United States Patent

Conklin

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[54] **SPIN DETECTOR FOR GOLF GAMES**

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

[58] **Field of Search**.....273/184, 185, 181, 182; 73/379, 380, 381, 432

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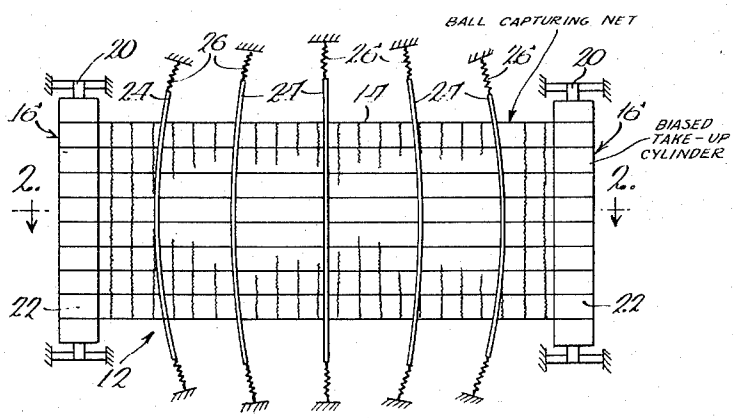
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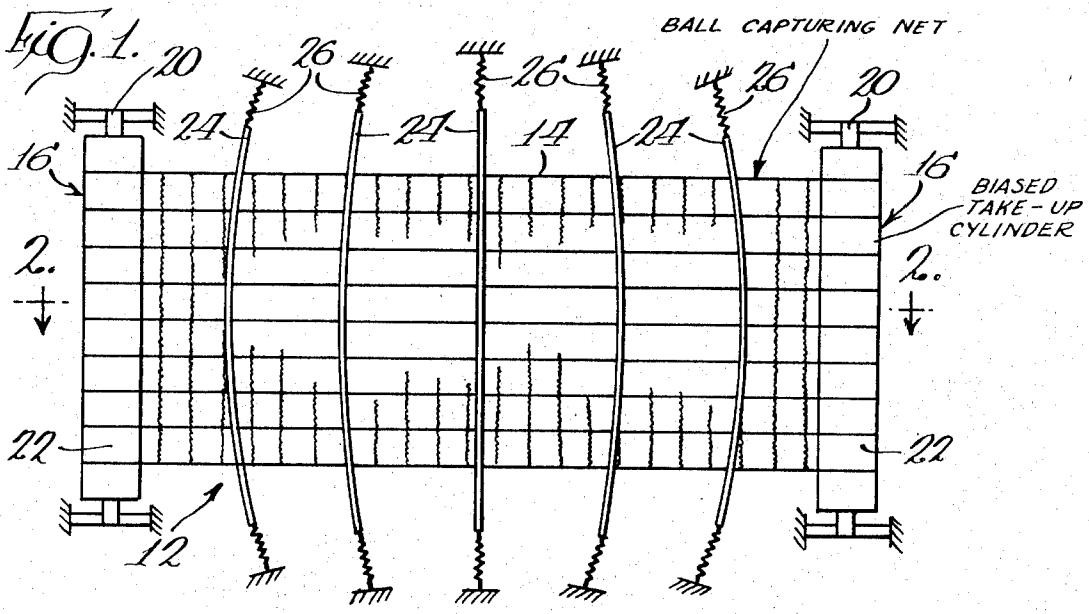
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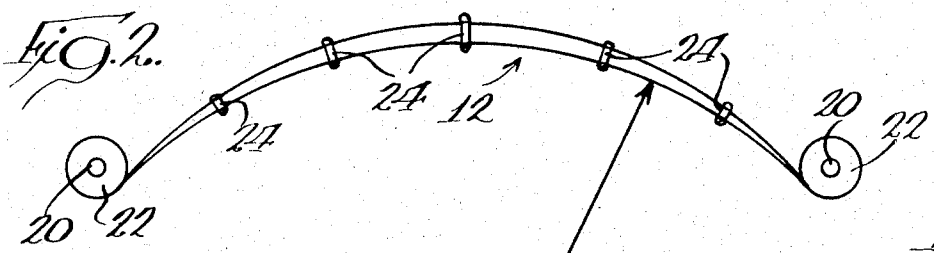
[57] **ABSTRACT**

