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(54) SYSTEM AND METHOD FOR CONTROLLING CONDITIONS IN PUTTING AS A PART OF A GOLF GAME

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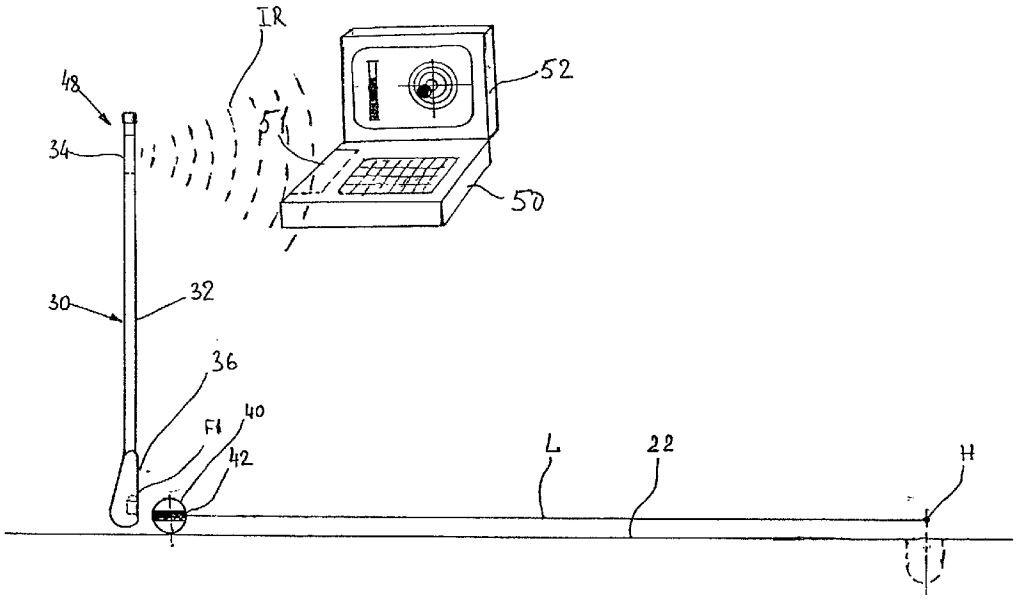
(57) **ABSTRACT**

The invention relates to system and method for measuring speed of a golf ball in putting as a part of a golf game, as well as other characteristics of the game. The system consists of a group of optical light emitting and receiving devices built into the putter head and exposed to the light reflected from the golf ball during rolling on the putter green. The putter head also contains force sensor for measuring a force applied from the club head to the golf ball and a gyro sensor which measures angular deviation of the actual direction of hit from a reference direction which has been preliminarily entered into the system. A microprocessor that receives and processed the information from the optical, force, and gyro components is built into the putter grip. The latter also contains a IR receiving/transmitting device which transmits the processed data to a remotely located microprocessor and display. The method and system of the invention are based on a principle of measuring the speed of rolling of the golf ball by measuring the number of revolutions of the ball during rolling. For this purpose the ball is provided with at least one equatorial mark detectable by the light receiving optical sensors. The ball is irradiated by the light emitted from the aforementioned light emitting devices, and each revolution of the ball is sensed as a light signal produced by the light reflected from the equatorial mark of the ball. The system produced a modulated light signal having a frequency of modulation corresponding to the frequency of rotation of the ball during rolling. The results of measurements of the angles and speed can be selectively shown to the golfer in a real time of the game.



