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Northeastern University

Capstone Design Program: Mechanical Engineering

Department of Mechanical and Industrial Engineering

November 05, 2007

The Golf Ball Detector

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Recommended Citation

Savran, Asli; Matlo, Matt; and Abdul-Ghaffar, Kevin, "The Golf Ball Detector" (2007). *Capstone Design Program: Mechanical Engineering.* Paper 100. http://hdl.handle.net/2047/d10011420

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THE GOLF BALL DETECTOR

ME 1501-1502

Technical Design Report

Final Report

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May 29, 2002

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Acknowledgments

We would like to thank Professor Taslim for his continuing help and support, and we also express our gratitude for the companies who provided the necessary materials for this project, Topflite and Intersoft.

Copyright

"We the team members,

Matt Matlo Asli Savran Kevin Abdul-Ghaffar

Mohammad E Taslim

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The Golf Ball Locator

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Abstract

The following document contains the final report for the Golf Ball Detector Senior Capstone Design Project. This Senior Capstone Design Group has proven the concept for a device to consistently locate golf balls. The golf ball detector is portable, easy to use, reliable, applicable in various situation and conditions, affordable to most golfers and safe for its user and the environment. The report discusses relevant background information on golf and golfers and presents the design developed by this Senior Capstone Design Group as a guide toward the solution. Preliminary researches on patent and exsisting alternatives are presented. Several preliminary design solutions that were eventually rejected are discussed in detail. After rejecting the earlier proposals, the design group decided to pursue the implantation of radio-frequency identification equipment within the ball as a solution. It has been shown that the RFID tag can still receive and transmit signals from inside a golf ball, that a passive RFID tag can survive the impact of a golf club from inside a ball, and that the addition of the tag does not significantly disrupt the physical properties of the golf ball. An RFID kit with suitable range is not currently available to the design group, but future advancements in RFID technology will complete the long-range golf ball locator. In addition to locating lost balls in play, this technology can be applied to prevent the theft of golf balls from driving ranges, saving the owners of these establishments thousands of dollars per year.

INTRODUCTION

The importance of practice is always emphasized in golf. Professional PGA Tour player spend as much as 4 hours daily at the driving range. Not including putting, chipping, and mental preparation. In the US alone, there are over 10000 driving ranges. Most are accessible to the public. Golfers can rent golf ball in numbers ranging from 50 up to 200. Top Golf Driving range in Saugus, MA, for example, charges $9.75 for a large bucket, of approximately 100 balls. As with any other establishment, driving range owners have to endure various expenses. In addition to normal operating expenses, driving ranges across the world are faced with the problem of prohibited removal of range balls. Based on a survey conducted across various driving ranges in the Boston Area (see appendix), the average driving range loses more than a thousand of balls per month. With the average cost of range ball at $0.50, range owners lose $500 to theft, not including damaged, lost or unplayable range balls.

There is no such thing as a perfect round of golf. Even the best players in the world will slice, hook, push, or pull their shots off the fairway into the heavy rough. More often than not, a ball shot into the rough will be permanently lost, adding to the frustration of golf. One can avoid such frustration by using a simple device, the golf ball detector. The device fits the following criteria:

1. **Hand held:** A device comparable in size to Palm Pilots and Laser Range Finders. This allows for easy storage in golf bags and/or golf carts.
2. **Accurate (within reason):** Under normal circumstances, golfers can estimate the location of the ball to within a radius of 10 yards or less. This can vary dramatically because of the ball's interaction with objects such as tress or rocks. The detector should operate accurately from within a radius of 10 to 20 yards from the golf ball.
3. **Flexible and reliable:** The function of the receiver should be unaffected by interfering objects and weather conditions.
4. **Easy to use:** Ergonomics and signal sensitivity should be an essential part of the design considerations.
5. **Affordable (< $300):** In conjunction with the number of golf balls lost per year and the cost thereof. The Golf ball detector should be priced to favor the welfare of the consumer.
6. **Non-hazardous to golfer & environment**: The safety of the consumer and the environment are important and will be considered. All components of the device should comply with federal health and safety regulations.