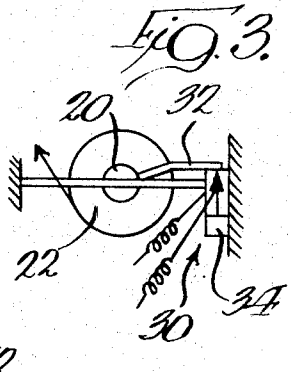
A golf game including a ball capturing net resiliently suspended in spherical form relative the tee point and biased laterally by two side take-up cylinders. Deflection of the net by the momentum and spin of an impacting ball unwinds the cylinders. The outputs of a piezo-electric signal generators activated by the unwinding of each cylinder are integrated, compared and the difference displayed by a galvonometer calibrated to indicate slice or hook of the ball.

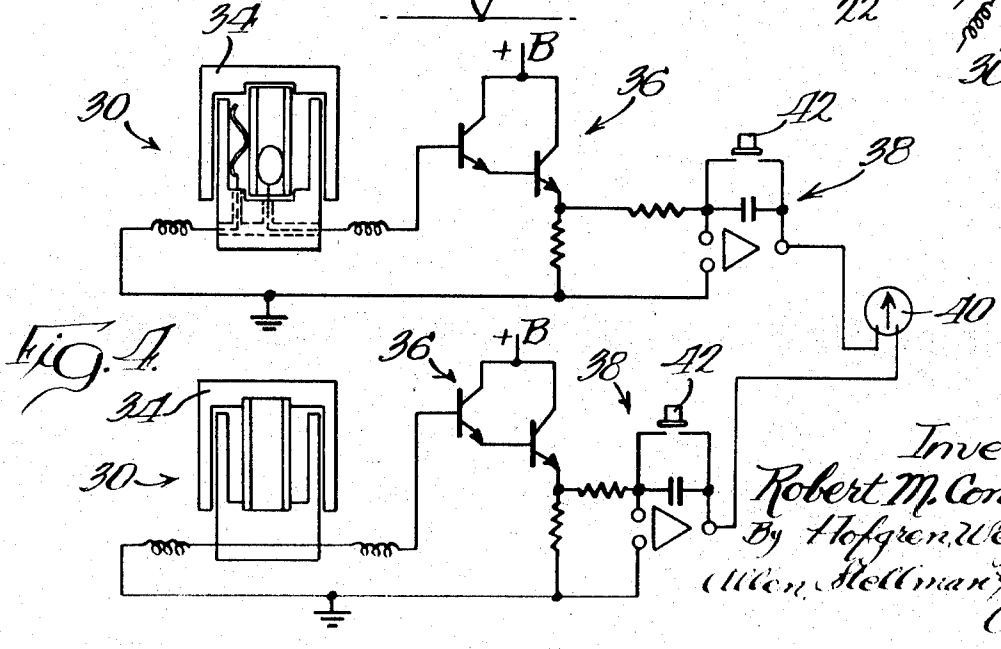
6 Claims, 4 Drawing Figures











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SPIN DETECTOR FOR GOLF GAMES

BACKGROUND OF THE INVENTION

1. Field of Invention

This invention relates to an apparatus used in a golf game that may be played indoors wherein a novel target means and sensing means associated therewith are employed to detect the spin on a driven golf ball.

2. Description of the Prior Art

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The ever increasing upsurge of the popularity of the game of golf has resulted in severe crowding of existing outdoor facilities. As a result, there have been numerous proposals for indoor golf games wherein an entire game of **18** holes may be played indoors. Such indoor golf games customarily involve tee areas from which a ball may be hit to be intercepted by a target. Suitable data acquisition means are interposed between the tee and the target and provide information relative to the initial trajectory, speed and spin of a driven golf ball. This information is then fed into a computer which will ascertain how far the ball would have traveled had it not struck the target. One of the factors taken into consideration is the amount of spin imparted to a driven golf ball which dictate whether or not the ball which has been hit will travel in a "sliced" or "hooked" trajectory.

In the past, it has been known to measure spin by means of a rebound type of target. This type of target requires that a ball, after hitting a target, be allowed to rebound to a second target area wherein, through different sensing means, the angle deviation between the actual angle in which the golf ball rebounds off the first target and the angle of rebound of a golf ball having no spin imparted thereon (normally equal to the angle of impact) is measured.

While such golf games embodying such a spin measuring means have been very satisfactory in measuring the amount of spin imparted to a driven golf ball, the require that there be a rebound becomes a disadvantage since additional space to house rebound sensing means away from the target is required. Also, since spin is measured after the rebound, more time is required for data acquisition than if spin were to be measured prior to a rebound. Finally, an errantly rebounding ball missing a spin detecting means may return to the tee to strike a golfer.

SUMMARY OF THE INVENTION

The principal object of this invention is to provide a new and improved apparatus for use in an indoor golf game which measures the spin imparted on a driven ball without requiring a rebound to do so, thereby minimizing space requirements.

The spin measuring apparatus includes a tee for a golf ball, a target means against which a ball strikes when driven directly from the tee, and means for measuring the impulse imparted to the target means from a golf ball having spin thereon. The impulse is measured in a direction normal to the line of travel of the driven golf ball. The impulse measuring means includes means mounting the target for movement in a direction normal to the flight of a driven golf ball so that the impulse tends to cause the target to move in said direction a distance proportional to the spin imparted to the golf ball and means for measuring the force which the target has imparted to the mounting means after being struck by the golf ball. After the impulse has been measured, an output signal representative of the measured impulse in generated.

An exemplary embodiment of the invention employs a concave spherical target formed of a net wherein the sphere has its center at the tee. The force that the ball imparts to the target is measured by two transducers which are operatively connected to the mounting means on opposite sides of the target. The system is arranged so that the impulse imparted to the target by a ball in the direction of its line of flight is eliminated by means of a differential circuit associated with both transducers.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a front elevation of a golf apparatus made according to the invention;

FIG. **2** is a horizontal section of the golf apparatus taken generally along line **2—2** of Fig. **1**;

FIG. **3** is an enlarged fragmentary plan view of an impulse measuring device employed in the invention; and

FIG. **4** is an electrical schematic diagram of a spin measuring and indicating circuit employed in the golf apparatus.

DESCRIPTION OF THE PREFERRED EMBODIMENT

An exemplary embodiment of an indoor golf game apparatus embodying the invention is illustrated in FIGS. **1** and **2** and is seen to comprise a tee point **10** from which a golf ball may be driven and target means, generally designated **12**, against which a ball impacts when driven from the tee **10**. The target **12** is made from a rectangular piece of netting **14** capable of capturing a golf ball and is located in front of the tee **10** generally transverse to an intended line of flight of a ball hit therefrom.

The net **14** forms a portion of a sphere having its center at the tee point **10**. This configuration insures that any point on the target **12** which is struck by a golf ball driven from tee **10** will be normal to the line of flight of the ball for purposes which will become more apparent hereinafter.

The net **14** is mounted by a pair of vertical mounting means, generally designated **16**, and each supporting one end of the net **14**. Each mounting means **16** is generally seen to include a vertical shaft **20**, secured at its top and bottom to a stationary surface and a cylinder **22** mounted concentrially about the shaft **20** for rotation thereabout. The ends of the net **14** are secured to respective ones of the rotatable cylinders **22**. Looking at Fig. **2**, the left-hand end of the net **14** is wound around the left-hand cylinder **22** in a clockwise direction while the right-hand end of the net **14** is wound about the right-hand cylinder **22** in a counterclockwise direction. To keep the net **14** taut at all times each cylinder **22** is spring biased by means not shown about the vertical shaft **20** in a direction tending to pull the net **14** toward the tee point **10**.

Maintenance of the desired spherical configuration of the net **14** is accomplished by a plurality of vertically curved brace members **24**. The brace members **24** are attached to the back of the net **14** and pull the net **14** backwards to present a concave spherical surface to

the tee point **10**. Each brace member **24** has a coil spring **26** attached at each end thereof which are fixedly secured to top and bottom stationary surfaces respectively, such as a ceiling and a floor of a room. The spring constant of each of the springs **26** is sufficiently weak that a ball impacting against the net **14** will cause brace members **24** along the net **14** to yield but is strong enough to restore the net **14** to the desired spherical configuration.

A golf ball driven in such a way as to impart spin to the same bears two forms of kinetic energy. The first form, hereinafter referred to as linear momentum, is that energy content of the ball present due to moving along its line of flight. The second, hereinafter referred to as angular momentum, is due to the rotation of the ball about its center due to the impartation of spin thereto. Therefore, when a golf ball having spin imparted thereto when struck from the tee impacts against the target **12**, the linear momentum of the golf ball will drive the net backwardly and the angular momentum will cause a movement of the net in a plane normal to the golf ball line of flight and in a direction in the plane corresponding to the direction of rotation of the ball about its center. The former movement of the net may be regarded as a velocity impulse while the latter may be regarded as a spin impulse.

The rearward motion of the net will tend to force each of the spring biased cylinders **22** to unwind the net while loading up the associated spring (not shown). The spin impulse, to the extent that it includes side spin responsible for hook or slice, will tend to cause one of the spring biased cylinders **22** to unload while the other will be further loaded. Since the velocity impulse is much greater than a spin impulse, both of the spring biased cylinders **22** will tend to unwind thereby loading up their respective springs, however, to a different degree depending upon the nature and magnitude of the side spin. That is, because the target **12** is spherical with respect to the tee point and a ball hit from the tee point will always impact against the same normal to the surface of the target at the point of impact, the loading of the cylinders **22** due to the velocity impulse will be equal and the loading due to the spin impulse, if any, will be unequal.

By way of example, looking at Fig. **2**, if a right-handed golfer drives a golf ball from the tee point **10** and has imparted a slicing side spin on the golf ball, (i.e., a spin in a clockwise direction looking down at Fig. **2**), the following sequence of events occurs: (1) the golf ball strikes the net **14** normal thereto; (2) the net **14** will tend to be forced backwards due to the velocity impulse normal to the net **14**; (3) the net **14** will tend to be forced in a right-hand direction normal to the flight of a golf ball from the tee **10** due to the impulse associated with the slicing side spin on the golf ball; (4) the left-hand cylinder **22** will have an unwinding force associated therewith in response to the combined velocity and impulse components acting simultaneously on the net **14**; and (5) the right-hand cylinder **22** will have an unwinding force associated therewith which is less than the force associated with the left-hand cylinder in response to the combined velocity and spin impulse components acting simultaneously on the net **14**.

As a result, the following conditions at the cylinders **22** will exist. For the left-hand cylinder **22**,

$$IL_t = I_v + I_s \qquad \text{(Equation 1)}$$

and the right-hand cylinder,

$$IR_t = I_v - I_s \qquad \text{(Equation 2)}$$

where:

IL_t is equal to the total impulse applied to the left-hand cylinder

IR_t is the total impulse applied to the right-hand cylinder

I_v is the impulse imparted to the net due to the velocity impulse and

I_s is equal to the impulse imparted to the net due to side spin.

Rearranging Equation 2 and incorporating the same in Equation 1, it will be seen that the impulse due to spin is proportional to the difference between the total impulse applied to each of the cylinders **22** as represented by Equation 3 below:

$$I_s \sim IL_t - IR_t \qquad \text{(Equation 3)}$$

Therefore, side spin on a ball can be ascertained by measuring the difference between the total impulse applied to the left-hand cylinder **22** and the total impulse applied to the right-hand cylinder **22** which may be accomplished by ascertaining the unwinding force applied to the cylinders **22**.

In order to measure the unwinding force in which each end of the net **14** exerts on its respective concentric shaft **22**, pair of impulse measuring means, generally designated **30**, one associated with each cylinder **22**, are provided as shown in Fig. **3**. The impulse measuring means measures the force or impulse which tends to unwind each cylinder **22**.

One measuring means **30**, shown in Fig. **3**, is seen to generally comprise an arm **32** fixedly attached to the right-hand cylinder **22** and extending outwardly therefrom in a normal abutting relation with a transducer **34** such as a piezo-electric crystal. When the cylinder is caused to rotate in a clockwise direction due to the striking of golf ball, the arm **32** is momentarily pressed hard against the piezo-electric transducer **34** which causes an electrical impulse proportional to the pressure applied thereto. It is apparent that the greater the unwinding force due to the golf ball impacting the target the greater pressure the arm **32** exerts on the piezo-electric transducer **34**, which produces a greater amount of electrical charge.

Turning now to Fig. **4**, the electrical circuits comprising both measuring means **30** are shown in greater detail. Each circuit is identical to the other and therefore only one shall be described in detail. Each circuit is seen generally to include means for sensing stress or strain such as the piezo-electric transducer **34**, an emitter follower amplifier generally designated **36**, and an operational amplifier in an integrating circuit, generally designated **38**. The circuit is appropriately powered as shown.

When pressure is applied to the transducer **34** by arm **32**, a signal is caused to flow out of the transducer **34**. This signal is amplified and integrated by amplifiers **36** and **38**, respectively.

A galvanometer **40** is connected across the outputs of both integrating circuits **38** in a differential manner and serves the purpose of subtracting the strength of the amplified and integrated transducer signals

generated by each measuring means **30** wherein the difference represents the amount of impulse imparted to the target as a function of spin.

For example, assuming that the uppermost measuring circuit shown in Fig. **4** is associated with the right-hand cylinder **22** and the lowermost circuit shown in Fig. **4** is associated with the left-hand cylinder **22** and further assuming that a right-handed golfer has hit a ball from the tee in such a way as to impart a slicing side spin thereto as mentioned above, it will be appreciated that the magnitude of the signal at the output of the integrating circuit **38** associated with the right-hand cylinder **22** will be less than the magnitude of the output of the integrating circuit **38** associated with the left-hand cylinder **22**. This difference will cause galvanometer **40** to deflect in a particular direction determined by the polarity of the imbalance and an amount determined by the magnitude of the imbalance which will therefore serve as an indication of the nature and magnitude of the side spin imparted to the ball.

It will also be appreciated that if the imbalance were of a polarity opposite of that mentioned in the preceding paragraph, the direction of deflection of the galvanometer **40** would be opposite that for the preceding example and further that if there were no imbalance, corresponding to a no side spin condition, there would be no deflection of the galvanometer.

Also provided in conjunction with each measuring means **30** as shown in Fig. **4** is a reset button **42** which, when closed, is operative to discharge each integrating circuit **38** to reset the apparatus for the next shot.

Those skilled in the art will appreciate that indicating means other than the galvanometer **40** may be employed. For example, a so-called ball spot projector responsive to known circuitry receiving the output signals from the integrating circuits **38** could be used in lieu thereof. Furthermore, the reset button **42** need not be manually operated as shown but could be operated automatically by golf game computer reset means known in the art.

While the disclosed embodiment is directed to the determination of side spin, it will be appreciated that the principles enunciated herein can also be employed in the measurement of backspin or overspin either alone or in conjunction with side spin simply by providing force measuring means responsive to spin impulses in the vertical direction imparted to the net **14**. By the same token, while the use of a spherical target permits a ball to strike the target's surface in a direction normal thereto for each shot so that linear momentum impulses on opposite sides of the net cancel out for simplicity of measurement, the principles of the invention are equally applicable to non-spherical targets. That is, a target shaped in such a way that the ball will not impact against the target's surface in a direction normal thereto can be used although additional means for eliminating any vector component of the velocity impulse normal to ball flight may be required. For example, a planar target may be employed along with means for sensing the angle of deviation of a ball hit from the tee from a line extending to the tee and normal to the target and the sensed angle of deviation utilized in computation to eliminate sideways impetus imparted to the target due to the velocity of the ball.

I claim:

1. In an indoor golf game, an apparatus for measuring the spin imparted to a driven golf ball comprising:
- a tee area from which a golf ball may be driven;
- target means for receiving the impact of a ball driven directly to said target means from the tee; and
- means for measuring the force exerted upon said target means by the spin on the golf ball impacting thereon.

2. The apparatus of claim **1** wherein said force measuring means includes
- means mounting the target means for movement in a direction generally normal to the line of flight of a driven golf ball so that said target will be displaced upon impact by the angular impulse of a golf ball having a spin thereon a distance in said generally normal direction proportional to the spin on the impacting golf ball; and
- means for measuring the force which the target means exerts on the mounting means as a result of such displacement.

3. In an indoor golf game, an apparatus for measuring the spin imparted to a driven golf ball comprising:
- a tee area from which a golf ball may be driven;
- target means for receiving the impact of a ball driven directly from the tee;
- means for retaining said target in a preselected position and means operationally coupled to said retaining means for sensing therethrough forces upon said target means exerted exclusively in a direction substantially normal to the flight path of the ball impacting the target.

4. In an indoor golf game, an apparatus for measuring the spin imparted to a driven golf ball comprising:
- a tee from which a golf ball may be driven;
- a spherical target means for receiving the impact of a ball driven directly from said tee,
- means resiliently mounting the spherical target means with its focus and said tee in coincidence whereby the angular impulse associated with a golf ball having spin thereon imparted to said target means upon impact of the ball tends to cause the target means to move in a plane substantially normal to the direction of travel of a ball hit from the tee; and
- means for measuring the force which the target means exerts on said resilient mounting means as a result of being struck by a spinning golf ball.

5. The apparatus of claim **4** wherein said spherical target means is made from a net which is capable of capturing a golf ball.

6. In an indoor golf game, an apparatus for measuring the spin imparted to a driven golf ball comprising:
- a tee from which a golf ball may be driven;
- a spherical target formed out of netting against which a ball strikes when driven directly from the tee, said spherical target having its focus at the tee and so presenting a surface normal to the direction of the flight of a golf ball driven from the tee;
- a pair of vertical means mounting the target at each end thereof, each mounting means including a fixed vertical shaft having a concentric cylinder mounted for rotation thereabout, said net being secured to said cylinder and wound thereabout and each cylinder being spring biased about the fixed shaft in opposite directions to keep the

netting taut whereby the angular impulse associated with a golf ball having spin thereon in combination with the impulse associated with the velocity of said ball is imparted to the target thereby tending to cause each cylinder to unwind an amount proportional to the spin and velocity imparted to the golf ball;

a pair of means, one associated with each cylinder, for measuring the unwinding force which the target exerts on each cylinder after the target has been struck by a golf ball and providing a signal representative thereof; and

means for subtracting the signals representative of the two unwinding forces thereby providing a signal representative of the sidespin imparted to the golf ball.

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