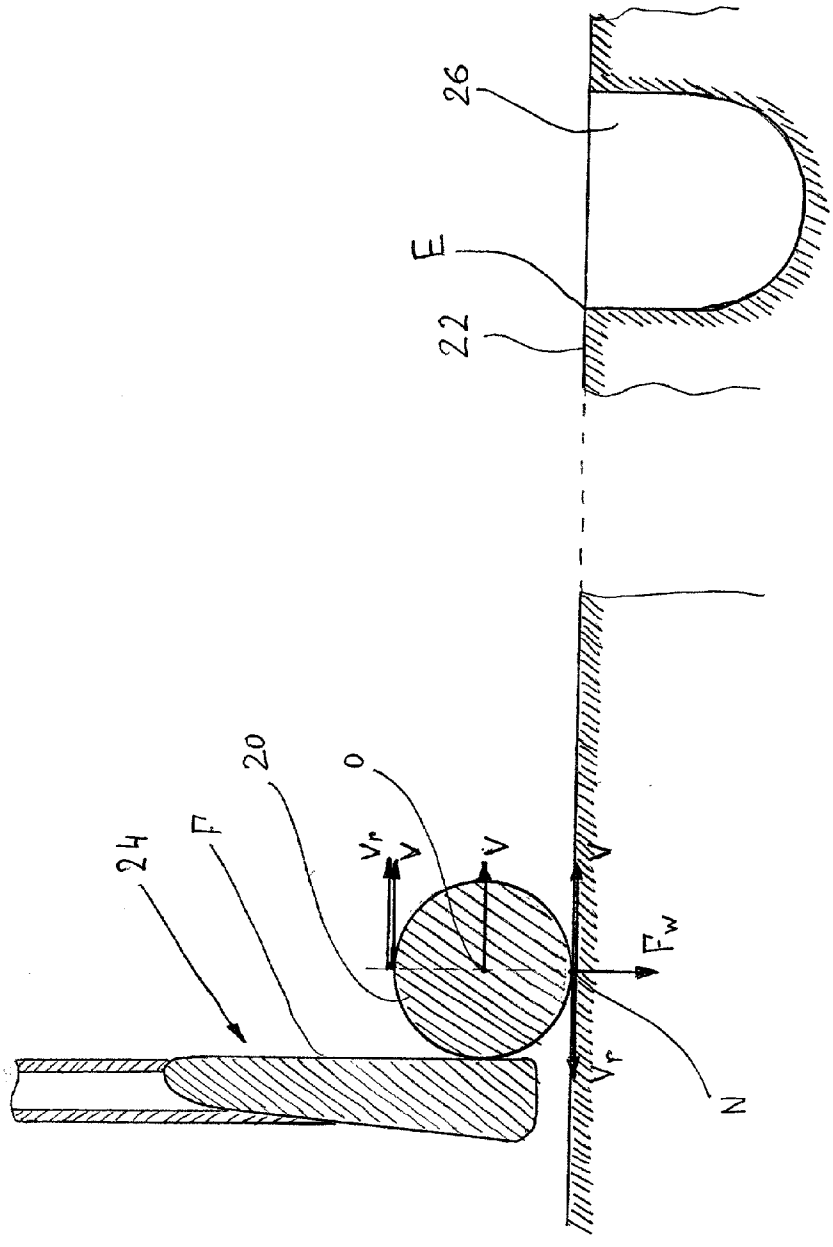


Fig. 1A

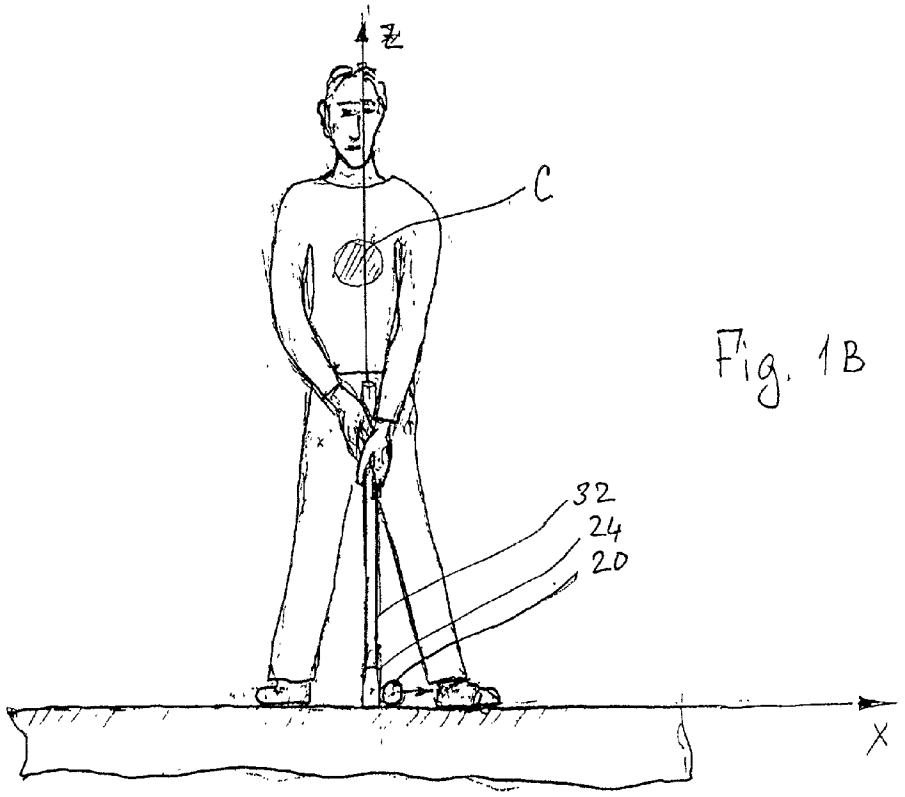


Fig. 1B

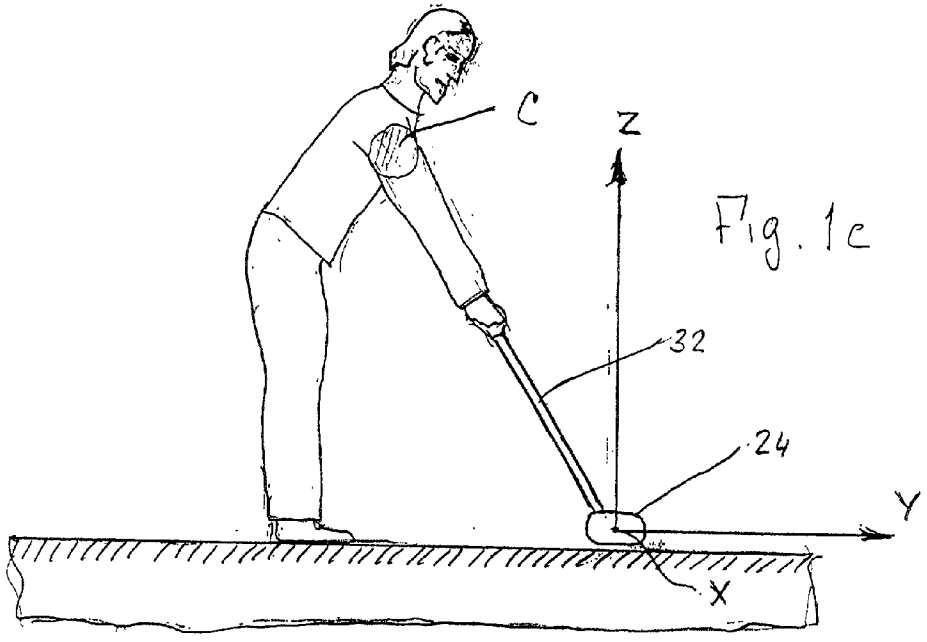


Fig. 1c

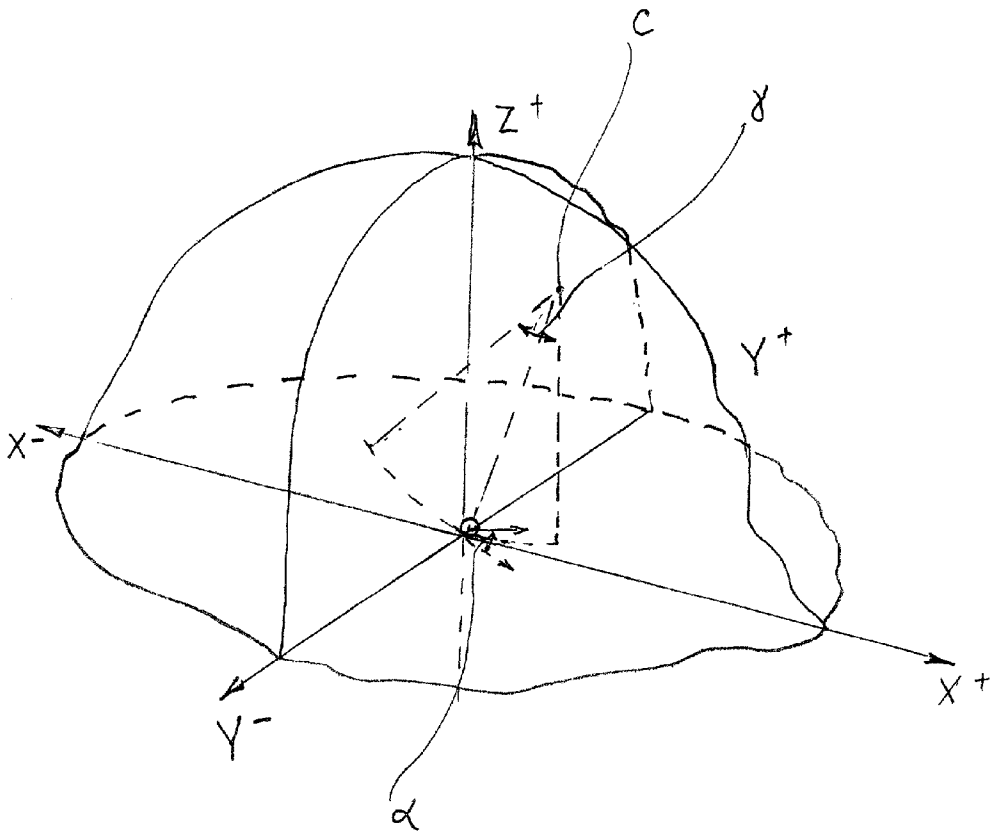


FIG. 1b

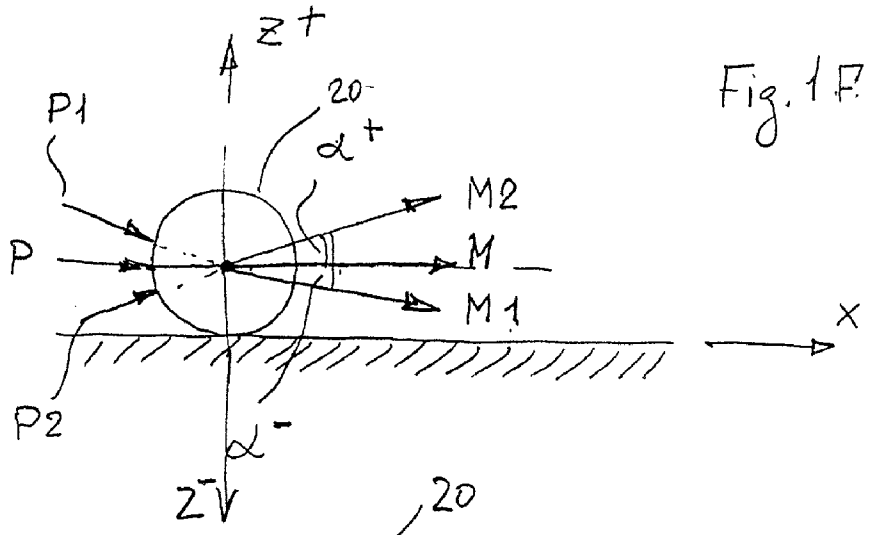


Fig. 1F

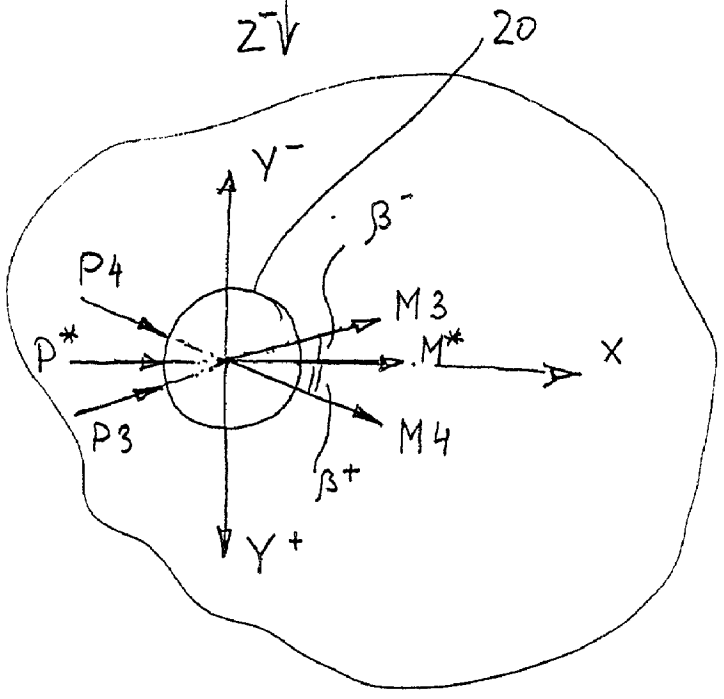


Fig. 1E

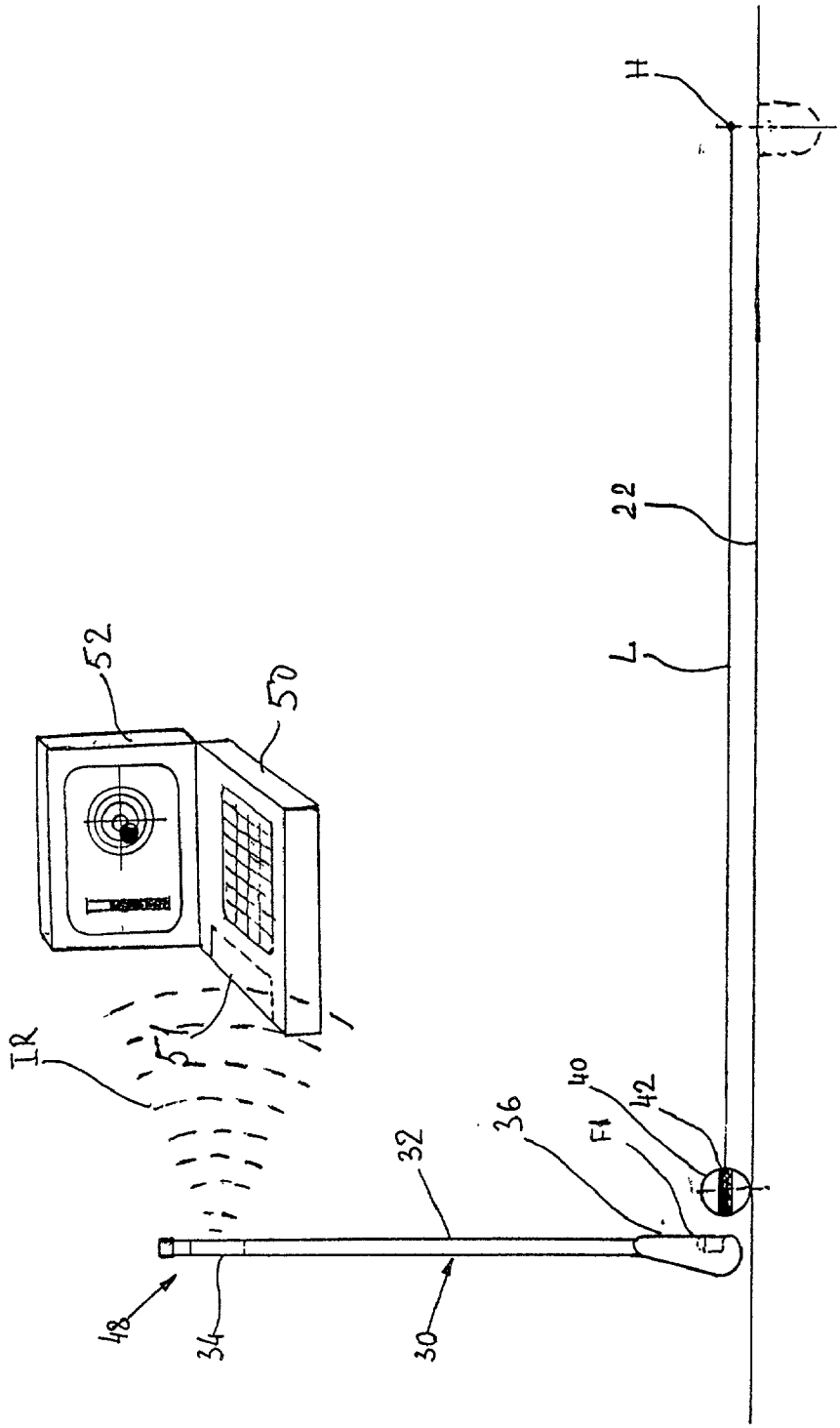


Fig. 2

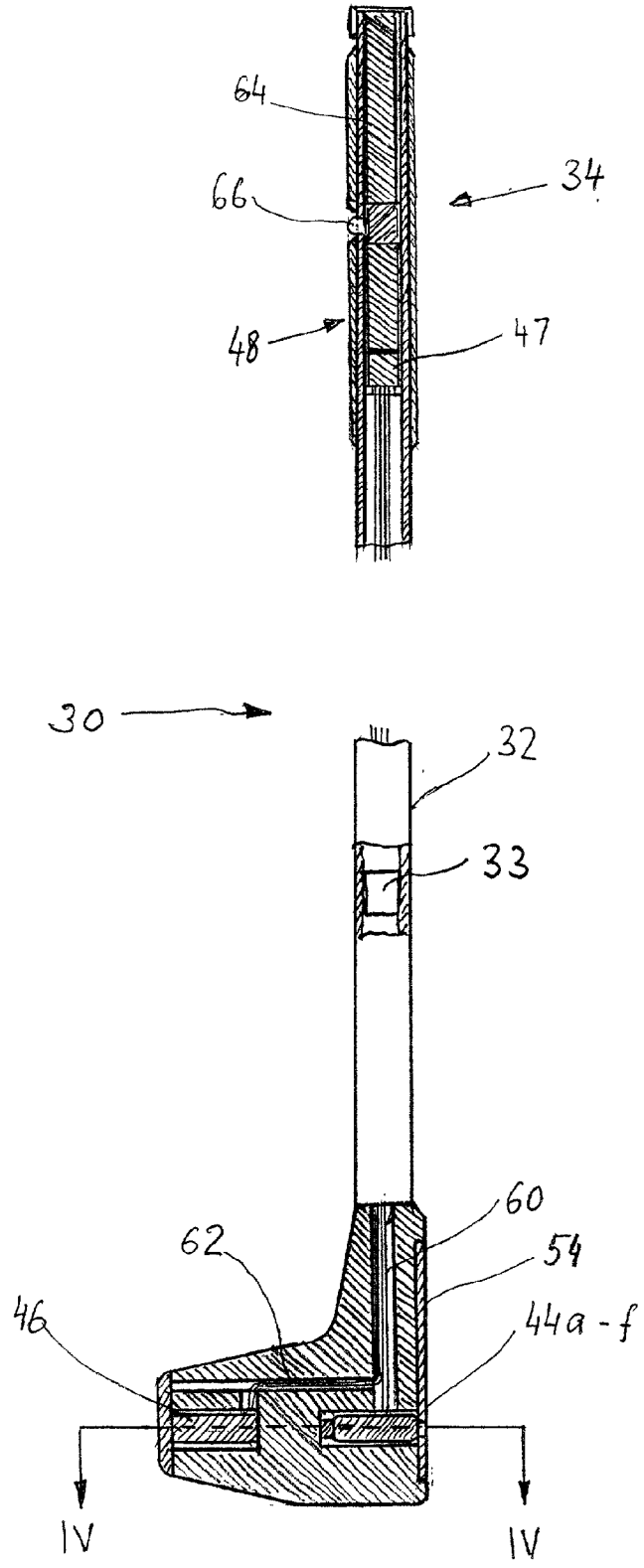


Fig. 3

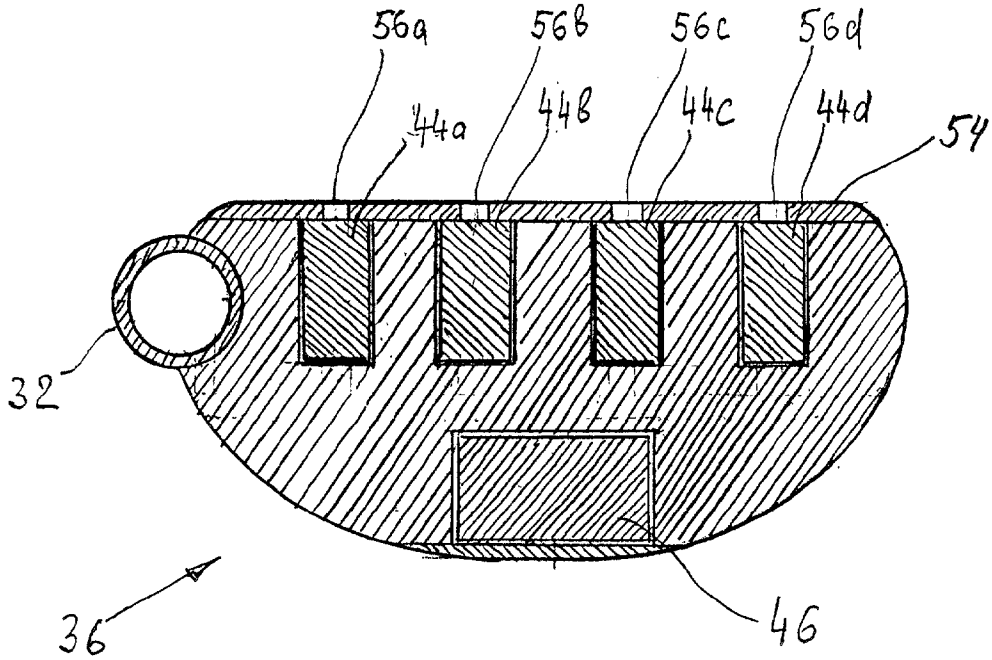


Fig. 4

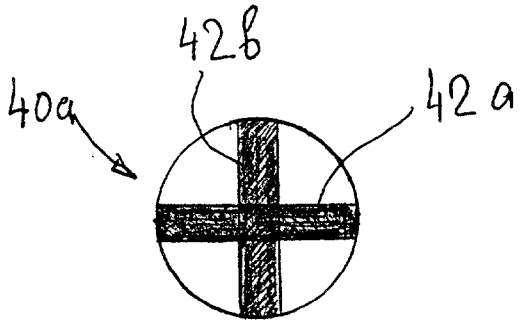


Fig. 6

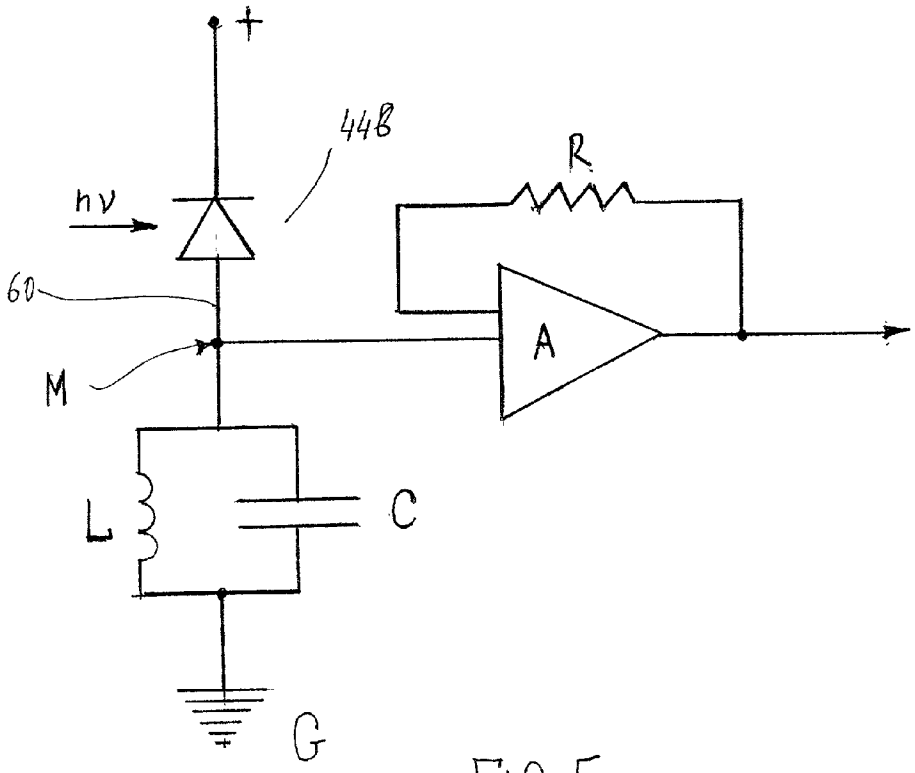


FiG.5

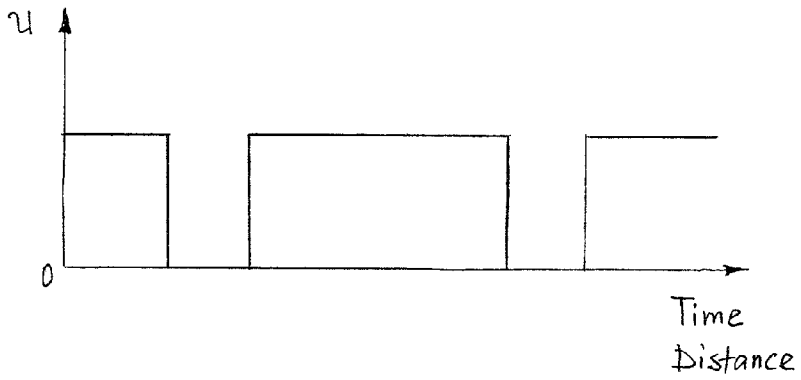


Fig.7

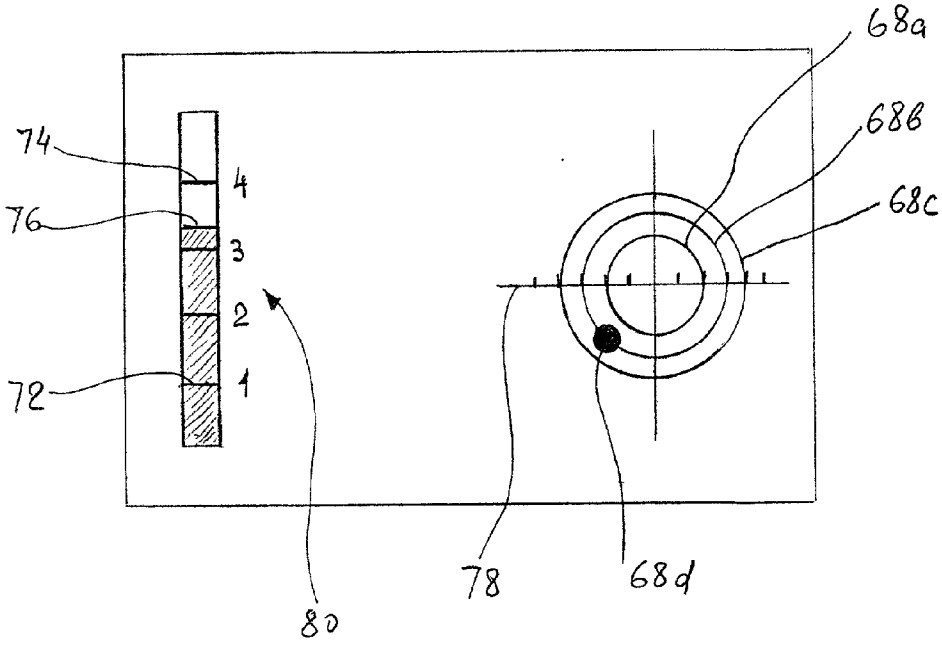


Fig. 8

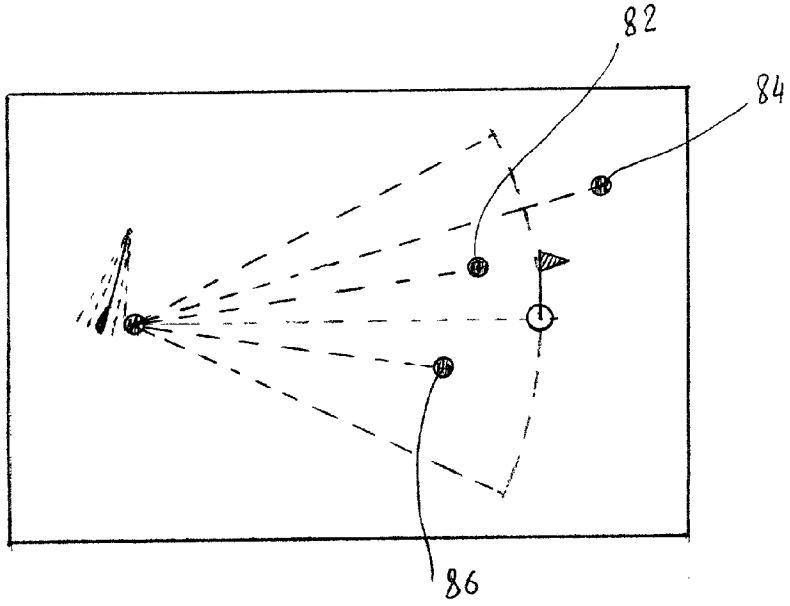


Fig. 9

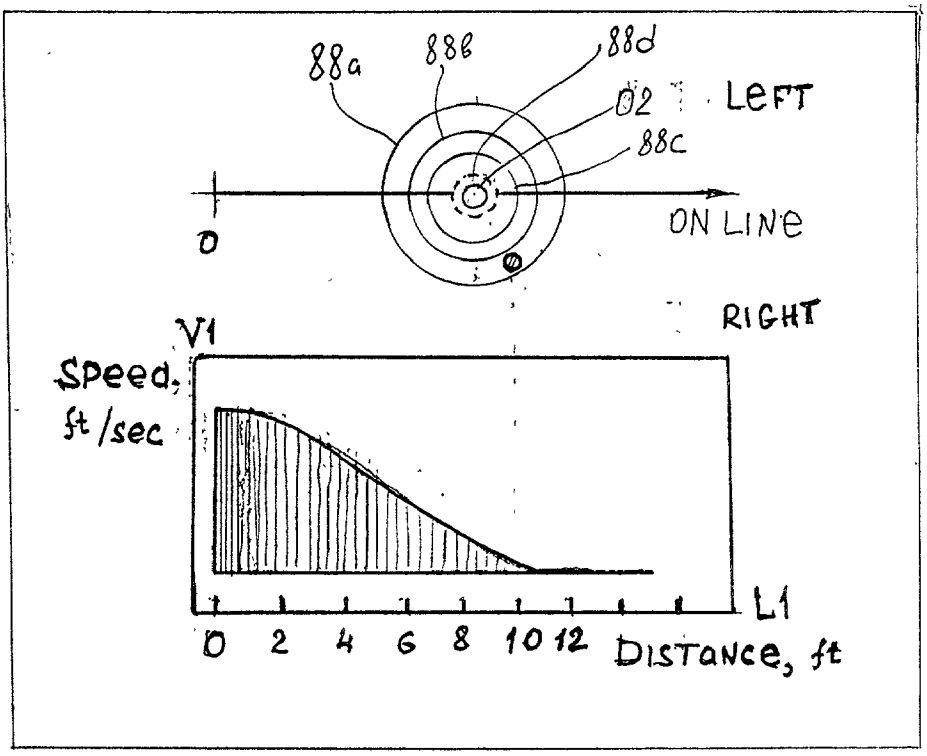

88a
88b
88d
02
LEFT
88c
ON LINE
0
RIGHT
V1
Speed, ft/sec
L1
0 2 4 6 8 10 12
DISTANCE, ft

FIG. 10

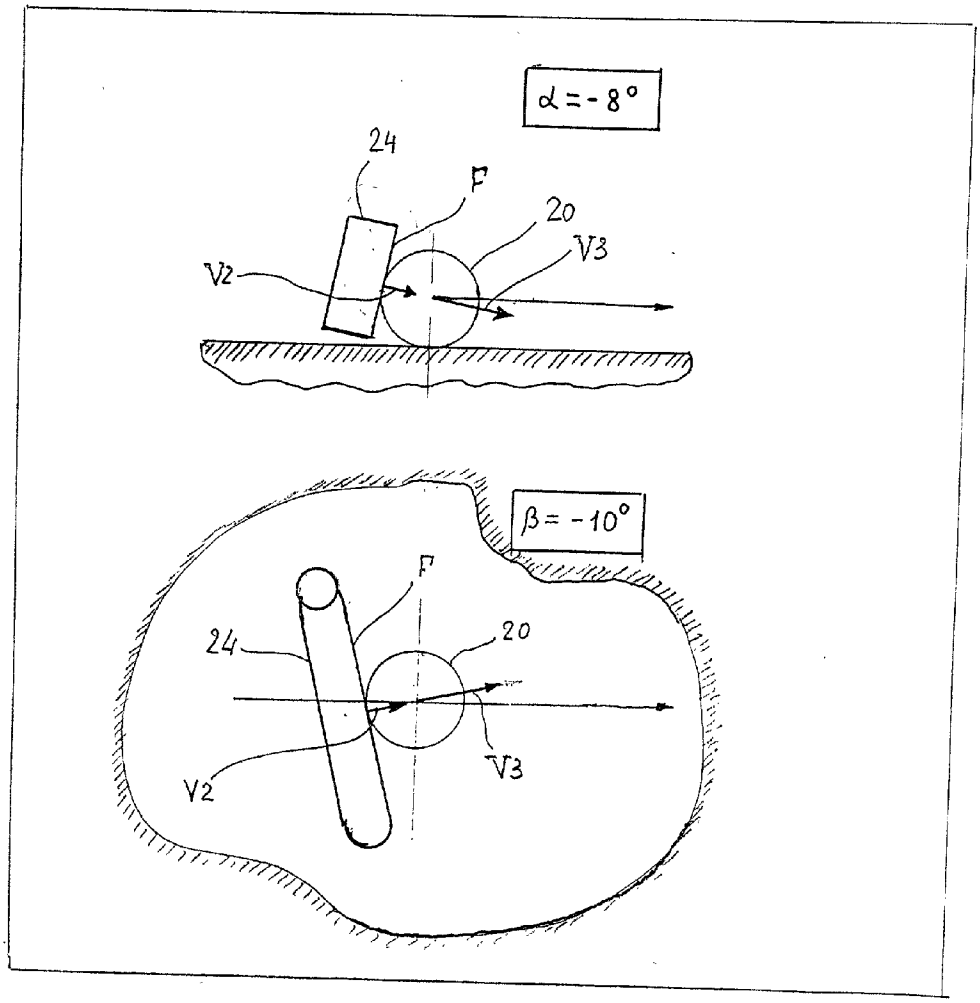


FIG. 11

SYSTEM AND METHOD FOR CONTROLLING CONDITIONS IN PUTTING AS A PART OF A GOLF GAME

CROSS-REFERENCES TO RELATED APPLICATIONS

[0001] This patent application is a continuation of my previous U.S. patent application Ser. No. 09/858,829 filed on May 17, 2001 and now pending.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to the field of golf and, in particular, a system and method for measuring speed of a golf ball in putting as a part of a golf game, as well as other characteristics of the game. More specifically, the invention relates to a system based on the use of sensors and a receiver/transmitter unit built into the head of a putter and capable of sensing a signal reflected from a golf ball.

[0004] 2. Description of the Related Art

[0005] Golf is one of the most popular sports in the world for people of all ages and skill levels. According to the definition from Encyclopedia Britanica, the game consists of playing the ball on a teeing ground and trying to put it into a hole by successive strokes in accordance with the rules. The stipulated round consists of 18 holes, and most golf courses have 18. Standard 18-hole courses measure from 6500 to 7000 yards (5900 to 6400 meters). Some courses have only nine holes; these are played twice in a stipulated round. The clubs are designed for the various positions in which the ball may come to rest and for the various distances to the hole. The objective is to put the ball into the hole with fewest strokes.

[0006] Golf balls have a maximum weight of 1.62 ounces (45.93 grams) and a minimum diameter of 1.68 inches (4.27 centimeters).

[0007] The golf clubs are different in length and suppleness of shaft, weight, size and shape of head, the angle at which the shaft ends and the head begins (the lie), and the angle of the face of the club from the vertical (the loft). In the average, good golfers set there are usually either three or four woods clubs and nine or ten irons. No two clubs in a set are the same. The game consists mainly of two stages. At first the golf ball is delivered as close to the nearest hole as possible with a powerful stroke or swing that hits the ball with a club of the type having an inclined face of the club head for delivering the ball to putting green along a ballistic trajectory. The golf ball is then delivered to the hole with minimal number of strokes by hitting the ball with a putter that has a flat surface on the head which is perpendicular to the surface of the putting green during the hit. At this stage of the game the ball is rolled over the surface of the putting green.

[0008] An apparatus for measuring dynamic characteristics of golf game and method for assessment and analysis of hits and movements in the aforementioned first stage of the game are described in my previous U.S. patent application Ser. No. 09/858,829 filed on May 17, 2001, now pending.

[0009] The apparatus of my aforementioned previous invention consists of three active electronic force sensors built into the head of the club head, a main electronic unit built into the shaft or grip of the club and electrically connected to the sensors within the club, and a remotely located data acquisition, processing and displaying unit connected with the electronic units within the club via an IR or RF transmitter which is a part of the main electronic unit. A first force sensor measures a force in the direction perpendicular to the front face of the club head (axis X'). The second sensor measures a force in the direction perpendicular to axis X' in the plane of the club head face which either contains the longitudinal axis of the shaft or is parallel thereto (axis Y'). The third sensor the direction perpendicular to the plane X'-Y'. The data collected during the game from the aforementioned self-contained system makes it possible to conduct complete dynamic analysis of swings and hit and correlate the results of this analysis with actual movements of the ball. The data and results of the analysis can be presented on the display of the data acquisition and processing system in a simple graphical or digital form convenient for observation and understanding by a golfer.

[0010] However, the apparatus and method of my previous invention relate to the first stage of the game in which the golf ball is hit with a swing or stroke that ensures a ballistic trajectory of the ball for delivering it to the point farthest from the point of heat and nearest to the position of the nearest hole or cup. In other words, the apparatus and method of our previous application are not applicable for putting the ball by rolling to its final destination, i.e., to the hole.

[0011] Heretofore many studies and analysis were dedicated to golf putting. There exists many types of putters of specific geometry for selecting the putter most suitable for specific physiological features and playing habits of a golfer. The putter stroke involves mainly the motion of the shoulder, and the arm and wrist motion is very low. Angular displacement of the shoulder determines putter head speed for a particular swing time. The distance of a putt depends on putter head velocity at impact.

[0012] In contrast to wood and iron club swings, a golfer in a putting situation does not typically strike the ball with the same club velocity regardless of the length of the putt. Instead, the golfer must adjust the velocity of the putting stroke while on the green in order to compensate for the length of a particular putt. Since the golfer must vary the velocity of the putting stroke for every putt, it is considerably more difficult in the case of putting for a golfer to develop a feel for a proper stroke. Therefore the aforementioned variety of putter clubs is available for selecting the club most suitable for specific conditions of putting. It would therefore be desirable to have a device which a golfer could use during a game situation in order to get a feel for a proper putting stroke in advance of attempting to make a putt. More particularly, it would be desirable for a golfer to have a device which the golfer could use, immediately before attempting to make a putt, in order to establish that the golfer is swinging the putter with a velocity and with an angular swing that matches the distance of the putt the golfer is attempting to make.

[0013] U.S. Pat. No. 5,788,583 issued in 1998 to Agulnek, et al. describes an apparatus for determining a predicted distance that a golf ball will travel when struck by a putter club head during a putting swing. A first optical sensor is

located in a first position outside the putter for sensing when the putter club head travels over the first position during the putting swing. A second optical sensor is located in a second outside position for sensing when the putter club head travels over the second position during the putting swing. The second position is a predetermined distance away from the first position. A timer, coupled to the first and second optical sensors, is provided for generating a time difference value representing a difference between a first time when the putter club head travels over the first position during the putting swing and a second time when the putter club head travels over the second position during the putting swing. A microprocessor is provided for determining the predicted distance in accordance with the time difference value and the predetermined distance. Means for communicating the predicted distance determined by the microprocessor to a user are also provided. An actual putting distance between the golf ball and a hole on the putting green is estimated by a golfer. While the golf ball remains positioned on the putting green, the golfer moves a putting club head over a pair of sensors with a practice putting swing to determine a predicted putting distance. Next, while the ball remains on the putting green, the golfer compares the actual putting distance with the predicted putting distance determined using the sensors. If the actual putting distance and the predicted putting distance are not within a predetermined threshold, then the golfer continues to swing the putter club head over the sensors until the actual putting distance and the predicted putting distance determined using the sensors are within the predetermined threshold. When the actual putting distance and the predicted putting distance determined using the sensors are within the predetermined threshold, the golfer then putts the golf ball toward the hole.

[0014] A disadvantage of the aforementioned system consists in that this system is a training bench rather than a system used in a real golf course. The parameters of the swing in putting are controlled by two external optical sensors which detect the moments when the golf club overlaps the path of light sensed by the sensors. In other words, the system of the aforementioned patent does not reproduce conditions of real game.

[0015] Many golfers, in spite of practice, remain inconsistent in their putting game. A common mistake some of the golfers make in their putting game is to strike the golf ball with the head of the putter while the velocity of the putter head is decelerating rather than accelerating. This deceleration generally results in uneven putting strokes because difficult to control such factors as the inconsistency in speed and the amount of initial acceleration and subsequent deceleration of the putting head.

[0016] A better method of putting is termed accelerated putting. In accelerated putting the ball is struck while the velocity of the putter head is increasing, i.e., the putter head is accelerating. In this type of putting the golfer is required to learn only a single acceleration motion of the putter which is applicable to any length of putter. This acceleration motion is retained, with repetition, as part of the golfer's muscle memory. The distance the ball travels is then determined by the amount of backswing of the putter head. As the backswing is increased, the pre-contact time of the club head, i.e., the time from the beginning of the swing until the ball is struck, also increases, and therefore the velocity of the club head is greater when it strikes the ball than it would be for a shorter backswing.

[0017] A second common mistake of some golfers is to stroke the ball with a putter head that is not traveling along the intended path of the golf ball. That is, the golfer does not swing the putter along the same line as the intended path of the ball, but rather in a path that is oblique to the intended path of the ball. Such a stroke causes the golf ball to deviate from the intended travel path.

[0018] A third common mistake of some golfers is to stroke the golf ball with the putter head at an oblique angle to the intended path of the golf ball, rather than perpendicular to the intended path. This oblique angle causes the golf ball to deviate from the intended travel path of the golf ball.

[0019] It can be appreciated that a golf putting teaching aid which aids golfers in establishing the proper method of accelerated putting, including the proper path of the putter head and the proper orientation of putter head with respect to the golf ball, is desirable.

[0020] U.S. Pat. No. 4,805,912 describes a golf putting teaching aid for use in establishing the proper method of accelerated putting. The teaching aid described therein, however, requires a movable, ruler-like apparatus (called a stroke length ruler) locatable along an edge of the putting surface. The stroke length ruler has marks thereon for aligning the stroke length ruler with squaring lines located on the putting surface and for indicating the proper length of the back swing for each of the squaring lines. The stroke length ruler costs money to fabricate and is inconvenient to use because it must be repositioned whenever the golfer wishes to practice putts from a different distance from the cup.

[0021] The above problems are obviated with the use of the golf putting teaching aid system described in U.S. Pat. No. 5,630,719 issued in 1997 to Franklin. This includes a generally rectangular putting surface having a first end and a second end, with a cup located near the first end. At least one teaching pattern is disposed on the surface of the putting surface a predetermined distance from the cup. The pattern has parallel lines that are disposed along a desired travel path for a golf ball. The parallel lines have a front portion oriented toward the first end of the rectangular surface and a rear portion oriented toward the second end of the putting surface. A central location between the front and rear portions is provided to define the location of the golf ball to be putted. The rear portion is of a predetermined length and the front portion is of a predetermined length for the parallel lines. A squaring line is disposed perpendicular to the parallel lines and on the distal side of the central location for allowing the head of a golf club to be squared to the parallel lines behind the golf ball located in the central location. A second squaring line is also disposed on the distal end of the rear portion perpendicular to the parallel lines for further helping the head of the golf club to be squared perpendicular to the parallel lines. In the putting exercise, the club head is first squared behind the ball and then is moved backward to the rear squaring line. Thereafter, the club head is moved forward from the rear squaring line to or through the proximal end of the pattern. The location of the ball in the central location is designed such that the acceleration of the club head when contacting the ball is optimal.

[0022] Commercially available golf putting practice devices are known in the art, including those that simulate a golf putting green by using a closely cropped simulated grass indoor/outdoor carpeting material. These devices frequently have a ramped surface which leads up to a flat putting platform containing a golf putting cup. In some devices ramped returns bring the ball from the cup back to the initial putting surface.

[0023] In addition, there are devices for the serious golf student which sense golf ball speed and timing and which emit audible messages or visual messages to instruct the golfer in game improvement. Such sophisticated devices are expensive, due to their use of complicated photoelectric beam sensing devices, microprocessors and voice synthesizers, or light emitting diodes (LED). These devices may be programmed to deliver an oral message or compute measurements and relay the results visually or aurally.

[0024] Putting practice devices which provide detailed putt information may be intimidating to the casual golfer, and, due to the precision sensors and computers required, are costly to produce.

[0025] What is need is a play apparatus which permits golf practice and which interacts with the golfer yet which may be manufactured at a low cost.

[0026] U.S. Pat. No. 5,242,169 issued in 1993 to Laabs, et al. discloses a golf practice device which has a thermoformed thermoplastic housing with a deck having a putting ramp and platform covered with a simulated putting-green carpet. A putting cup extends beneath the platform. A recording playback unit comprised of a combined speaker and miniature record golfer is mounted beneath the cup by a thermoformed thermoplastic support member. The support member affixes the electronic components of the apparatus and extends beneath the deck to engage the apparatus support-surface to stabilize the housing deck and ensure a stiff play surface. A false bottom plate is hinged to the sidewall of the putting cup. The false bottom overlies a lever and contact button of a switch. A made putt directs a ball into the cup and onto the false bottom. The weight of the ball on the false bottom plate depresses the false bottom to close the lever on the contact button. The closed switch activates the miniature record golfer. The record golfer plays several messages in a random sequence which are broadcast through the speaker.

[0027] The above device is a training system which does not reproduce conditions of real game and therefore possesses the same disadvantages as the previously discussed devices.

[0028] Thus, devices and methods for accurately measuring the speed of a golf ball as well as angular and dynamic characteristics of impact during putting as a part of the golf game do not exist.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] **FIG. 1A** is a schematic view of the putter head, ball, putting green, and the hole illustrating the physics of the putting stage in a golf game.

[0030] **FIGS. 1B and 1C** are front and side views which illustrate approximate positions of a golfer, golf ball and golf club at the moment of hit.

[0031] **FIG. 1D** is a three-dimensional view of a coordinate system stationary with respect to the putting green for representation of movements of the golf ball and the golf club.

[0032] **FIG. 1E** is a view of a horizontal plane illustrating impulses acting on the golf ball ands directions of the impulses at different positions of the golf club head at the moment of hit.

[0033] **FIG. 1F** is a view which illustrates lateral (angular) deviations in the plane XZ possible during the game.

[0034] **FIG. 2** is a general schematic view of the entire system of the invention.

[0035] **FIG. 3** is a schematic longitudinal cross section of the putter.

[0036] **FIG. 4** is a cross sectional view of the putter head along line IV-IV of **FIG. 3**.

[0037] **FIG. 5** is an electric diagram of receiving electronics which receives optical signals from the rolling ball.

[0038] **FIG. 6** is a view of a golf ball with two mutually perpendicular equatorial marks.

[0039] **FIG. 7** is a graph that shows an example of a signal sent to an amplifier included into the circuit of **FIG. 5**.

[0040] **FIGS. 8, 9, 10**, and **11** are examples of graphical presentation of the results of the hit shown on the display of the data processing unit.

OBJECTS AND SUMMARY OF THE INVENTION

[0041] It is an object of the invention to provide a self-contained system and method for controlling positions in putting and a golf ball speed after hitting with the putter. Another object is to measure angular deviation of the hit direction from the reference direction which has been preliminarily entered into the system. Still another object is to provide a self-contained measurement system of the aforementioned type built into the golf club. Another object is to provide the measurement system of the aforementioned type designed specifically for putting as a part of a golf game. Still another object is to provide a data processing display system which can accumulate, analyze and display data on the game in a simple visually represented form which facilitates training and elaboration of correct habits for the game.

[0042] The system consists of a group of optical light emitting and receiving devices built into the putter head and exposed to the light reflected from the golf ball during rolling on the putter green. The putter head also contains a gyro sensor which measures angular deviation of the head face from axes X (which approximately coincides with the direction of hit) and Y (which approximately coincides with the direction perpendicular to the direction of hit) which form a horizontal plane. The putter shaft contains a swing angle sensor which measures the angle of club swing, which is proportional to the force of the hit. A microprocessor that receives and processed the information from the optical, gyro and force components is built into the putter grip. The latter also contains a IR receiving/transmitting device which transmits the processed data to a remotely located microprocessor and display. The method and system of the inven-

tion are based on a principle of measuring the speed of rolling of the golf ball by measuring the number of revolutions of the ball during rolling. For this purpose the ball is provided with at least one equatorial mark detectable by the light receiving optical sensors. The ball is irradiated by the light emitted from the aforementioned light emitting devices, and each revolution of the ball is sensed as a light signal produced by the light reflected from the equatorial mark of the ball. The system produced a modulated light signal having a frequency of modulation corresponding to the frequency of rotation of the ball during rolling. The results of measurements of the angles and speed can be shown to the golfer in a real time of the game.

DETAILED DESCRIPTION OF THE INVENTION

[0043] For better understanding the principle of the invention, it would be advantageous to consider some theoretical aspects of motions and forces that occur during putting in a system "club head—golf ball". Let us first assume, for simplification of the physical picture of putting, that after being hit the golf ball rolls over the surface of the putting green without sliding and the surface of the putting green is ideally horizontal.

[0044] The aforementioned physical picture is shown in **FIG. 1**A, where reference numeral **20** designates a golf ball, **22** is the surface of a putting green, and **24** is a club head which has a head face F that contacts the ball at the moment of hit. The center of the ball is designated by letter O, **26** designated the hole into which the ball has to be delivered as a result of the hit, and letter V designates the translational motion speed of the golf ball **20**. An arrow F_w designates a gravity force with which the ball **20** acts on the surface **22** in a stationary condition.

[0045] Let us assume that the "ideal" hit is the one with the face F being perpendicular to the surface **22**.

[0046] After being struck with the "ideal" hit, the golf ball begins to move. Under the aforementioned "ideal" conditions, the translational motion speed V is equal to a linear speed V_r on the surface of the rolling ball **20**. It is understood that an instant resulting speed (which is obtained by adding the speed V to the V_r) in each current point N of contact of the ball **20** with the surface putting green surface **22** is equal to 0. It is clear that this condition corresponds to ideal rolling without sliding. In this case, kinetic energy of the golf ball **20** can be expressed as mV^2, which consists of a translational energy component and a rolling energy components. Each of these components is equal to $mV^2/2$.

[0047] All deviations from the aforementioned "ideal" conditions, which may take place in a real golf game, are reduced to redistribution of the energy between the translational and rolling motion components. These deviations will depend on a character of the hit, condition of the putting green **22**, etc.

[0048] Let us consider the nature of the aforementioned deviations in more detail. **FIGS. 1B and 1C** illustrate approximate positions of a golfer, golf ball and golf club at the moment of hit. For better understanding quantitative parameters, which affects the quality of the game and which are needed for detailed description of the game, I introduce a coordinate system stationary with respect to the putting green. This coordinate system is shown in **FIG. 1D**. Let us assume, in first approximation, that the putting green is absolutely horizontal and that the center of origins of the above coordinate system coincides with the center of the golf ball **20** which is in a stationary state just before the hit. Axis X of the above coordinate system extends in a direction of the line that connects the center O of the golf ball **20** with the center (not shown) of the target hole **26** in the plane of the putting green **22**. Axis Z is a vertical axis initiated from the center O of the golf ball **20**, and axis Y also passes through the center O of the ball **20** perpendicularly to the XZ plane.

[0049] With the "correct" strike, the putter head **24** moves along a trajectory close to circular with radial orientation of the longitudinal axis of the club, and with the center of rotation C1 (**FIG. 1D**) located approximately in the center of the golfer's chest at the level of his/her shoulder. In **FIGS. 1B and 1C** this zone is designated by symbol C. In other words, the center of rotation of the club in putting should be in the YZ plane (**FIG. 1D**), and the golfer's shoulders should be parallel to the XZ plane. Errors of the golfer during putting may be construed, first, as a deviation of the actual direction of the impulse transmitted to the golf ball **20** at the moment of hit from a target direction, and, second, as an excessive or insufficient impulse. In the case of an excessive impulse, the ball **20** rolls over the hole **26**, and in the case of an insufficient impulse, the ball **20** does not reach the hole **26**.

[0050] The situations described above related to events which take place in the plane XZ. **FIG. 1G** illustrates lateral (angular) deviations in the plane XY possible during the game. When the impact is absolutely resilient, the direction of the impulse M* transmitted from the club head **24** to the ball **20** coincides with the axis X. Two other directions (P3 and P4) of the club head **24** correspond to impulses M3 and M4, respectively, with respective angular deviations β^-, β^+ from the vertical plane XZ. A new (lateral) component of the impulse, which appear in this case in the plane YZ, also causes deviation of the ball **20** from the "correct" direction along axis X.

[0051] A less typical error, which still may occur during putting, and its dynamic analysis are illustrated in **FIG. 1E**. This case corresponds to angular deviation of impact in the plane XZ. The impulse M1 transmitted from the club head **24** to the ball **20** deviates from the horizontal axis X in the vertical plane by angle α^-. In accordance with the law of conservation of energy, the impulse P2 is concerted into impulse M2 of the golf ball M2 directed at an angle α^+ to axis X in the XZ plane.