The next section of this report will present background information and a history of golf that is necessary to rationalize the need for a breakthrough device for golfers: the golf ball detector.

BACKGROUND AND HISTORY

History of Golf

The origin of the game of golf has never been clearly established. The Romans during the reign of Julius Caesar played a game resembling golf by striking a feather-stuffed ball with club-shaped branches. Book illustrations show the Dutch playing a similar game on their frozen canals about the 15th century. Cross-country variations were popular in France and Belgium.

In 1457 golf was banned in Scotland because it interfered with the practice of archery, which was vital to the defense effort. Nevertheless, the Scots continued to oppose both Parliament and church by playing the game on seaside courses called links. Scotland is the home of the world's oldest golf courses, St. Andrews, which was used as early as the 16th century. Golf became firmly established in Great Britain by the 17th century when James VI of Scotland, later known as James I of England, was attracted to the sport. The Royal and Ancient Golf Club at St. Andrews, the cradle of golf, was founded in 1754. During the 1800s the gutta-percha ball, or "gutty," replaced the feather-filled ball that had been used for centuries. In 1860 the first British Open was played at Prestwick, Scotland. The competition was opened to both professionals and amateurs the following year. The first permanent golf club in North America, Canada's Royal Montreal Club, was founded in 1873.

St. Andrews, also the name of one of the oldest golf clubs in the United States, was established as a 3-hole layout in 1888 at Yonkers, N.Y. Its founders were known as the "Apple Tree Gang" because of the many apple trees on their course, which was extended to 6 holes on a cow pasture. During the next few years numerous 6-, 8-, 9-, and 12-hole courses were opened in the East. The first 18-hole course in the United States, the Chicago Golf Club, was founded near Wheaton, Ill., in 1893.

A History of the Golf Ball

Featherie
(c. 1400)

Some might assume all great technological advances were made after humanity figured out how to make beach sand into microchips. With a pastime as ancient as golf, something must have clicked early on or it never would have survived this long. That hook may well have been the featherie golf ball, perfected by the Dutch around five or six hundred years ago from a basic technique used for game balls in ancient Rome. They would stuff a hatful of wet feathers (and remember, they liked BIG hats in those days) into a wet inch-and-a-half leather pouch, sew it up, and let it dry. The feathers would expand, and the leather would shrink, creating a ball as hard as... well, a golf ball. This made for a very resilient and lively projectile, especially when compared to the wooden balls used previously.

Guttie
(c. 1860)

The featherie performed remarkably well on the links, as shown by a recorded drive of 361 yards by Samuel Messieux in 1836, at the Old Course in St. Andrews! Sure, it was just skin and bird hair, but it was still a quantum leap by any measure, sort of the transistor of golf balls. For more than 400 years, it was the ball of choice. That is, if you could afford it. The extravagant cost of the featherie (the best ballmakers could produce only four or five per day) sealed their fate when the cheap "guttie" ball appeared around 1850.

Hammered Guttie
(c. 1870-80)

This new ball was made from a solid piece of gutta percha, a natural gum from Malaysia. Not only did it make a cheap and durable golf ball, it also made a lively, rounder and smoother one without the featherie's ugly stitched seams. Thus it was both unfortunate and inexplicable that the guttie's performance was no match for the featherie. It ducked and veered unpredictably, falling considerably short of the old bag of feathers.

Bramble Pattern

But hackers soon noticed that the more they scarred the ball, the longer and straighter it flew. Fresh new gutties were soon being mercilessly hammered right out of the box, before the first stroke was taken. Golf ball aerodynamics had been discovered, if not understood. For 400 years, no one had suspected that the featherie owed its graceful flight to its ugly seams, which acted like the scars of a veteran guttie.

(c. 1890)

Early Dimple Pattern

Behold the Dimple

Pounding each new guttie must have been quite inconvenient, not to mention inconsistent. So it didn't take a rocket scientist (fortunately, considering the era) to realize that there would be a marketing advantage for a pre-hammered ball. By the turn of the century, gutties were being sold with all manner of grooves, gouges, divots, bumps, and lumps already molded into their surfaces. Of course, aerodynamics was still a murky endeavor at that time, and these designs were more artistic than scientific. However, the hammered ball was still far better than a smooth ball. Out of this field, the emerging early winner was a design called the bramble pattern, which featured a closely packed array of bumps like the surface of a raspberry.

Modern Dimple Pattern

Today, we might still be using golf balls resembling fruit if not for the English engineer William Taylor. In 1908 he patented an inverted bramble pattern which consisted of evenly distributed circular depressions covering the surface of the ball. That's patentese for dimples. Unlike many of the other configurations, dimples proved to be effective aerodynamically and cosmetically, and they virtually owned the market by 1930. Aside from occasional departures, the circular dimple in one form or another has been the standard of the game ever since.

Typical Golf Ball Construction

Core Construction

A golf ball's source of energy is its core. In fact, differences in core construction affect many important golf ball performance characteristics: spin rate (control), initial velocity (distance) and compression (feel). The primary golf ball core constructions, wound and solid, offer significant differences in control and feel. Most better players can discern subtle differences in backspin and workability, and can identify different ball types by hitting them. While not all serious golfers can distinguish a three-piece wound core ball from a two-piece solid core ball, one can select the golf ball construction that contributes to his desired performance characteristics.

The Wound Core

The wound ball consists of the center, the windings and the cover. The center is either liquid-filled or solid and the cover is balata, elastomer or Surlyn, The type of center in combination with the windings and the cover material dramatically alters the spin rate and feel of the ball. The center is generally made of a rubber or thermoplastic elastomer compound.

Most balata-covered golf balls feature a hollow center, filled with a liquid. The hollow centers of the Titleist Tour Balata and the Titleist Professional are molded from natural rubber to exact size, weight and wall thickness and then the outer shells are filled to a precise weight with a non-toxic solution of water, corn syrup and sale. It is the combination of the liquid-filled center, windings and cover which optimizes the ball's spin rate.

Surlyn-covered wound balls, such as the Titleist DT Wound, have a solid rubber center. The harder, more durable Surlyn cover decreases the spin rate of the golf ball. Titleist uses a solid center to increase the ball's overall spin rate.

Both the liquid-filled and solid centers are then wound to a predetermined size to optimize velocity and spin. The formulation and size of the thread and the winding process (which determines the length, tension and pattern of the windings) dictates the velocity of the ball's core. The thread materials used in different ball types vary in size and formulation to optimize the initial velocity for that specific construction.

The Solid Core

A two-piece golf ball consists of a solid core and a durable cover. The formulation of the ingredients blended into a solid core is critical to the initial velocity of the golf ball and its resulting distance. The solid core is a high-resiliency rubber compound, with a blend of additives to further enhance its performance. The blend of rubbers is mixed, controlling both time and temperature. Even humidity needs to be precisely controlled so that excess moisture will not lower the core's velocity. During extrusion, core material is rolled and cut into sheets, extruded into blanks and molded into spheres. During the core molding process, rubbers are linked together, or cured, by a chemical reaction. Meanwhile, computers monitor time, temperature, and pressure to ensure consistent compression and velocity.

In the final core finishing, every core is ground with a centerless grinding machine, similar to those used to make professional billiard balls. Titleist's manufacturing precision results in uniform core size, weight, velocity and compression for consistent performance.

Cover Material

There are three basic types of cover materials used for golf balls: Balata, Elastomer and Surlyn.

Balata

Balata used in earlier years was a natural material. It has since been replaced by a synthetic. Balata-covered wound balls provide the highest spin, the softest feel, and the greatest control of any other golf ball. The soft, flexible balata compresses against the face of the club at impact, creating the ball's high spin rate. This high spin allows the golfer maximum control of shots into the green. In addition, the soft cover material transmits a softer feel to the golfer. These desirable performance characteristics make the Titleist Tour Balata the ball of choice among tour professionals worldwide.

Elastomer

The second basic cover type is Elastomer which is used in the Titleist Professional. This revolutionary cover material provides the soft feel and spin of traditional balata-covered golf balls as well as exceptional durability. The breakthrough Elastomer material is so unique Titleist invented a new manufacturing process around it.

Surlyn

The most widely used cover material, ionomer, is a thermoplastic resin. This material offers excellent cut and abrasion resistance. The most commonly used ionomer, Surlyn is the trademark for the resin developed by the DuPont Company over twenty years ago. Surlyn is chemically different than balata or Elastomer and is available in a wide range of hardness and flexibility.

Different blends of Surlyn are used in the design of Titleist golf ball models to offer golfers varying performance options in spin rate, feel and durability. By selecting the appropriate grades of Surlyn Titleist produces cover blends that provide a range of performance characteristics from high spin/soft feel to low spin/longer distance

Current Trend and Statistics

Golf's Popularity Continues to Rise

Golf has witnessed one of the greatest increases in popularity due to a growing, aging, and wealthier population with more leisure time. Participation in golf in the United States has risen 18.1% between 1987 to 1997. Golf received a major boost in 1997 as a result of the popularity of newcomer Tiger Woods. His success increased the popularity among a much younger group. Tiger Woods' popularity also increased visibility among minority groups who have since become more interested in the sport.

Tiger Woods has increased the popularity of golf

Golfers in the US[i]

There are 26.7 million golfers age 12 and over in the U.S. Approximately 6.3 million are classified as 'avid' golfers, meaning they play 25 or more rounds a year. States with the highest percentage of residents who play golf include Minnesota, Wisconsin, Michigan and South Dakota. The participation rates in these states are about 20% as compared to the national participation rate of 12%. More than 40% of all U.S. golfers (44% or 11.7 million] are between the ages of 18 and 39. Seniors *[age 50 and over]* comprise another 27% or 6.7 million. The rest of the golfer population falls into the forty-something and Junior *[age 12-17]* categories at 21% and 8% respectively. Today's typical golfer is male, just over 40 years old, has a household income of $71,558 and plays 22 rounds per year.[i] Golfers spent $22.2 billion in 1999 on equipment and fees. They spent $16.3 billion on green fees and dues in 1999, which accounted for 73% of all

spending and $2.5 billion on golf club purchases (11% of the total). Avid golfers (25+ rounds annually) make up the smallest player segment (25%), but accounted for 53% of all golf-related spending in 1999. These statistics provide a picture of the average golfer and how much money he spends on his golf game. Some might believe that the price of the golf ball finder is too high, but at $300 for the detector and an additional $0.20 per ball, the device costs less than a high-quality driver. The avid golfer who seeks to improve his game should have no objections to the cost of the device.

Important technological advancements

New technology has improved the game of golf through more aerodynamic golf balls and titanium clubs, but it has also affected the maintenance of golf courses themselves. Other new technologies most superintendents depend upon today include:

- TGRs (turf grass growth regulators) that strengthen cell walls against disease and insects, and reduce mowing, water and fertilizer requirements.
- Computer-controlled irrigation systems that calculate water requirements and maximize pump station performance.
- VFDs (variable frequency drives) in sprinkler motors that reduce costs and improve efficiency.
- Siphon drainage systems to remove excess water quickly from poorly drained areas.
- Sub-air greens drainage systems and extraction systems that increase soil oxygen and remove toxic gases.
- Subsurface warming systems to keep soil temperatures in a range conducive to turfgrass growth to extend the season of playability.
- Fan systems to improve air movement over greens surrounded by trees or other impediments.
- