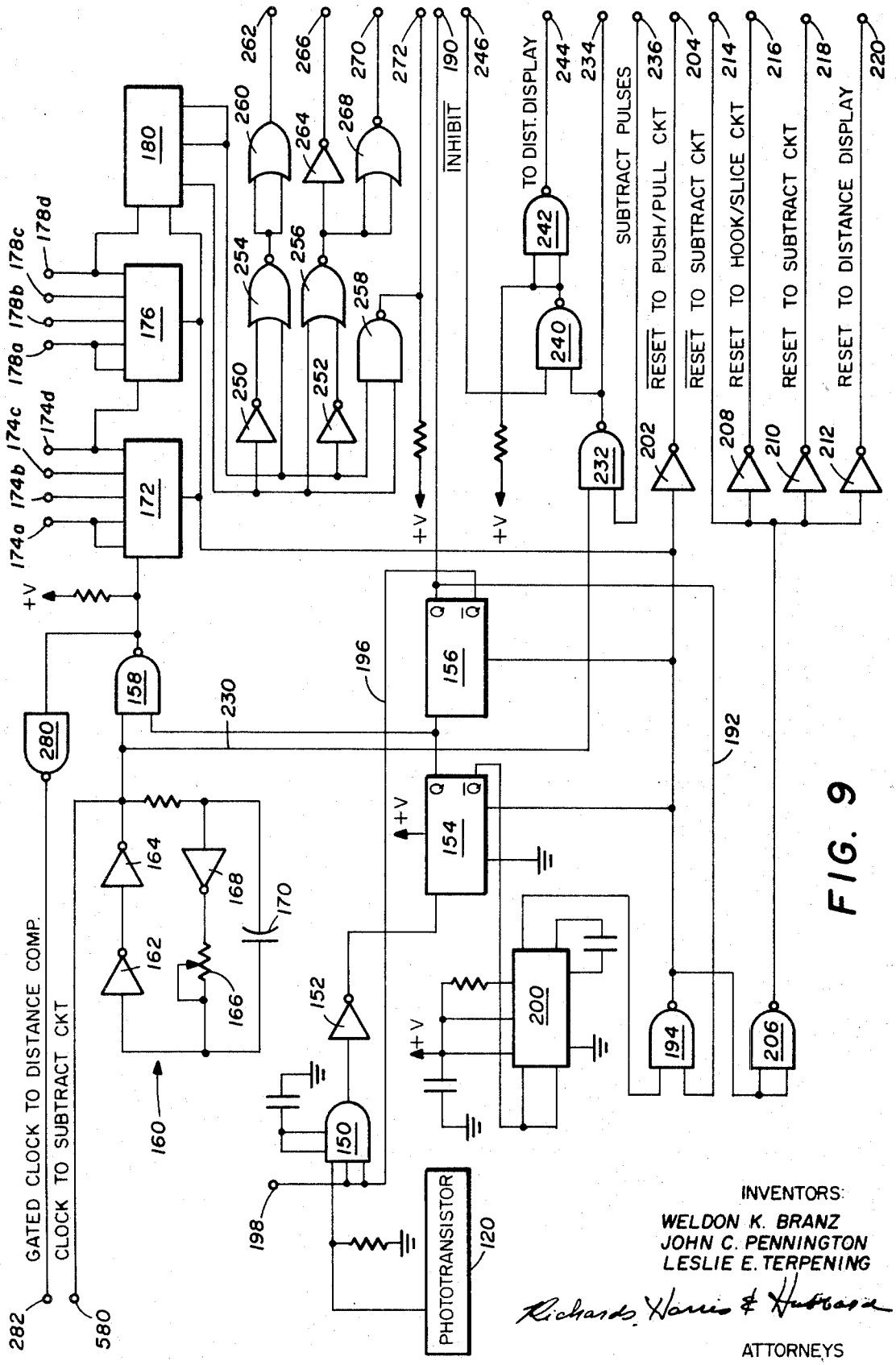


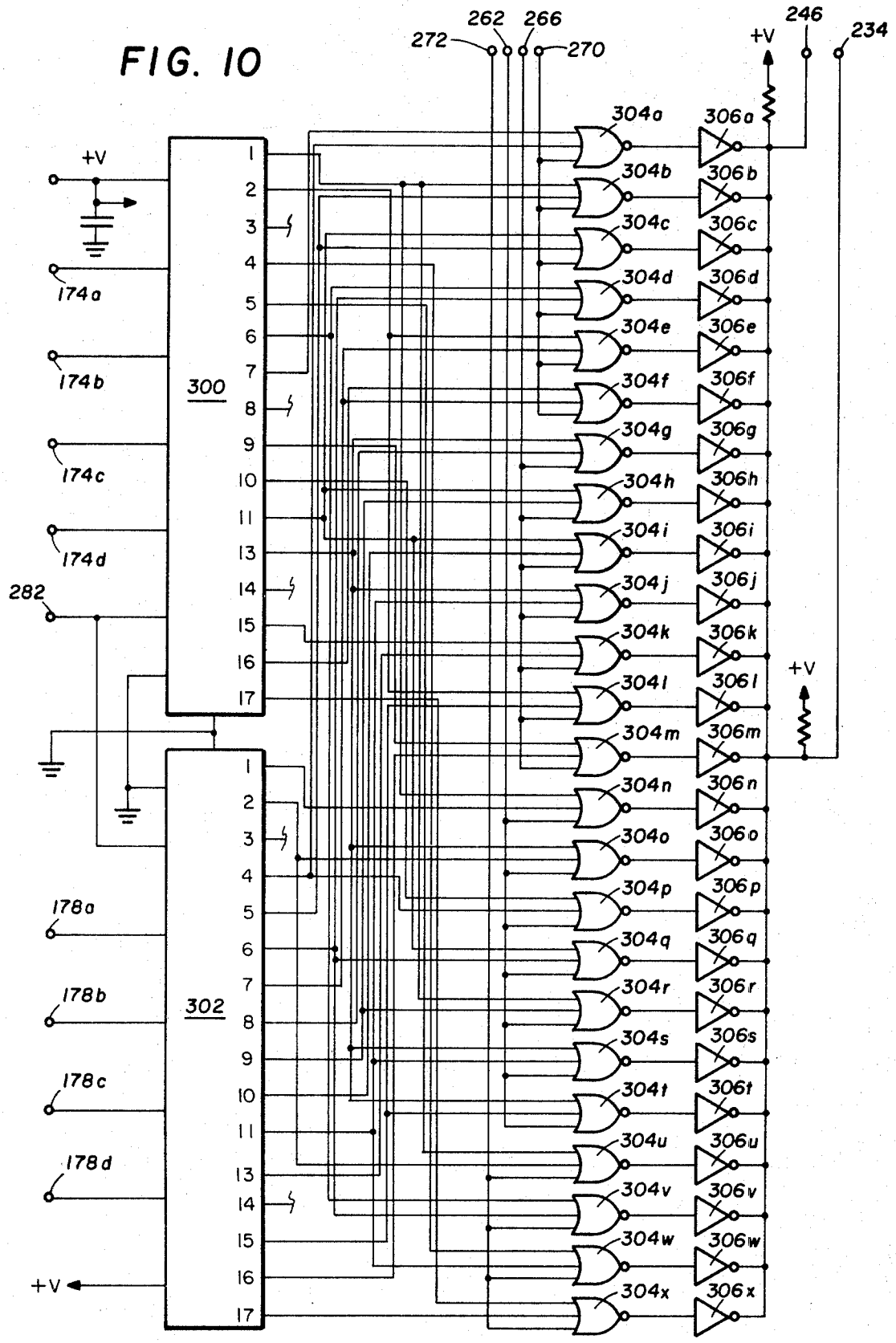
FIG. 9

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FIG. 10


262
266
272
270
246
234
+V
304a
306a
304b
306b
304c
306c
304d
306d
304e
306e
304f
306f
304g
306g
304h
306h
304i
306i
304j
306j
304k
306k
304l
306l
304m
306m
304n
306n
304o
306o
304p
306p
304q
306q
304r
306r
304s
306s
304t
306t
304u
306u
304v
306v
304w
306w
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174d
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302
178a
178b
178c
178d
+V

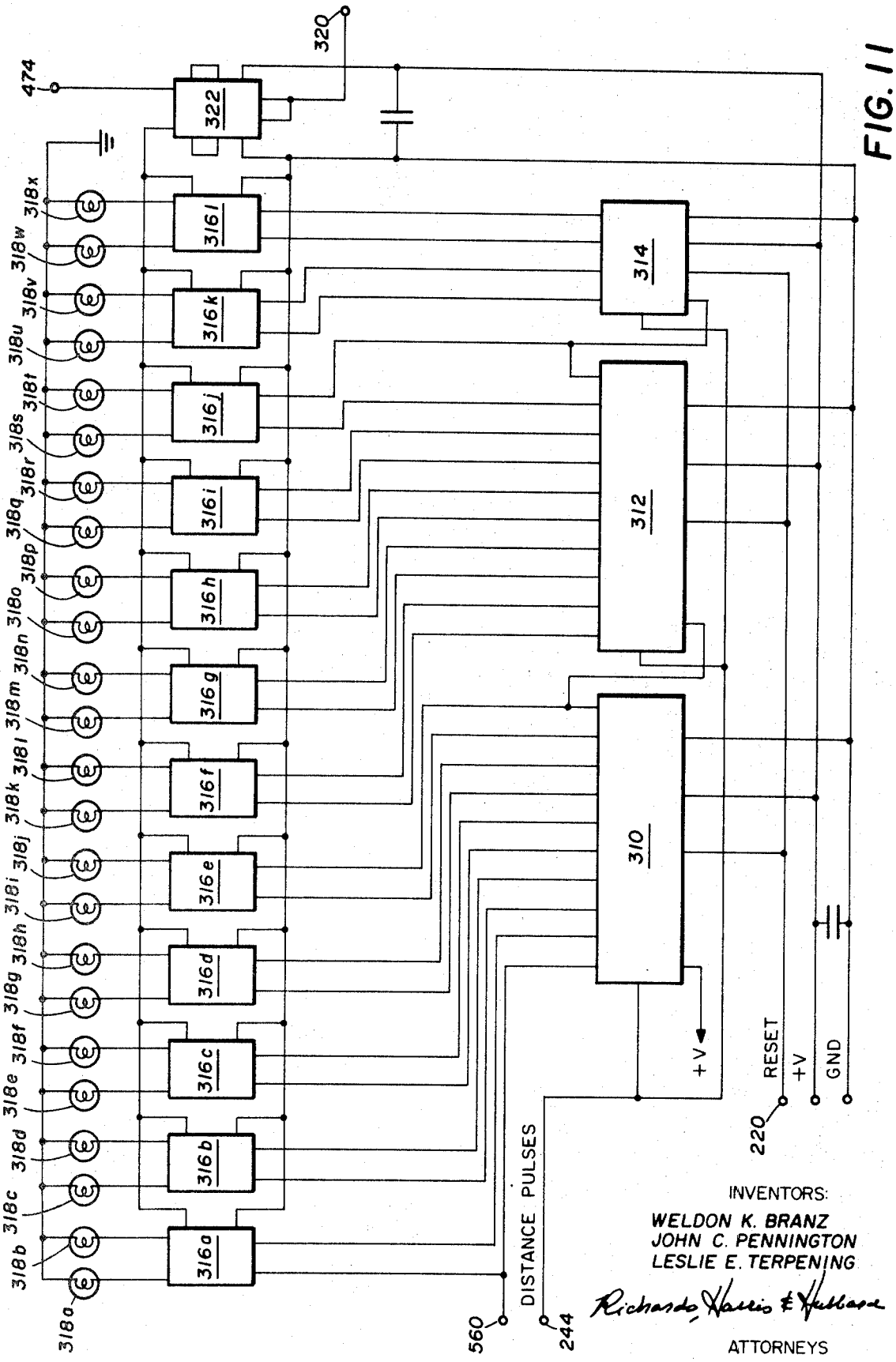


FIG. 11

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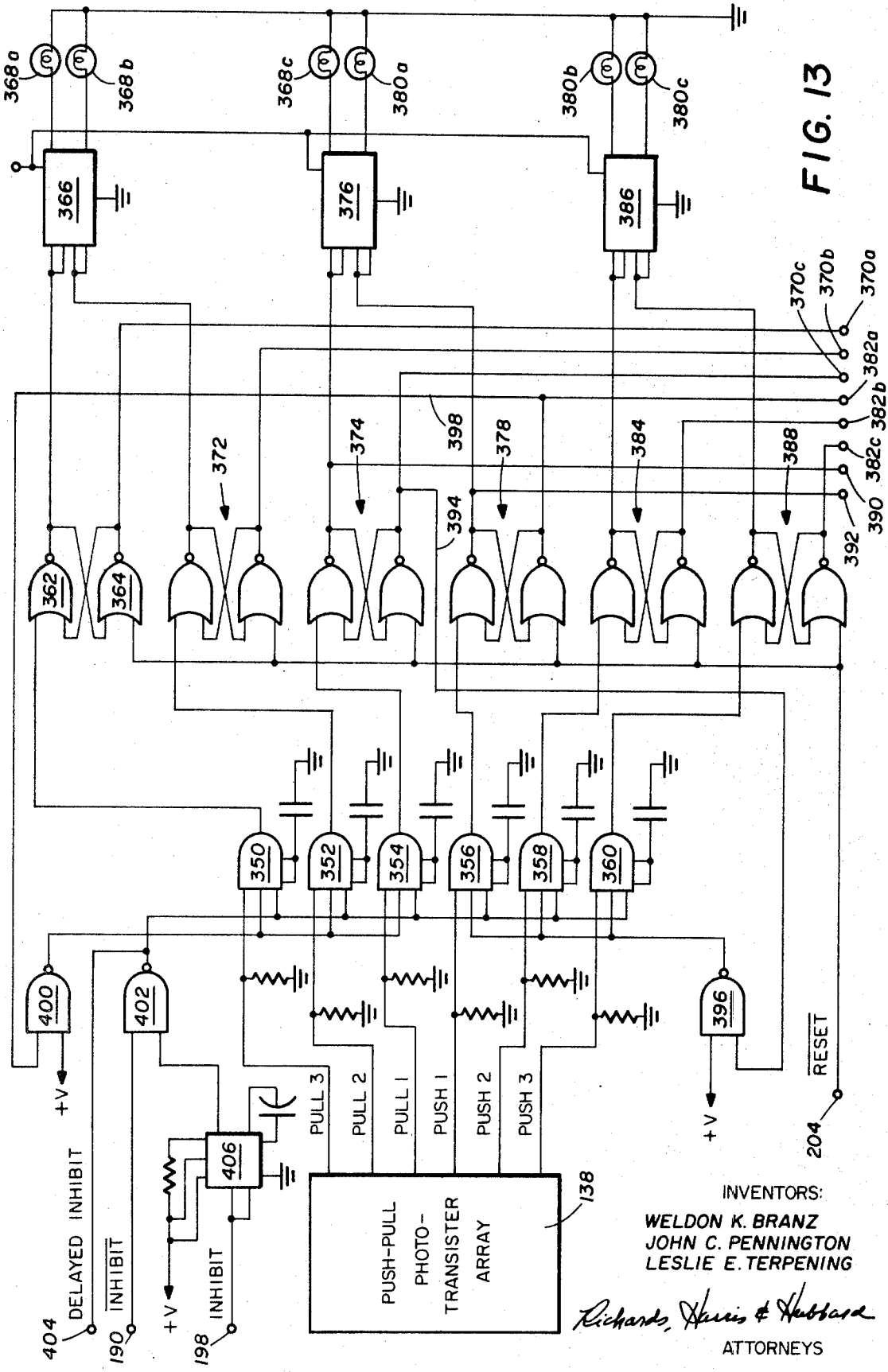


FIG. 13

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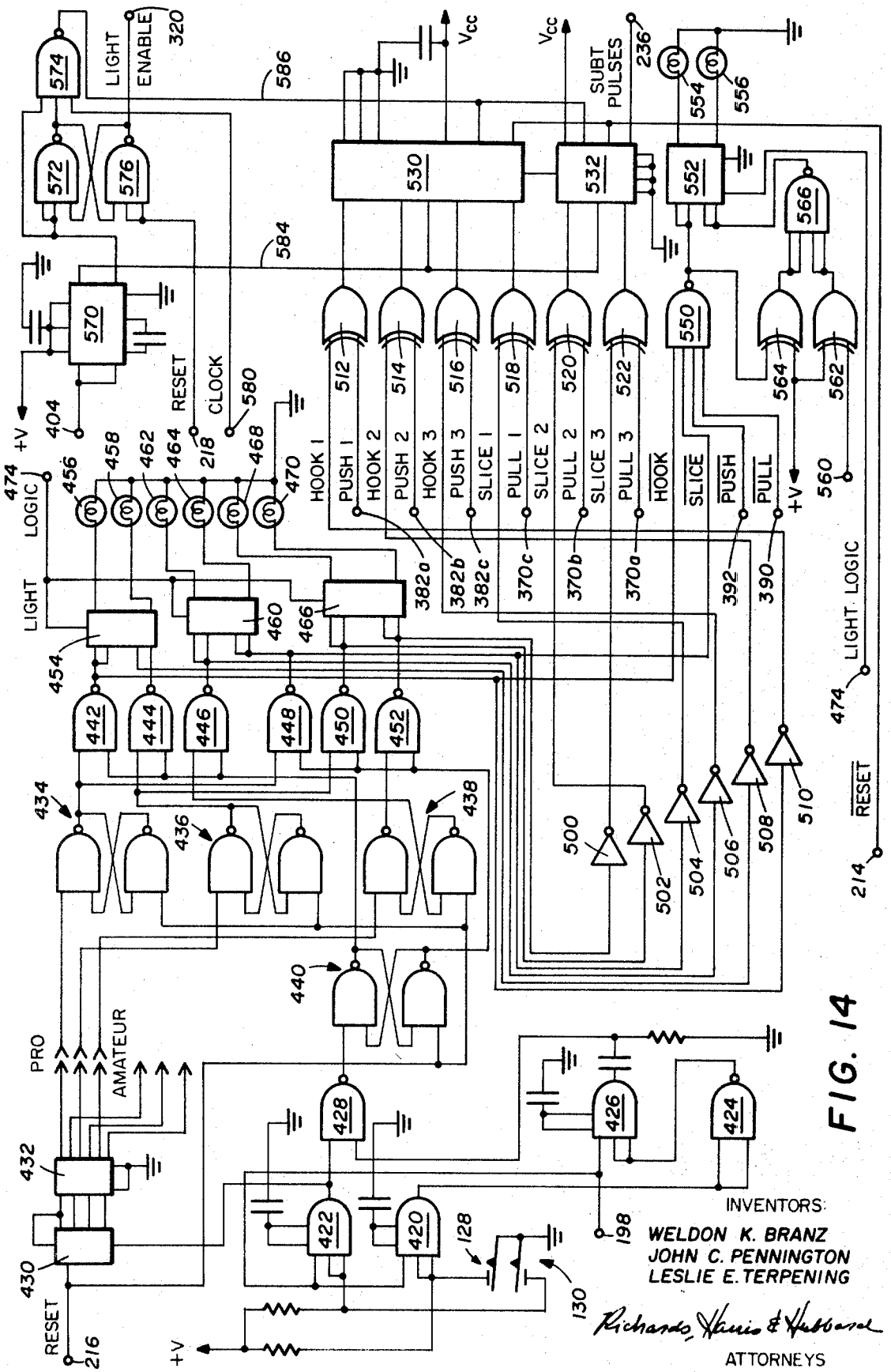


FIG. 14

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GOLF PRACTICING APPARATUS

BACKGROUND AND SUMMARY OF THE INVENTION

This invention relates to a golf practicing apparatus, and more particularly to a device for analyzing practice golf shots in terms of distance information, hook-slice information and push-pull information.

It has long been realized that it would be advantageous to be able to practice golf shots in confined areas and/or in inclement weather. To this end, numerous attempts have been made at designing a workable golf practicing apparatus. However, notwithstanding the fact that considerable time and effort have been expended in this regard, most of the golf practicing devices that are presently commercially available exhibit numerous disadvantageous characteristics.

For example, most prior art golf practicing devices include a simulated golf ball mounted for impact by a golf club, and structure for generating information as to how far a real golf ball would travel in response to the same impact. Typically, the simulated golf ball is returned to the same orientation after each shot, so that the same "side" of the simulated golf ball receives each impact. This causes rapid deterioration of the impact receiving side of the simulated golf ball.

Another problem that is often encountered in the use of prior art golf practicing devices is the rapid deterioration of the sensing mechanism. Heretofore, it has been common either to connect the sensing mechanism directly to the simulated golf ball, or to mount the sensing mechanism for impact by the simulated golf ball. In either case, the sensing mechanism is subject to repeated shocks,vibrations, etc., and is therefore extremely susceptable to damage.

Still another disadvantage in the use of many prior art golf practicing devices relates to the inability of such devices to provide a complete analysis of a practice golf shot. Early golf practicing devices were equipped to provide distance information only. Somewhat later, golf practicing apparatus capable of determining both how far a real golf ball would have traveled and the extent to which it would have been hooked or sliced were provided. Only very recently has there been any attempt to design a golf practicing apparatus capable of providing all of the information that is necessary for the complete analysis of a golf shot, i.e., distance information, hook-slice information and push-pull information.

The present invention comprises an improved golf practicing apparatus which overcomes the foregoing and other disadvantages that are characteristic of the prior art. In accordance with the preferred embodiment of the invention, a target includes a simulated golf ball mounted for impact by a golf club, and a stem fixed to the simulated golf ball. The target is supported for rotation about a first axis which extends through the ball and the stem, about a second axis which extends perpendicular to the plane of the first axis and a third axis which extends perpendicular to the second axis and within the plane of the second axis. The invention further comprises structure for measuring the speed of rotation of the target about the second axis and circuitry for generating a distance indicative signal in response thereto, and structure for measuring both the amount and the direction of rotation about the first and third axes and circuitry responsive to the latter measurements for generating error signals. Preferably, additional circuitry is provided for altering the distance indicative signal whenever rotation about either the first or the third axis is detected.

DESCRIPTION OF THE DRAWINGS

A more complete understanding of the invention may be had by referring to the following Detailed Description when taken in conjunction with the accompanying drawings, wherein:

FIG. **1** is a perspective view of a golf practicing apparatus incorporating the present invention;

FIG. **2** is a top view of the display panel of the golf practicing apparatus shown in FIG. **1**;

FIG. **3** is an illustration of the assembly sequence of the golf practicing apparatus;

FIG. **4** is a longitudinal sectional view illustrating the target of the golf practicing apparatus;

FIG. **5** is a bottom view taken generally along the line **5—5** in FIG. **4** in the direction of the arrows;

FIG. **6** is a top view of the target of the golf practicing apparatus;

FIG. **7** is a side view taken generally along the line **7—7** in FIG. **6**;

FIG. **8** is an end view taken generally along the line **8—8** in FIG. **6**;

FIG. **9** is a schematic illustration of a portion of the distance display circuitry of the invention;

FIG. **10** is a schematic diagram of the nonlinear distance computation circuitry of the invention;

FIG. **11** is a block diagram of the distance display circuitry of the invention;

FIG. **12** is a graph illustrating the nonlinear relationship between the displayed distance and the pulses representative of time which are generated by the circuitry shown in FIGS. **9** and **10**;

FIG. **13** is a schematic diagram of the push-pull computation and display circuitry of the invention, and

FIG. **14** is a schematic diagram of the hook-slice and subtraction computation and display circuitry of the invention.

DETAILED DESCRIPTION

Referring now to the drawings, and particularly to FIG. **1** thereof, there is shown a golf practicing apparatus **20** incorporating the present invention. The golf practicing apparatus **20** comprises a platform **22** which preferably is of suitable size and construction to support a golfer. A target **24** is mounted in the platform **22** and is normally positioned for impact by a conventional golf club that has been driven by a golfer standing on the platform **22.** Following such an impact, distance information, hook-slice information and push-pull information concerning the practice golf shot is indicated on a display panel **26.** The golf practicing apparatus **20** may also be provided with a conventional coin box **28,** whereby money must be paid before the golf practicing apparatus **20** can be operated. It will be appreciated, however, that the coin box **28** may be replaced with a conventional on-off switch, if desired.

The display panel **26** of the golf practicing apparatus **20** is shown in greater detail in FIG. **2.** The display panel **26** includes a distance scale **30** comprising a series of individual segments **32.** A lamp is positioned behind each segment **32,** and selected lamps are actuated following impact of the target **24** by a golf club to indicate the distance that a conventional golf ball would have traveled in response to an identical impact. The

display panel 26 further includes a hook scale 34, a slice scale 36, a push scale 38, and a pull scale 40. Each of the scale 34–40 includes three segments 42, and an individual lamp is positioned behind each segment 42. Following the impact of a golf club with the target 24, one or more of the segments 42 of one or more of the scales 34–40 may be illuminated to indicate the extent to which a real golf ball would have been hooked or sliced in response to an identical impact, and/or the extent to which the practice golf shot was pushed or pulled.

The assembly sequence of the golf practicing apparatus 20 is illustrated in FIG. 3. Initially, a frame 44, a plurality of stringers 46, and a bottom 48 are assembled to form a base 50. The display panel 26 comprises a plate 52 which receives a lamp harness 54, and a cover 56 which is mounted on the plate 52. Similarly, the target 24 comprises a pivot assembly 58 which is mounted on a yoke 60, and a housing 62 which receives the yoke 60. Thereafter, the display panel 26 and the target 24 are mounted in the base 50 and are combined with the coin box 28, a plurality of electronic circuit cards 64 and a power supply 66. The golf practicing apparatus 20 is completed by joining a steel plate 68 and a rubber pad 70 to a top 72, mounting a strip of artificial grass 74 on the top 72 to form a cover assembly 76, and then mounting the cover assembly 76 on the base 50 to complete the platform 22.

The structural details of the target 24 of the golf practicing apparatus 20 are illustrated in FIGS. 4 through 8. Referring particularly to FIG. 4, the pivot assembly 58 of the target 24 comprises a simulated golf ball 78 and a stem 80 which extends from the simulated golf ball 78 to a pair of bearings 82. The simulated golf ball 78 and the stem 80 comprise a length of wire rope 84 having a pair of steel plugs 86 swaged to its opposite ends, and a cover 88 which may be formed from polyurethane, or the like. The bearings 82 are mounted in a cross shaft 90 and support the simulated golf ball 78 and the stem 80 for free rotation about a first axis 92 extending axially through the simulated golf ball 78 and the stem 80, and through the pivot point 94.

As is best shown in FIGS. 4 and 6, the cross shaft 90 is supported in the yoke 60 by a pair of bearings 96. The bearings 96 permit rotation of the simulated golf ball 78, the stem 80, the bearings 82 and the cross shaft 90 about a second axis 98 which extends through the pivot point 94 and perpendicular to the first axis 92. A spring 100 is connected between the cross shaft 90 and the yoke 60 and functions to provide a restoring force which returns the target to a position illustrated in FIG. 1 following impact of the target by a golf club.

Referring now specifically to FIG. 6, the yoke 60 comprises a U-shaped member 102 which supports the bearings 96, and a cylindrical shaft 104 which supports the U-shaped member 102. The housing 62 is supported between two of the stringers 46 of the base 50 and includes a mounting block 106. The mounting block 106 receives the shaft 104 and supports the yoke 60, the bearings 96, the cross shaft 90, the bearings 82, the stem 80, and the simulated golf ball 78 for rotation about a third axis 108 which extends through the pivot point 94 perpendicular to the second axis 98, and in the plane of the first axis 92.

From the foregoing, it will be understood that the target 24 of the golf practicing apparatus 20 comprises a simulated golf ball mounted for rotation about first, second, and third axes. In the operation of the golf practicing apparatus 20, rotation of the simulated golf ball 78 about the axes 92, 98 and 108 is employed to generate hook-slice information, distance information, and push-pull information, respectively. More particularly, the speed of rotation of the simulated golf ball 78 about the second axis 98 is employed to generate distance information, the direction and amount of rotation of the simulated golf ball 78 about the first axis 92 is employed to generate hook-slice information, and the direction and amount of rotation of the simulated golf ball 78 about the third axis 108 is employed to generate push-pull information.

Referring now to FIGS. 6 and 7, a shutter 110 is secured to the end of the cross shaft 90 remote from the spring 100. The shutter 110 has a pair of holes 112 and 114 formed in it and is positioned in a slot 116 extending between a lamp assembly 118 and a phototransistor 120. The shutter 110 is opaque, and normally functions to prevent the passage of light between the lamp assembly 118 and the phototransistor 120. However, upon impact of the simulated golf ball 78 by a golf club, the simulated golf ball 78 and the stem 80 pivot clockwise (FIG. 7) about the second axis 98 until the simulated golf ball strikes an impact damper 122. During this action, the passage of light between the lamp assembly 118 and the phototransistor 120 is permitted, first through the hole 112, and subsequently through the hole 114. The phototransistor 120 generates an output pulse whenever light is permitted to pass to it from the lamp assembly 118 and the elapsed time between the two pulses that are generated by the phototransistor 120 following impact of the simulated golf ball 78 by a golf club is measured to determine the speed of rotation of the simulated golf ball 78 about the second axis 98.

Referring now to FIG. 5, a circular plate 124 is secured to the bottom of the cross shaft 90, and an octagonal cam 126 is secured to the bottom of the stem 80 for rotation therewith about the first axis 92. A pair of conventional automobile breaker point assemblies 128 and 130 are mounted on the plate 124 and are positioned for actuation by the cam 126. It will be noted that whereas the breaker point assembly 128 is mounted in alignment with the second axis 98, the breaker point assembly 130 is offset with respect to the axis 98. Because of this positioning, the breaker point assemblies 128 and 130 cooperate to generate a combined output which is indicative of both the direction and the amount of rotation of the simulated golf ball 78 about the first axis 92.

Referring now to FIGS. 6 and 8, the shutter 132 is secured to the shaft 104 of the yoke 60 for rotation therewith about the third axis 108. The shutter is positioned in a slot 134 formed between a lamp assembly 136, and a phototransistor array 138. As is best shown in FIG. 8, the phototransistor array 138 includes six phototransistors 138*a*–138*f* which are positioned in a V-shaped array. The shutter 132 is opaque, and normally prevents the passage of light between the lamp assembly 136 and the phototransistor array 138. However, upon rotation on the shutter about the third axis 108, one or more of the phototransistors 138*a*–138*f* is uncovered, and by this means an output indicative of both the amount and the direction of rotation of the simulated golf ball 78 about the third axis 108 is generated.

Referring now to FIGS. 9–14, the electrical circuitry of the invention is illustrated. The electrical circuitry is connected between the target movement sensing structure previously described and the display panel 26 in order to visually indicate distance information, hook-slice information, and push-pull information. Referring now to FIG. 9, the phototransistor 120 is connected to an input of an AND gate 150. The output of the gate 150 is connected through an inverter 152 to a control terminal of a flip-flop 154. The Q terminal of the flip-flop 154 is connected to a flip-flop 156 and also to an input of a NAND gate 158. The second input of the NAND gate 158 is connected to a free running oscillator 160 comprising series connected inverters 162 and 164, a potentiometer 166, an inverter 168 and a capacitor 170. The oscillator 160 generates a series of clock pulses at about 500 KHz which are applied to the input of the gate 158. The potentiometer 166 may be varied in order to vary the frequency of the oscillator 160.

The output of the gate 158 is connected to the input of a register 172, the output of which is applied upon a series of terminals 174*a–d*. The output 174*d* is applied to the input of a second register 176. The register 176 includes output terminals 178*a–d*. The output terminal 178 of the register 176 is connected to the input of a third register 180. Registers 172, 176 and 180 comprise, for example, Model 8281A 4-bit counters manufactured and sold by Signetics.

In the operation of the circuitry thus described, the phototransistor 120 generates a pulse each time one of the holes 112 or 114 in the shutter 110 become aligned with the light beam from the lamp assembly 118. These pulses are applied through the gate 150 which provides a smoothing action to the rising voltage of the phototransistor 120. The inverter 152 inverts the pulse and applies the pulse to the flip-flop 154 which then toggles. The Q output of the flip-flop 154 goes high for a prescribed period upon the interception of the first pulse in a cycle from the phototransistor 120. This high state allows the clock pulses from the oscillator 160 to be applied through the gate 158 to the register 172 which then stores counts from the oscillator 160. Upon reception of the second pulse from the phototransistor 120 due to the passage of the hole 114 through the light beam from the lamp assembly, the Q output from the flip-flop 154 goes low to turn the NAND gate 158 off. The count thus stored in the registers 172, 176 and 180 is inversely proportional to the velocity of the target 24.

When the Q output of the flip-flop 154 goes low, the flip-flop 156 is toggled. The $\overline{Q}$ output of the flip-flop 156 goes low to thus provide an inhibit signal which is applied via a terminal 190 to the inhibit circuitry shown in FIG. 13. The Q output from the flip-flop 156 is also applied via a lead 192 to the input of a NAND gate 194. The $\overline{Q}$ output of flip-flop 156 is connected via a lead 196 to inputs of the AND gate 150 in order to inhibit operation of the distance determining circuitry for the remainder of a cycle. In effect, the gate 150 is allowed to only pass two pulses from the phototransistor 120 until a suitable reset signal is applied in the manner to be subsequently described. The $\overline{Q}$ inhibit signal from the flip-flop 156 is also applied to terminal 198 for application to the hook-slice determining circuitry of the invention which is shown in FIG. 14.

The $\overline{Q}$ output from flip-flop 154 is applied to a one-shot multivibrator 200 which operates to control the reset circuitry of the invention. The output of the multivibrator 200 is applied to the second input of the NAND gate 194, the output of which is applied through an inverter 202 to provide a reset signal to the push-pull circuit shown in FIG. 13 via a terminal 204. The output of gate 194 is also connected to the inputs of a NAND gate 206 which provides an output which is applied through a trio of inverters 208, 210 and 212. A reset signal is thus applied from the gate 206 via a terminal 214 to the subtract circuitry shown in FIG. 14. A reset signal is applied from the inverter 208 which is applied to the hook-slice circuit shown in FIG. 14 via a terminal 216. A reset signal is applied from the output of the inverter 210 to the subtract circuitry shown in FIG. 14 via a terminal 218. A reset signal is applied from the output of the inverter 212 to the distance display circuitry shown in FIG. 11 via a terminal 220.

The output from the oscillator 160 is also applied via a lead 230 to the input of a NAND gate 232, the output of which is connected via a terminal 234 to the circuitry shown in FIG. 10. The second input of the gate 232 is connected to the terminal 236 to receive subtract pulse signals from the subtract circuit shown in FIG. 14.

The output of the gate 232 is connected to an input of a NAND gate 240, the output of which is connected to the inputs of a NAND gate 242. The output of the gate 242 is applied to a terminal 244 for application to the display circuitry shown in FIG. 11. The second input of the gate 240 is connected to a terminal 246 to receive an inhibit signal from the circuitry shown in FIG. 10.

The outputs of the register 180 are interconnected as shown to the inputs of a pair of inverters 250 and 252, a pair of NOR gates 254 and 256, and a NAND gate 258. The output of gate 254 is connected through a NOR gate 260 to a terminal 262 for connection to the circuitry shown in FIG. 10. The output of the gate 256 is fed through an inverter 264 to a terminal 266 also for application to the circuitry shown in FIG. 10. The output of the gate 256 is also fed to the inputs of a NOR gate 268, the output of which is applied to a terminal 270 for application to the circuitry shown in FIG. 10. The output of the gate 258 is connected to a terminal 272 for application to the circuitry shown in FIG. 10. The output of the NAND gate 258 is connected through a NAND gate 280 to a terminal 282 for application of the gated clock pulse signals to the distance computation circuitry shown in FIG. 10.

The outputs from the register 172 are applied via the terminals 174*a–d* to an inline decoder 300 shown in FIG. 10. The outputs from the register 176 are applied via the terminals 178*a–d* to a second inline decoder 302. Referring to FIG. 10, the inline decoders 300 and 302 decode the binary outputs from the registers 172 and 176 into decimal data. Suitable inline decoders for use as circuits 300 and 302 are Model SN74154 decoders manufactured and sold by Texas Instruments Incorporated of Dallas, Tex. The decoded outputs from the decoders 300 and 302 are interconnected to the inputs of various ones of 24 NOR gates 304*a–x*. The outputs of the gates 304*a*–1 are connected through inverters 306*a*–1, the outputs of which are tied to the terminal 246. The outputs of the gates 304*m–x* are connected through inverters 306*m–x* to the terminal 234. The counts in the registers 172 and 176 are inversely proportional to the velocity of the target 24. The circuitry shown in FIG. 10 decodes this data to provide output

signals proportionally representative of the distance that a real golf ball would travel in response to the same impact that was applied to the target **24.**

The graph shown in FIG. **12** represents the relationship between the number of pulses applied to the decode circuitry of FIG. **10** and the distance in yards that a real golf ball would travel. As an example, 1,023 counts applied to the decode circuitry is representative of a distance of 100 yards, while a count of 310 counts is representative of 330 yards of travel. The circuitry shown in FIG. **10** is interconnected to provide outputs representative of distance in accordance with the graph shown in FIG. **12.** A synchronizing signal for the system is applied from the circuitry shown in FIG. **9** via a terminal **282.**

The counts are derived by the decode circuitry in the following manner. As an example, a logic high upon the terminal **270** is representative of 256 counts. Six counts are added from terminal **7** of the decoder **300,** while 48 counts are derived from terminal **4** of the decoder **302.** The respective inputs to the gate **304***a* are thus representative of 256 + 6 + 48, which equals the 310 counts required to be counted by the system before the gate **304***a* generates a true output through the inverter **306***a* for application to the display circuitry. The remainder of the gates **304***b–x* are operated in a similar manner to provide predetermined count logic operation according to the curve shown in FIG. **12.**

The gates **304***b–x* go true when additional pulses are stored in the registers. A series of nonlinearly spaced output pulses are thus provided on the terminals **246** and **234** which are applied to the inputs of a summing NAND gate **240** shown in FIG. **9.** The output of the gate **240** is inverted by the gate **242** and is applied to a distance display register **310** shown in FIG. **11** via the terminal **244.** The register **310** is connected in series with a second register **312** and a third shift register **314.** The registers **310** and **312** comprise 10-bit shift registers such as the Model 8202 shift registers manufactured and sold by Signetics. The register **314** comprises a 4-bit shift register such as the Model 8271 register manufactured and sold by Signetics. The registers **310–314** are initially set to zero at the beginning of a cycle through a reset signal applied through the terminal **220** from the reset circuitry. As the distance pulses arrive via the terminal **244,** voltage is shifted down through the registers.

The outputs of the register **310** are applied to respective ones of a series of transistor lamp drivers **316***a–e,* while the outputs of a shift register **312** are applied to a series of transistor lamp drivers **316***f–j.* The four outputs from the shift register **314** are applied to a series of transistor lamp drivers **316***k–l.* The lamp drivers **316***a–l* may comprise the Model SN75451 lamp drivers manufactured and sold by Texas Instruments Incorporated. Each of the lamp drivers controls the operation of a pair of lamps. The transistor lamp drivers **316***a–l* thus control the operation of a series of lamps **318***a–x.* The lamps **318***a–x* are disposed underneath the individual segments **32** of the display panel **26** shown in FIG. **2** in order to provide a visual indication of the distance imparted to the target **24.** For example, the lamp **318***x* would be illustrated to provide an indication of a drive of 100 yards, while the lamps **318***s–x* would be illuminated to provide an indication of a drive of 150 yards. All of the lamps **318***a–x* would be illuminated to indicate a drive of 330 yards.

The shift registers **310–314** are not shifted until a threshold count of 310 is reached by the circuitry shown in FIG. **10.** The lamp drivers **316***a–l* are normally disabled so that none of the lamps **318***a–x* are normally illuminated. During an operational cycle of the system, the registers **310–314** store the counts provided by the circuitry shown in FIGS. **9** and **10.** After the count applied to the registers **310–314** is terminated, none of the lamps **318***a–x* is yet energized due to the fact that a signal applied to terminal **320** maintains each of the lamp drivers **316***a–l* in a nonenergized condition. The lamp drivers **316***a–l* are maintained in the off condition until a subtract signal is applied from the subtract circuitry, as will be later described. After the reception of the subtract signal, selected lamp drivers **316***a–l* are energized in order to illuminate the desired lamps.

A reset signal is applied to the distance display circuitry via a terminal **220.** The one-shot multivibrator **200** shown in FIG. **9,** which may comprise either a **7** or a **10** second period one shot, automatically generates a reset signal for resetting all of the flip-flops and registers of the system to zero after the completion of the cycle.

Referring now to FIG. **13,** the push-pull circuitry of the invention will be described. The push-pull phototransistor array **138,** previously described with respect to FIG. **6,** generates output signals in response to movement of the shutter **132.** When the shutter **132** is rotated out of the beam of light emanating from the lamp assembly **136,** respective ones of the phototransistors in the array **138** are energized to generate electrical output signals. Each of the transistors in the array **138** are connected to a respective one of the three input AND gates **350–360** shown in FIG. **13.** The output of the gate **350** is applied to an input of a NOR gate **362.** The gate **362** is interconnected with a NOR gate **364** in a latch configuration. Gate **364** receives at one input the reset signal applied via the terminal **204** from FIG. **9.** The output of gate **362** is applied to an input of a transistor lamp driver **366** for control of a lamp **368***a.* The output of the gate **364** is connected to a terminal **370***a* to provide an indication of the pull-3 signal.

The output of an AND gate **352** is applied to a pair of latch interconnected NOR gates **372,** the output of one of the gates being connected to control the transistor lamp driver **366** for control of the lamp **368***b.* The output of the second one of the gates **372** is connected to a terminal **370***b* to provide an indication of the pull-2 signal. Similarly, the output of gate **354** is connected to a pair of latch interconnected NOR gates **374,** one of the outputs thereof being connected to a transistor driver **376** for control of the operation of a lamp **368***c.* The other output of the gate **374** is connected to a terminal **370***c* for an indication of a pull-1 signal.

Latch interconnected gates **378** operate to control the operation of a lamp **380***a* and provide a signal via a terminal **382***a* representative of a push-1 signal. Latch interconnected NOR gates **384** control the operation of a transistor lamp driver **386** for control of the energization of a lamp **380***b.* The gates **384** also provide an output signal via a terminal **382***b* representative of the push-2 signal. Latch interconnected NOR gates **388** operate the lamp driver **386** for control of a lamp **380***c* and generate a signal via a terminal **382***c* representative of the push-3 signal. Interconnected NOR gates **374** also provide a signal via a terminal **390** representative

of a pull signal and gates **278** provide a push signal via a terminal **392**.

Gates **374** provide a signal via a lead **394** to the input of a NAND gate **396**, the output of which is applied to the inputs of a trio of gates **356, 358** and **360**. Gates **378** are connected via a lead **398** to a NAND gate **400**, the output of which is connected to inputs of the gates **350, 352** and **354**. An inhibit signal is applied from the circuitry shown in FIG. **9** via a terminal **190** to a NAND gate **402**, the output of which is applied to a terminal **404** for connection with the circuitry shown in FIG. **14**. The output of a gate **402** is also connected to inputs of each of the gates **350–360**. An inhibit signal from the circuitry shown in FIG. **9** is applied through the terminal **198** to an input of a one-shot multivibrator **406**, the output of which is connected to an input of the gate **402**.

In operation of the push-pull circuitry shown in FIG. **13**, the phototransistor array **138** generates output signals which are applied to the gates **350–360** representative of the magnitude of the push or pull force imparted to the target **24**. The transistor lamp drivers **366, 376** and **386** are thus controlled to selectively energize one of the lamps **368***a–c* to indicate the three various stages of a pull, while lamps **380***a–c* are selectively energized to indicate the magnitude of push imparted to the target. A reset signal applied to terminal **204** resets the NOR gates to zero after the completion of a cycle of operation. The gates **396** and **400** provide a feedback inhibit signal so that bouncing of the target **24** does not provide the opposite of a push or pull as an indication, an allows only the initial indication of a push or pull to be visually indicated.

The signals applied to the terminals **370***a–c*, **382***a–c*, **390** and **392** are applied to the circuitry shown in FIG. **14** for utilization in the subtract portion of the system. The inhibit signals applied to the terminals **190, 198** and **404** operate to inhibit further operation after a preselected time interval.

Referring to FIG. **14**, the hook-slice display circuitry and the subtraction circuitry is illustrated. The breaker point assemblies **128** and **130** are closed in the manner previously described in order to indicate hook-slice movement of the target **24**. The breaker point assemblies **128** and **130** are offset from one another in order to indicate the direction of rotation of the target **24** around the first axis **92**. In operation of the breaker point assemblies, one of the assemblies is designated as a reference switch. When the output from the switch is high and the output from the second switch makes a negative transition, one direction of rotation is indicated. When the reference switch output is low and the second switch makes a negative transition, the opposite direction of rotation is indicated.

While the breaker point assemblies **128** and **130** have been illustrated for use in one embodiment of the invention, it should be understood that other, preferably nonmechanical sensing devices could be utilized with the system. For instance, magnetic pickups/or electro-optics could be utilized in place of the breaker point assemblies **128** and **130**.

The two breaker point assemblies **128** and **130** are connected to inputs of a pair of AND gates **420** and **422**, respectively. The gates **420** and **422** smooth up the transition signals from the breaker point assemblies to provide a smooth output signal. The output of the gate **420** is applied to the inputs of a NAND gate **424**, the output of which is connected through an AND gate **426** to an input of a NAND gate **428**. Logic from the circuitry shown in FIG. **9** is applied to an input of gate **426** from the terminal **198**. The output of the gate **422** is also applied to an input of a gate **428**. The number of pulse outputs from the gate **422** are applied to a 4-bit counter **430** for counting. The output of the counter **430** is applied through a binary to 16 decoder **432**,which may comprise for example, a Model SN74154 decoder manufactured and sold by Texas Instruments Incorporated.

The output from the decoder **432** is applied through either PRO or AMATEUR outputs from the decoder **432**. Switches are provided to select either the PRO or the AMATEUR outputs for selection of the amount of hook or slice which is displayed. The output from the decoder **432** is applied to the inputs of a series of NAND gate latch circuits **434,436**, and **438**. The output of gate **428** is applied to a NAND gate latch configuration **440**. The outputs of the latches **434–440** are applied to respective ones of a series of the NAND gates **442–452**. The outputs of the gates **442** and **444** are applied to a dual transistor lamp driver **454** which controls the operation of a hook-**1** lamp **456** and a hook-**2** lamp **458**. The outputs of the gates **446** and **448** are applied through a dual transistor lamp driver **460** for control of a hook-**3** lamp **462** and a slice-**1** lamp **464**.

The outputs of the gates **450** and **452** are applied through a dual transistor lamp driver **466** for control of a slice-**2** lamp **468** and a slice-**3** lamp **470**. Outputs from each of the transistor lamp drivers **454, 460** and **466** are also applied to a terminal **474** for application of the circuitry shown in FIG. **11** for control of the distance display circuitry. The hook-slice lamps **456, 458, 462, 464, 468** and **470** are located underneath the segments **42** of the hook-slice display **34** of the display panel **26**.

In operation of the hook-slice circuit, when the gate **428** goes true in response to one direction of rotation of the target **24**, a hook of the target **24** is indicated. The latch **440** thus goes true to enable the gates **442, 446** and **448** to go high in response to an output from the decoder **432**. The output from the decoder **432** determines which of the lamps **456–462** are energized, with a low count energizing only the latch **434** to illuminate only the lamp **456**, and with a high count energizing each of the latches **434–438** to energize each of the lamps **456, 458** and **462**. Conversely, if the gate **428** does not go true, a slice is indicated and the gates **448** and **452** are prepared for indication of a slice. The magnitude of the value stored in the decoder **432** then determines which of the latches **434–438** are energized to control the energization of the slice lamps **464–470**.

Referring again to FIG. **14**, the subtract portion of the circuitry will now be described. The outputs from gates **442–452** are applied through a plurality of inverters **500–510** for application to inputs of a plurality of exclusive OR gates **512–522**. Push and pull indicators derived from the circuitry shown in FIG. **13** are applied through the terminals **382***a–c* and **370***a–c* to the gates **512–522**. The interconnections of the gates **512–522** are made according to the fact that a push tends to negate a hook, while a pull tends to negate a slice of the target **24**. Therefore, the exclusive OR gates **512–522** tend to compensate a slice and a pull, or a hook and a push. That is, if a hook-**1** and a push-**1** signal are pres-

ent, no output appears from the gate **512**. However, if only a hook signal is applied to the gate **512**, a high output is applied to a shift register **530** for storage. Similar logic applies for gates **514** and **522**.

The outputs of the gates **512–518** are stored in a register **530**, while the outputs of gates **520** and **522** are stored in the register **532**. The outputs from the register **530** are applied to terminal **236** for application to the distance display circuit shown in FIG. **9**. The signals are summed at the gate **232**. As the subtract pulses are negative, the pulses tend to subtract from the final magnitude display by the distance lamps **318***a–x*.

Hook and slice signals are also applied to a NAND gate **550**, the output of which is connected to a transistor lamp driver **552** which controls the operation of a flag **554** and a green lamp **556**. If no push or pull is applied to the target **24**, the gate **550** goes low to enable the lamp driver **552** to illuminate the flag lamp **554**. If a push or pull is applied to the target **24**, the lamp **554** will not be illuminated. If no push or pull is applied to the target **24**, and an indication is received on a terminal **560** from the distance circuitry shown on FIG. **11** indicating that the target has been hit with an impact sufficient to drive a real golf ball 330 yards, exclusive OR gates **562** operate through a NAND gate **566** to cause the green lamp **556** to become illuminated. If the target is not hit at least 330 yards, or if the target is not hit straight, the green light **556** will not be illuminated.

A delayed inhibit signal is fed to the terminal **404** from the circuitry shown in FIG. **13** to a one-shot multivibrator **570**. The Q output of the multivibrator **570** is connected to registers **530** and **532**. The $\overline{Q}$ output of the multivibrator **570** is applied to the inputs of a pair of NAND gates **572** and **574**. A reset pulse is applied via a terminal **218** from the circuitry shown in FIG. **9** to an input of a NAND gate **576**. The gate **576** is interconnected in a latch configuration with the gate **572**. A clock signal from the oscillator **160** shown in FIG. **9** is applied via a terminal **580** to one of the inputs of the gate **574**. The output of the gate **574** is interconnected with the registers **530** and **532**. The output of the gate **576** is connected to the light enable terminal **320**.

In operation, the one-shot multivibrator **570** provides a predetermined amount of time for the push-pull circuitry to settle prior to the initiation of the subtraction operation. After settling of the push-pull circuitry, a light enable signal is applied via a lead **584** to shift data into the shift register **530**, while the latch arrangement comprising the gates **572** and **576** provides clock shift pulses via a lead **586** to the registers **530** and **532**. When the latch comprising the gates **572** and **576** true, a light enable signal is applied via the terminal **320** which goes back to the circuitry shown in FIG. **11** to enable the energizing of the distance indicating lamps **318***a–x*.

It will thus be seen that the present invention provides a golf practicing apparatus which visually displays accurate information with regard to the distance, hook or slice, and the push or pull forces that are imparted to the target **24**. The present golf practicing apparatus is extremely reliable in operation, due to the manner of detection of target motion, and also due to the use of solid state circuitry in the compuation and display portions of the system. The present golf practicing system provides an accurate indication of the actual distance which is imparted to the ball target by the use of the subtraction circuitry of the invention which subtracts when the ball is hooked, sliced, pushed or pulled. In addition, the present invention includes circuitry which compensates for various combinations of hook-slice and push-pull with respect to the distance computation. The reset and enable circuitry of the present system prevents false indications due to bouncing or other movement of the target after the initial impact. Finally, the mounting of the simulated golf ball for free rotation about the first axis, and the use of remote sensing to detect movement about the second and third axes results in a golf practicing apparatus that is extremely durable and trouble-free in operation.

Although the preferred embodiment of the invention has been illustrated in the accompanying Drawings and described in the foregoing specification, it will be understood that the invention is not limited to the embodiment disclosed, but is capable of rearrangement, modification and substitution of parts and elements without departing from the spirit of the invention.

What is claimed is:

1. In a golf practicing method of the type in which a target is struck with a golf club, the improvement comprising:

measuring the movement of the target about a first axis and generating a first error indicative output in response to the measurement;

measuring the speed of movement of the target about a second axis that extends perpendicular to the first axis and generating a distance indicative output in response to the measurement, and

measuring the movement of the target about a third axis that extends perpendicular to the second axis and generating a second error indicative output indicative output in response to the measurement.

2. The improved golf practicing method according to claim **1** wherein the first measuring step is further characterized by generating an output indicative of both the direction and the amount of rotation of the target about the first axis.

3. The improved golf practicing method according to claim **1** wherein the third measuring step is further characterized by generating an output indicative of both the direction and the amount of rotation of the target about the third axis.

4. The improved golf practicing method according to claim **1** including the additional step of altering the distance indicative output in response to the generation of either of the error indicative outputs.

5. A golf practicing apparatus comprising:

a target supported for rotation about a first axis; a second axis which extends horizontally through the first axis, and a third axis which extends perpendicularly to and through the second axis;

means for generating an output signal indicative of the speed of rotation of the target about the second axis;

means for generating a first error signal indicative of rotation of the target about the first axis, and

means for generating a second error signal indicative of rotation of the target about the third axis.

6. The golf practicing apparatus according to claim **5** wherein the output signal generating means comprises remote sensing means for measuring the speed of rotation of the target without physical attachment thereto.

7. The golf practicing apparatus according to claim **5** wherein the first error signal generating means com-

prises means for generating an error signal indicative of both the direction and the amount of rotation of the target about the first axis.

8. The golf practicing apparatus according to claim **5** wherein the second error signal generating means comprises means for generating a second error signal indicative of both the direction and the amount of rotation of the target about the third axis.

9. The golf practicing apparatus according to claim **5** further characterized by means responsive to the generation of either error signal for altering the output signal.

10. The golf practicing apparatus according to claim **5** wherein the means for generating an output signal comprises:

means for generating first and second signals representative of the passage of the target past predetermined fixed locations;

circuitry responsive to said first and second signals for generating a sequence of clock pulses representative of the speed of passage of the target past said fixed locations, and

means for converting said sequence of clock pulses into a distance indicative signal proportional to said speed of passage of the target.

11. The golf practicing apparatus according to claim **10** wherein said converting means comprises:

binary to decimal converting means for nonlinearly converting said sequence of clock pulses into said distance signal and register means for accumulating said distance signal.

12. The golf practicing apparatus according to claim **11** further comprising:

circuitry for subtracting from said distance signal in response to either of said error signals, and

circuitry for inhibiting the display of said distance signal until the generation of one of said error signals.

13. The golf practicing apparatus according to claim **12** further comprising:

compensation circuitry for inhibiting the subtraction from said distance signal upon the occurrence of preselected combinations of said error signals.

14. A golf practicing apparatus comprising:

a simulated golf ball;

a stem fixed to the simulated golf ball and extending therefrom to a pivot point;

first bearing means for supporting the stem for rotation about a first axis extending through the ball, the stem and the pivot point;

second bearing means for supporting the stem for rotation about a second axis extending through the pivot point and perpendicular to the first axis,

third bearing means for supporting the stem for rotation about a third axis extending through the pivot point and perpendicular to the second axis, and

means responsive to the speed of rotation of the ball and the stem about the second axis for generating a distance indicative output signal.

15. The golf practicing apparatus according to claim **14** further including means for generating an error signal in response to rotation of the stem and the ball about the first axis.

16. The golf practicing apparatus according to claim **15** further including means responsive to rotation of the ball and the stem about the first axis for altering the distance indicative output signal.

17. The golf practicing apparatus according to claim **16** wherein the speed responsive means comprises:

means responsive to movement of the ball and stem past first and second locations for generating first and second signals;

circuitry responsive to said first and second signals for generating a sequence of clock pulses representative of the speed of movement of the ball and stem past said first and second locations, and

means for converting the sequence of clock pulses into a distance indicative display proportional to said speed of movement.

18. The golf practicing apparatus according to claim **17** wherein said means responsive to movement of the ball and stem comprises:

means for generating a light beam;

a shutter mounted for movement with the ball and stem, and

means responsive to said light beam and to the movement of the shutter with the ball and stem past said first and second locations for generating said first and second signals.

19. In a golf practicing apparatus of the type including a simulated golf ball mounted on a stem and structure supporting the ball and stem for rotation about a first axis extending through the ball and the stem for rotation about a second axis extending through and perpendicular to the first axis, the improvement comprising:

means supporting the ball and stem for free rotation in either direction about the second axis and for permitting termination of such rotation with the ball randomly oriented relative to the axis;

means for generating an output indicative of both the direction and the amount of rotation of the ball about the first axis, and

means responsive to the output for generating an error signal.

20. The improved golf practicing apparatus according to claim **19** wherein the output generating means includes a member mounted for rotation with the ball about the first axis, at least two rotation detecting members positioned at spaced points circumferentially of the member and each for generating an output in response to rotation by the member, and circuitry responsive to the combined outputs of the rotation detecting members for generating an error signal.

21. The improved golf practicing apparatus according to claim **20** wherein the circuitry is further characterized by means for counting the number of rotations of the member relative to rotation detecting members.

22. In a golf practicing apparatus of the type including a simulated golf ball mounted on a stem and structure supporting the ball and stem for rotation about a first axis extending through the ball and the stem and for rotation about a second axis extending through and perpendicular to the first axis, the improvement comprising:

photosensitive means;

a lamp for directing a light beam toward the photosensitive means, and

a shutter positioned between the lamp and the photosensitive means and mounted for rotation with the ball and stem about the second axis, and including means for changing the energization of the photosensitive means by the light beam from the lamp in response to movement of the ball and stem past

first and second locations, whereby the photosensitive means generates first and second signals indicative of the speed of rotation of the ball and the stem about the second axis.

23. The golf practicing apparatus according to claim **22** further characterized by:

circuitry responsive to said first and second signals for generating a sequence of clock pulses representative of the speed of rotation of the ball and stem past the first and second locations, and

means for converting said sequence of clock pulses into a distance indicative signal proportional to the speed of rotational of the ball and stem.

24. The golf practicing apparatus according to claim **23** wherein the shutter is opaque and has a pair of apertures formed through it, one for permitting the light beam to engage the photosensitive means as the ball and stem pass the first location, and the other for permitting the light beam to engage the photosensitive means as the ball and stem pass the second location.

25. A golf practicing apparatus comprising:

a target assembly including a simulated golf ball and a stem affixed thereto;

first bearing means for supporting the target assembly for free rotation about a first axis extending through the stem and the ball;

second bearing means for supporting the target assembly for rotation about a second axis extending perpendicular to the plane of the first axis;

means responsive to the speed of rotation of the target assembly about the second axis for generating a distance indicative signal,and

means responsive to rotation of the target assembly about the first axis for generating an error signal.

26. The golf practicing apparatus according to claim **25** further characterized by means interconnecting the distance indicative signal generating means and the error signal generating means for altering the distance indicative signal in response to the generation of an error signal.

27. The golf practicing apparatus according to claim **25** wherein the distance indicative signal generating means includes a member mounted for rotation with the target assembly about the second axis; remote sensing means detached from and responsive to the speed of rotation of the member for generating an output signal indicative of the speed of rotation of the member, and circuitry for receiving the output signal of the rotation responsive means and for converting such signal into a distance indicative display.

28. The golf practicing apparatus according to claim **25** wherein the error signal generating means is further characterized by means for generating an error signal indicative of the direction and the amount of rotation of the target assembly about the first axis.

29. The golf practicing apparatus according to claim **28** wherein the error signal generating means is further characterized by dual means each for detecting rotation of the target assembly about the first axis,said dual means being positioned at circumferentially spaced points about said axis, and circuitry responsive to the outputs of both of said dual means for generating an error signal indicative of the direction and the amount of rotation of the target assembly about the first axis.

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