[0052] Two scenarios are possible in the situation shown in **FIG. 1E**. The first scenario occurs when a part of the impulse is directed along axis Z^-. In this case, a part of energy (impulse M1) transmitted from the head **24** to the ball **20** will be spent for non-elastic deformation of the surface of the putting green **22** (**FIG. 1A**) directly under the ball **20**. The second scenario occurs when a part of the impulse (M2) is directed along axis Z^+. Impulse component M2 will decrease pressure of the ball **20** (F_w in **FIG. 1A**) on the surface of the putting green **22** and hence will decrease the force of friction of the ball on the aforementioned surface. Such movement may consist of pure sliding or sliding with a small component of rolling. In this case, relationship

between the kinetic energy of translational movement and that of rolling energy will be different from the first scenario.

[0053] In reality, a golfer may transmit to the golf ball **20** an impulse which is neither in plane XZ nor in plane YZ. It is understood, however, that any real impulse can always be described in terms of angles α, β and an absolute value of impulse transmitted to the ball **20**.

[0054] It is understood, however, that the physical picture of the putting, as a part of the golf game, can be described, with practical accuracy, by measuring the force of impact, direction of impact, and frequency of rolling of the golf ball **20**. It is also understood that in order to get into the hole **26**, the rolling golf ball **20** must reach the edge E of the hole **26** with a speed within a range from a magnitude close to 0 and a certain maximal threshold V_{thr} above which the ball **20** may roll over the hole **26**.

[0055] Another important criteria for evaluation of the results of putting in a golf game is sequential registration of the positions of the golf club during "small swing", i.e., putting. It is understood that movements of hands and body of the golfer are transmitted to the putter and determine the quality of hit on the ball. It is also understood that the purpose of training is elaboration in a golfer of muscle memory which later is realized in a game as his/her game habits. In my previous U.S. patent application Ser. No. 09/858,829, relating to a swing in the initial stage of the game, I have described a system where data on the movements of the club head are obtained from an acceleration sensor built into the club head. Similar system for measuring and processing dynamic parameters of the swing is used in the system of the present invention where the aforementioned acceleration sensor is referred to as a "gyro sensor".

[0056] The system and method of the present invention collect data mentioned in connection with **FIG. 1**A and make it possible in a real time to collect the data, produce quantitative analysis of the data, and to monitor the quality of the game under real conditions by instructing the golfer on the results of each hit.

[0057] This it can be summarized that the system of the present invention:

[0058] 1) measures parameters of movements of the golf club prior to contact of the club head with the ball and processes the measured parameters in a real time for indication of these parameters and their derivatives on the display of a computer monitor in a customer-friendly manner;

[0059] 2) measures dynamic parameters of the golf ball which completely describe the phenomenon of hit with the club on the golf ball in real time and which indicates these measured parameters on the display of the computer monitor independently and in correlation with the parameters of item 1) in a formal convenient for use;

[0060] 3) registers parameters of a trajectory of the ball movement after the hit from the initial point till full stop or fall into the target hole, processes the measured data, and indicates them or their derivatives on the display in an independent form or in a form correlated correlated with the parameters of items 1) and 2); and

[0061] 4) statistically processes the data of items 1), 2), and 3) on the basis of the accumulated data.

[0062] The system of the invention is shown in **FIG. 2** which schematically illustrates a putter **30** which in general consists of a shaft **32**, a grip **34** on one end of the shaft **32**, and a head **36** with a face F1. **FIG. 3** is a schematic longitudinal cross section of the putter **30**, and **FIG. 4** is a cross-sectional view through the putter head **36** along line IV-IV of **FIG. 3**. The second component of the system is a golf ball **40**, which preferably is white and has a mark **42**, preferably black, over the equator of the ball. The third element of the system is a measurement system that consists of groups **44***a*-**44***d* of optical transmitting devices and receiving sensors, a gyro sensor **46**, an infrared data transmitting unit **48** built into the grip **34**, a microprocessor **47** built into the club grip **34**, a data processing unit **50**, and a display unit **52** (**FIGS. 3 and 4**). Reference numeral **33** designates a force sensor or a force moment sensor built into the club grip **34**. The data processing unit **50** and the display unit **52** can be built into a common housing and can be placed during the game into any position convenient for the golfer (not shown).

[0063] Some of the aforementioned main components of the system will be further described in more detail. It can be seen that the putter head **36** houses a group of optical transmitting devices and receiving sensors which are built into the head **36** so that the light-emitting elements of the transmitting devices and sensitive elements of the sensors are exposed through the head face F1 towards the golf ball (not shown in **FIGS. 3 and 4**). The transmitting optical devices are designated by reference numerals **44***a*, **44***c*, whereas the receiving optical sensors are designated by reference numerals **44***b*, **44***d*. In the illustrated embodiment the transmitting devices and receiving sensors are arranged in an alternating order. It is understood that two optical transmitting devices and two optical receiving sensors and their alternating order are shown only as an example and that the number of sensors and their arrangement can be different. In order to protect the exposed elements of the transmitting devices and of the sensors, they are located below the putter head face F1 and can be covered with a protective layer **54** with exposure openings **56***a*, **56***b*, **56***c*, and **56***d*.

[0064] Located inside the head **36** is a gyro sensor **46** which is connected by a group of conductors **62** to the aforementioned microprocessor **47** built into the club grip **34**. The microprocessor **47** may be a chip, such as MPS430 produced by Texas Instruments, USA.

[0065] Each optical transmitting device **44***a* and **44***c* can be represented by a laser diode such as SDL 980 which comes in TO-9 can package produced by SD, Inc.

[0066] **FIG. 5** illustrates receiving electronics for receiving signals from outputs of the aforementioned optical transmitting devices **44***a*, **44***c* and sensors **44***b*, **44***d*. The receiving electronic consist of a signal amplifiers A (one for each diode). Only one amplifier A is shown in **FIG. 5**. The amplifier A is connected in point M to the optical receiving sensors (one of which **44***b* is shown in **FIG. 5**) via a group wires **60**. The receiving electronics also contains a parallel oscillating circuit consisting of an inductance L and a capacitance C. This circuit is connected between point M and the ground G.

[0067] The outputs of the amplifiers A are electrically connected to the aforementioned microprocessor **47**.

[0068] The gyro sensor **46** built into the body of the putter head **36** can be represented by a device such as a single-chip Yaw rate gyro sensor of ADXRS 150 type produced by Analog Devices, Nortwood, Mass., USA. This is a complete angular rate sensor (gyroscope) which, in the system of the invention, is used for determining the angular direction of the putter face surface before the impact, in the moment of impact, and after the impact on the ball. In order to improve accuracy of angular measurements to fit specific conditions of the putting operation, the gyro sensor **46** is located on the longitudinal axis of the shaft in the lowest possible place in the head **36**. In fact, the gyro sensor **46** registers its own angular positions on the trajectory **39** shown by a broken line in **FIG. 1D**. After being processed in a microprocessor **47**, this data can be presented as angle γ shown in **FIG. 1D**. If necessary, an additional gyro sensor similar to the gyro sensor **46** can be built into the club head for measuring angular positions of the head **24** in planes XZ and YZ.

[0069] The microprocessor **47** receives signals with information on the frequency of rolling of the golf ball as well as the information about angle of the direction of hit and about the force of the hit. The microprocessor **47** processes the aforementioned signals and generates on its output an output signal about the number of revolutions of the ball and an output signal about the angle and force of the hit. These output signals are sent to an infrared signal transmitting and receiving unit **48** built into the club grip **34**. The latter sends this information in the form of infrared signals shown in **FIG. 2** in the form of concentric arcs IR to the remotely located data processing unit **50**. This unit, in turn, has a transmitter/receiver **51** mounted into processing unit **50**. This transmitter/receiver operates in the same frequency range as the transmitting unit **48**. An example of transmitter/receivers pair **48** and **51** is any commercially available compact radio telephone having a telephone transmitter and receiver mounted into the grip **34** and the telephone receiver and transmitter **51** mounted into the remotely located data processing unit **50**. In other words, each transmitter/receiver **48** and **51** can operate in both transmitting and receiving modes. This is necessary for feedback, for calibration of the measurement system, or for adjustment in accordance with the specific conditions of the game.

[0070] The data processing and displaying unit **50** is located remotely either in the form of a IR receiver/transmitter **51** in combination with a display unit **52**, e.g., in the form of a laptop-type personal computer placed in the field of direct vision of the golfer for observation of the results of the game or in the form of a pocket-size mini-display.

[0071] The IR receiver/transmitter **51** can be represented by a MAX3120 IrDA 1,2-compatible infrared transceiver commercially produced by MAXIM, California. This receiver/transmitter is suitable and optimized for battery-powered space-constrained applications. It consumes only 120 μA while supporting data rates up to 115 kbps over a wide 3 V to 5.5 V operating range. This unit is extremely compact and can be used in conjunction with light-emitting diodes built into miniature and hand-, as well as with the palm-top computer displays.

[0072] The signal receiving/transmitting unit **51** is a custom-designed infrared receiver the block diagram of which is shown in **FIG. 6**. The unit is plugged into the PC RS232 interface of the data processing and displaying unit **52** and is characterized by the following features:

[0073] 1) Powered from the laptop or palmtop serial port (does not require a separate battery or external power supply);

[0074] 2) Obeys the Infrared Data Association (IrDA) protocol;

[0075] 3) Generates a 16×Baud clock from the received infrared signal;

[0076] 4) Contains RS232 compatible driver for data transmission to the laptop or palmtop.

[0077] All the elements of the signal receiving/transmitting unit **51** are mounted on a single printed circuit board and comprise the pin diode PD connected to the following sequentially arranged main elements: an infrared transceiver MAX3120, two timer modules, i.e. TLC555(1) and TLC555(2), IRDA encoder/decoder, and MAX233A driver.

[0078] A power source **64** (e.g., a conventional DC 12 V Duracell-type N.21 battery or the like) for supplying electric power to the elements of the measurement and data processing system built into the putter is located inside the grip **34** so that it could be conveniently reached for activation. Reference numeral **66** designates a switch for switching the power source **64** on or off. The aforementioned group of wires also includes wires for connecting the laser diodes **44***a* and **44***c* with a driver (not shown) which is controlled from the microprocessor **47**.

[0079] Description of Operation

[0080] In order to use the system of the invention for monitoring the golf game or for training purposes, it is require merely to place the remotely located data processing unit **50** (**FIG. 2**) into a position convenient for use. For this purpose, the display unit **52** (**FIG. 2**) can be placed within the vision field of the golfer or can be located in a different place for analyzing the result of the game after the game is completed. For example, the pocket-size palmtop can be kept in the golfer's pocket, and the larger-size displays can be located in the couch's office or on the ground in front of the golfer.

[0081] The golfer switches the power supply of the measurement and data processing system on by pushing on the switch **66**. For observing the results of the hits the data processing unit **50** also has to be switched on so that its display unit **52** is activated and is ready for reproduction of images indicating the results of the hits. It is understood that after the battery **64** is switched on, the optical transmitting devices **44***a* and **44***c* begin to irradiate light, e.g., in an infrared range of the spectrum, e.g., 980 nm. If necessary, the optical signal transmitting device **44***a* and **44***c* and the optical signal receiving devices **44***b* and **44***d* can be automatically switched on by the impact on the ball. Furthermore, in order to obtain current data for each specific moment and for conservation of power in the battery, the light transmitting/receiving devices can be switched off in a time intervals proportional to the force of the impacts, e.g., in 3 sec. More specifically, measurement of the ball speed with the use of optical light transmitting/receiving devices can be started and activated by an impulse signal from the force sensor **33**. The force sensor can be placed in the shaft or in the putter head. This signal can be detected by the

microprocessor **47** and then programmed to activate the optical signal transmitting devices, e.g., a laser diodes **44***a* and **44***c*, and optical signal receiving devices **44***b* and **44***d*.

[**0082**] Successful putting depends in large part upon the golfer's proper consideration of the frictional resistance of the green surface and the contour and terrain of the green surface.

[**0083**] The frictional resistance of a green surface is commonly expressed in terms of a stimp number. The stimp number is a measure of the distance which a ball will travel on a level green when released from a stimp meter. A stimp meter is a simple device consisting of an aluminum trough with a length of 30 inches inclined at a 20 degree angle from the horizontal green surface. A ball released from a stimp meter will always have the same initial velocity when it comes into contact with the green surface and will travel a certain distance on a horizontal green depending upon the friction imparted to the ball by the putting green. The distance which the ball travels is that particular green's stimp number. Stimp numbers typically range from about 7 feet for very slow greens to about 12 feet for very fast greens.

[**0084**] The resulting stimp numbers are also introduced into the system of the invention prior to the initiation of the game and are used for establishing a reference value. The actual ball speed is compared with the aforementioned reference value and the results of the comparison are sent to the golfer as a feedback information.

[**0085**] The golfer then places the golf ball **40** (**FIG. 2**) into the starting point for initiation of the game. If necessary, the golf ball may have two or more equatorial marks, as shown in **FIG. 6** where a golf ball **40***a* has two marks **42***a* and **42***b* formed in two mutually perpendicular equatorial planes of the ball.

[**0086**] The golfer hits the golf ball **40** in accordance with his/her golf habits and rules of the game. It is assumed that in putting a correct swing of the putter for striking the ball is the one in which the putter head moves practically parallel to the surface of the putting green **22** so that the golf ball **40** would acquire pure rolling movement. It is also understood that in first approximation, for the case of the absolutely horizontal plane of the putter grass, at the moment of hit the line L that passes through the centers of the golf ball **40** and of the hole H (**FIG. 2**) should be perpendicular to the face F1 of the putter head (**FIGS. 2 and 4**). This line L determines the direction of the ball **40** for reaching the hole H in the case of a correct hit. Since the gyro sensor **46** measures an angle between a given direction and an actual direction of the impulse in hit, the aforementioned line L is assumed as the aforementioned given direction (i.e., reference direction), which is preliminarily entered into the measurement system and into the display system as one of the input data.

[**0087**] During rolling over the surface of the putting green **22**, the golf ball **40** rolls so that its mark **42** (or marks **42***a* and **42***b*) are seen for a viewer, as well as for the optical receivers **44***b* and **44***d*, with periodicity of variations in brightness/darkness equal to number of revolutions of the ball **40** during rolling (or equal to a doubled number of revolutions, if two marks are used).

[**0088**] The optical receivers **44***b* and **44***d* sense the light reflected from the ball and produce on their outputs electrical signals with the frequency corresponding to the frequency of revolutions of the ball. One of the optical receivers, e.g. the optical receiver **44***b*, is shown in **FIG. 5** as a part of the signal receiving electronic circuit. In point M of **FIG. 5**, the signal has a periodical shaped shown in **FIG. 7**, which is a graph where the abscissa axis shows time and the ordinate axis shows the value of the signal, e.g., in volts. This signal shown in **FIG. 7** has the same periodicity as the actual frequency of revolutions of the ball **40**. The amplitude of the signal in point M for the supply to the amplifier A is determined by the impedance (at the carrier frequency lock diode modulation).

[**0089**] The signal amplified by the amplifier A (**FIG. 5**) is supplied to the input of the microprocessor **47**, and after being processed in the microprocessor **47** the signal is transmitted to the infrared data transmitting unit **48** (**FIG. 3**), where the signal about the frequency of revolutions (i.e., about the speed of rolling) of the golf ball **40** is converted into an infrared signal irradiated toward the receiver/transmitter **51** of the data processing unit **50**. The transmission of the signal is done after the swing.

[**0090**] At the same time, the gyro sensor **46** also generates signals corresponding to the angular position of the putter face F (**FIG. 1A**) prior to hitting the ball **40**, at the moment of hit, when the face F contacts the ball **40**, and after the hit (see angle γ in **FIG. 1D**). This angular dimension of putting, which is shown on the display **52** (**FIG. 2**) is a very important criterion for evaluating the quality of the game.

[**0091**] The signals of the gyro sensor **46** are sent via the wires **62** to the microprocessor **47** (**FIG. 3**). In the infrared data transmitting unit **48** these signals are processed. The resulting angular infrared signals are also irradiated toward the receiver **51** of the data processing unit **50**. In the case of an "ideal" hit, i.e., when the angles α and β (**FIGS. 1***f* and **1***g*) are equal to 0, the ball **40** will roll to the target hole without sliding or flying.

[**0092**] The data processing unit **50** processes the signal obtained from the devices built into the putter **30** and transmitted from the infrared data transmitting unit **48**. The processed signals, which in general consists of a signal indicating the speed of the golf ball **40** and the angular direction of the ball trajectory in the plane of the putting green **22**, can be presented on the screen **52** in a variety of graphical forms. Two of these forms are shown as examples in **FIGS. 8 and 9**. In **FIG. 8** the displayed information consists of two image. The first image contains concentrated circles **68***a*, **68***b*, **68***c* with the center of the circles corresponding to the center of the hole H and a black mark **68***d* corresponding to the actual direction of the ball trajectory in direction of hit, i.e., the angular deviation from the aforementioned reference line L.

[**0093**] The second image shows the range of ball speeds required for putting the ball into the hole, where line **72** (**FIG. 8**) corresponds to the minimal speed and the line **74** corresponds to the maximal speed. The mark **76** illustrate an actual speed of the ball.

[**0094**] For quantitative evaluation of the results, the images are provided with respective scales **78** and **80**.

[**0095**] It is understood that the ideal hit in putting corresponds to the central positions of the line **80** and of the black spot **68***d*. Another example of graphical presentation of the

results of the putting hit is shown in **FIG. 9**. This three-dimensional picture shows a part of the putting green and with certain approximation imitates the actual position of the ball **40** after the hit with respect to the hole H. Position of the ball **40** in point **82** corresponds to a weak strike and to an angular deviation of the ball trajectory to the left. Position of the ball **40** in point **84** corresponds to an excessively string strike and to an angular deviation of the ball trajectory to the left. Position of the ball **40** in point **86** corresponds to a weak strike and to an angular deviation of the ball trajectory to the right, etc.

[**0096**] **FIG. 10** is a form for presentation of the results of the game control which displays concentric circles **88***a*, **88***b*, **88***c* . . . with dark spot **90** showing position of the golf ball at holt with respect to the center of the circles which corresponds to the center of the target hole. The circle **88***d* which is shown by a broken line and is the nearest to the center O2 of the circles designate a boundary area around the center O2 from which the golf ball **20** will automatically rolls down to the hole **26**. The graph below the concentric circles shows ball speed V1 versus rolling distance L1.

[**0097**] **FIG. 11** is a form for presentation of the results of the game control with reference to angles α and β shown in **FIGS. 1E and 1F**. In this version, the display shows the tilt of the club head face F or angular deviation of the face F from the "correct" angular position at the moment of hit on the ball **20**. The tilt is shown graphically and with the digital values of the angles in vertical and horizontal planes. The arrow V2 designates the speed of the head, and the arrow V3 designates the speed of the golf ball **20**. Since the mass of the head **24** is greater than the mass of the ball **20**, the arrow V2 is shorter than the arrow V3.

[**0098**] It is understood that in order to obtain all the measurements and indication points on the screen of the display **52**, after purchase and before the first use the system has to be calibrated by repeating the aforementioned measurement procedures one or more times and then selecting the most advanced results as reference data for input into the microprocessor **47** and the data processing unit **50**.

[**0099**] The display unit **52** (**FIG. 2**) may present the results of monitoring and control of the game in the forms described above, as well as in many other forms, such as curves obtained by processing statistically accumulated data, results of calibration, stimp measurements, the set of all parameters of the game in real time, etc. The mode of indication can be selected and switched between variety of options to satisfy the customer's needs.

[**0100**] Thus, it has been shown that the invention provides a system and a method for measuring angular deviations of a golf putter face with respect to the position of the golf ball and a golf ball speed after hitting with the putter. The system measures angular deviation of the hit direction from the reference direction which has been preliminarily entered into the system. The invention also provides a self-contained measurement system of the aforementioned type built into the golf club and designed specifically for putting as a part of a golf game. The system can accumulate, analyze and display data on the game in a simple visually represented form which facilitates training and elaboration of correct habits for the game.

[**0101**] Although the invention has been shown and described with reference to specific embodiments, it is understood that these embodiments should not be construed as limiting the areas of application of the invention and that any changes and modifications are possible, provided these changes and modifications do not depart from the scope of the attached patent claims. For example, a gyro sensor of the type different from the one mentioned in the description can be use. The optical transmitters and receivers may operate in the range of the light spectrum different from the 980 nm. The results can be represented in a variety of different forms. Instead of the data processing system, the receiver/transmitter **50** can be automatically connected in an interactive manner to a virtual coach in the Internet so that the golfer can automatically receive recommendations from the "coach" in the coarse of the game. The signal transmitting and receiving means are not necessarily those operating with light energy and may comprise devices operating on microwave energy. For example, the signal transmitting devices can be Gunn diodes, which emit microwave signals. In this case, the golf ball should have alternating marks capable of absorbing microwave energy. In accordance with another modification, the signal transmitting and receiving devices may operate on ultrasonic signals used, e.g., on the principle of bias of frequency caused by the Doppler effect. If necessary, the putter can be provided with devices for measuring only the angle of hit or only the number of revolutions of the rolling ball, or the putter may contain devices measuring both aforementioned parameters but discontinue measuring one of them for concentration on the other. The optical transmitting-receiving units can be replaced by a compact CCD camera built into the club head for receiving a signal from the golf from in the form of a naturally reflected light. In order to amplify the signal received from the ball, the latter can be coated with a luminescent layer. The force sensor **33** may be presented by the moment sensor.

1. A system for controlling conditions in putting as a part of a golf game consisting in delivering a golf ball by rolling over the surface of a golf field to a selected hole, comprising:

a golf ball and a golf club having a club head, a club grip, a shaft interconnecting said club head and a club grip;

light emitting means for emitting light from said club head toward said golf ball during the game;

light receiving means capable of receiving light reflected from said golf ball;

marking means on said golf ball capable of producing light signals on said light receiving means corresponding to a number of revolutions of said golf ball during rolling thereof over said surface;

a gyro sensor means built into said club head for determining the angular direction of impact transmitted from said club head to said golf ball during said game;

a microprocessor built into said golf club and capable of receiving and processing signals transmitted thereto from said light receiving means and said gyro sensor means;

first signal receiving/transmitting means installed on said golf club for receiving signals from said microprocessor; and

a remote data processing and displaying unit which is located remotely from said golf club and has means for

processing and displaying data received from said first signal receiving/transmitting means.

2. The system of claim 1, wherein said marking means comprises at least one mark formed on the equator of said golf ball and sensible by said light receiving means.

3. The system of claim 2, wherein said light emitting means comprises at least one laser diode.

4. The system of claim 2, wherein said first signal receiving/transmitting means comprises an infrared signal receiver/transmitter.

5. The system of claim 2, wherein said club head has a flat face on the side which is intended for striking said golf ball, and said light emitting means and said light receiving means are built into said golf club and exposed through said face towards said golf ball.

6. The system of claim 1, further comprising second signal receiving/transmitting means located in said remote data processing and displaying unit.

7. The system of claim 4, further comprising second signal receiving/transmitting means located in said remote data processing and displaying unit.

8. The system of claim 1, wherein said remote data processing and displaying unit comprises a personal computer selected from a laptop and a palm top.

9. A system for controlling conditions in putting as a part of a golf game consisting in delivering a golf ball by rolling over the surface of a golf field to a selected hole, comprising:

a golf ball and a putter having a putter head, a putter grip, a shaft interconnecting said putter club head and a putter grip, said golf ball having means for selectively reflecting signals sent to said golf ball;

signal emitting means for emitting signals from said putter head toward said golf ball during the game;

signal receiving means capable of receiving signals reflected from said golf ball, said signals selectively reflected from said golf ball corresponding to a number of revolutions of said golf ball during rolling thereof over said surface;

a gyro sensor means built into said club head for determining the angular direction of impact transmitted from said club head to said golf ball during said game;

a microprocessor built into said golf club and capable of receiving and processing signals transmitted thereto from said signal receiving means and said gyro sensor means;

first signal receiving/transmitting means installed on said golf club for receiving signals from said microprocessor; and

a remote data processing and displaying unit which is located remotely from said golf club and has means for processing and displaying data received from said first signal receiving/transmitting means.

10. The system of claim 9, wherein said signal transmitting means comprises light emitting means and said means for selectively reflecting signals from said golf ball comprises at least one mark formed on the equator of said golf ball and sensible by said light emitting means.

11. The system of claim 10, wherein said light emitting means comprises at least one laser diode.

12. The system of claim 9, wherein said first signal receiving/transmitting means comprises an infrared signal receiver/transmitter.

13. The system of claim 9, wherein said putter head has a flat face on the side which is intended for striking said golf ball, and said signal emitting means and said signal receiving means are built into said putter head and exposed through said face towards said golf ball.

14. The system of claim 9, further comprising second signal receiving/transmitting means located in said remote data processing and displaying unit.

15. The system of claim 13, further comprising second signal receiving/transmitting means located in said remote data processing and displaying unit.

16. The system of claim 9, wherein said remote data processing and displaying unit comprises a personal computer selected from a laptop and a palm top.

17. A system for controlling conditions in putting as a part of a golf game consisting in delivering a golf ball by rolling over the surface of a golf field to a selected hole, comprising:

a golf ball and a golf club having a club head, a club grip, a shaft interconnecting said club head and a club grip;

light receiving means capable of receiving light reflected from said golf ball;

a gyro sensor means built into said club head for determining the angular direction of impact transmitted from said club head to said golf ball during said game;

a microprocessor built into said golf club and capable of receiving and processing signals transmitted thereto from said light receiving means and said gyro sensor means;

first signal receiving/transmitting means installed on said golf club for receiving signals from said microprocessor; and

a remote data processing and displaying unit which is located remotely from said golf club and has means for processing and displaying data received from said first signal receiving/transmitting means.

18. The system of claim 17, further comprising a force sensor rigidly connected to said golf club for measuring a force with which said golf club hits said golf ball.

19. The system of claim 17, further comprising with a signal transmitting means for transmitting signal from said club head toward said golf club, said golf ball having marking means which can be sensed by said signal receiving means.

20. The system of claim 18, further comprising with a signal transmitting means for transmitting signal from said club head toward said golf club, said golf ball having marking means which can be sensed by said signal receiving means, said forced sensor, signal receiving means, said gyro sensor means, and said first signal receiving/transmitting means being connected to said microprocessor.

21. The system of claim 19, wherein said marking means comprises at least one mark formed on said golf ball and sensible by said signal receiving means.

22. The system of claim 20, wherein said marking means comprises at least one mark formed on said golf ball and sensible by said signal receiving means.

23. The system of claim 22, wherein said signal emitting means comprises at least one laser diode.

24. The system of claim 17, wherein said first signal receiving/transmitting means comprises an infrared signal receiver/transmitter.

25. The system of claim 17, wherein said club head has a flat face on the side which is intended for striking said golf ball, and said signal emitting means and said signal receiving means are built into said golf club and exposed through said face towards said golf ball.

26. The system of claim 22, wherein said club head has a flat face on the side which is intended for striking said golf ball, and said signal emitting means and said signal receiving means are built into said golf club and exposed through said face towards said golf ball.

27. The system of claim 26, wherein said signal emitting means comprises at least one laser diode.

28. The system of claim 17, further comprising second signal receiving/transmitting means located in said remote data processing and displaying unit.

29. The system of claim 27, further comprising second signal receiving/transmitting means located in said remote data processing and displaying unit.

30. The system of claim 17, wherein said remote data processing and displaying unit comprises a personal computer selected from a laptop and a palm top.

31. The system of claim 29, wherein said remote data processing and displaying unit comprises a personal computer selected from a laptop and a palm top.

32.A system for controlling conditions in putting as a part of a golf game consisting in delivering a golf ball by rolling over the surface of a golf field to a selected hole, comprising:

a golf ball and a putter having a putter head, a putter grip, a shaft interconnecting said putter club head and a putter grip, said golf ball having means for selectively reflecting signals sent to said golf ball;

light emitting means for emitting signals from said putter head toward said golf ball during the game;

light receiving means capable of receiving light signals reflected from said golf ball, said light signals selectively reflected from said golf ball corresponding to a number of revolutions of said golf ball during rolling thereof over said surface;

a gyro sensor means built into said club head for determining the angular direction of impact transmitted from said club head to said golf ball during said game;

at least one force sensor for measuring a force applied from said putter head to said ball during hit;

a microprocessor built into said golf club and capable of receiving and processing signals transmitted thereto from said light signal receiving means, said gyro sensor means, and said force sensor;

first signal receiving/transmitting means installed on said golf club for receiving signals from said microprocessor; and

a remote data processing and displaying unit which is located remotely from said golf club and has means for processing and displaying data received from said first signal receiving/transmitting means.

33. The system of claim 32, wherein said light transmitting means comprises light emitting means and said means for selectively reflecting signals from said golf ball comprises at least one mark formed on the equator of said golf ball and sensible by said light emitting means.

34. The system of claim 33, wherein said light emitting means comprises at least one laser diode.

35. The system of claim 32, wherein said first signal receiving/transmitting means comprises an infrared signal receiver/transmitter.

36. The system of claim 32, wherein said putter head has a flat face on the side which is intended for striking said golf ball, and said signal emitting means and said signal receiving means are built into said putter head and exposed through said face towards said golf ball.

37. The system of claim 32, further comprising second signal receiving/transmitting means located in said remote data processing and displaying unit.

38. The system of claim 36, further comprising second signal receiving/transmitting means located in said remote data processing and displaying unit.

39. The system of claim 32, wherein said remote data processing and displaying unit comprises a personal computer selected from a laptop and a palm top.

40.A method for controlling conditions in putting as a part of a golf game consisting in delivering a golf ball to a selected hole by rolling over the surface of a golf field, comprising:

providing a system that comprises:

a golf ball with means for reflecting selected signals;

a golf putter with signal transmitting means and signal receiving means;

a microprocessor capable of receiving and processing signals obtained from said signal receiving means, and first signal receiving/transmitting means; and

a signal processing and displaying means having second signal receiving/transmitting means;

sending signals from said signal transmitting means toward said golf ball;

hitting said golf ball with said putter for accomplishing said putting by rolling said golf ball toward said selected hole;

receiving at said signal receiving means said selected signals reflected from said golf ball by said means for reflecting selected signals;

generating on said signal receiving means a first output signal corresponding to number of revolutions of said golf ball during said rolling;

transmitting said first output signal to said microprocessor;

processing said first output signal in said microprocessor and generating on said microprocessor a second output signal with information about said number of revolutions;

sending said second output signal to said first signal receiving/transmitting means;

processing said second output signal in said first signal receiving/transmitting means, and transmitting thereof to said second signal receiving/transmitting means;

processing signals received by said second signal receiving/transmitting means in said data processing and displaying means for generating a displayable output signal with information about said number of revolutions; and

displaying said displayable output signal on said data processing and displaying means.

41. The method of claim 40, further comprising the steps of:

additionally providing said golf putter with a at least one force sensor and at least one gyro sensor for measuring a force applied to said golf ball from said golf putter and a direction of hit by said golf putter on said golf ball;

measuring said force with said force sensor and said direction of hit with said gyro sensor and producing on said gyro sensor an output signal with information about said force and said angle;

sending said output signal with information about said force and said angle of hit to said microprocessor;

processing said output signal with information about said force and said angle of hit in said microprocessor and generating in said microprocessor a third output signal with information about said force and said angle of hit;

sending said third output signal to said first signal receiving/transmitting means;

processing said third output signal in said first signal receiving/transmitting means, and transmitting thereof to said second signal receiving/transmitting means;

processing signals with information about said force and said angle of hit received by said second signal receiving/transmitting means in said data processing and displaying means for generating an additional displayable output signal with information about said force and said angle of hit; and

displaying said additional displayable output signal on said data processing and displaying means.

42. A method for controlling conditions in putting as a part of a golf game consisting in delivering a golf ball to a selected hole by rolling over the surface of a golf field, comprising:

providing a system that comprises:

a golf ball with means for reflecting selected signals;

a golf putter with signal transmitting means, signal receiving means, gyro sensor means for measuring an angle of hit by said putter on said golf ball, a force sensor for measuring a force applied from said golf putter to said golf ball at the moment of said hit, a microprocessor capable of receiving and processing signals obtained from said gyro sensor means, said force sensor, and from said signal receiving means;

a first signal receiving/transmitting means located in said golf putter; and

a signal processing and displaying means having second signal receiving/transmitting means;

sending signals from said signal transmitting means toward said golf ball;

hitting said golf ball with said putter for accomplishing said putting by rolling said golf ball toward said selected hole;

measuring said force applied from said golf putter to said golf ball and sending the results of measurement to said microprocessor;

receiving at said signal receiving means said selected signals reflected from said golf ball by said means for reflecting selected signals;

generating on said signal receiving means a first output signal corresponding to number of revolutions of said golf ball during said rolling;

generating on said gyro sensor means a second output signal corresponding to said angle of hit;

transmitting said first output signal and said second output signal to said microprocessor;

processing said results of measurement of said force, said first output signal, and said second output signal in said microprocessor and generating on said microprocessor a third output signal with information about said force and said number of revolutions and a fourth output signal about said angle of hit;

sending said third output signal and said fourth output signal to said first signal receiving/transmitting means;

processing said third output signal and said fourth output signal in said first signal receiving/transmitting means, and transmitting them to said second signal receiving/transmitting means;

processing signals received by said second signal receiving/transmitting means in said data processing and displaying means for generating a first displayable output signal, with information about said force and said number of revolutions, and a second displayable signal with information about said angle of hit; and

displaying said first displayable output signal and said second displayable output signal on said data processing and displaying means.

43. The method of claim 42, wherein means for reflecting selected signals comprises at least one mark formed on the equator of said golf ball and sensible by said light receiving means.

44. The method of claim 43, wherein said signal transmitting means comprises at least one laser diode.

45. The system of claim 44, wherein said first signal receiving/transmitting means comprises an infrared signal receiver/transmitter.

46. The method of claim 45, wherein said second displayable signal is displayed In the form of a first image which contains concentric circles with the center of the circles corresponding to the center of said selected hole with a black mark corresponding to an actual direction of said hit and wherein said additional displayable signal is displayed in the form of a range of speeds of said golf ball required for putting said ball into said selected hole, said range being shown as a first mark that corresponds to a minimal speed and a second mark that corresponds to a maximal speed.

47. The method of claim 46, further provided with a step of indicating change in speed of said golf ball versus time during said rolling.

48. The method of claim 45, wherein said first displayable signal and said second displayable signal are shown as a three-dimensional picture which shows a part of said surface, said selected hole, and a position of said golf ball after said hit.

49. The method of claim 45, wherein said putter has a putter head with a face on a side facing said golf ball, said gyro sensor means are two gyro sensors, said second displayable signal being shown in digital and graphic forms of angles of tilt of said face in a vertical plane and a horizontal plane.

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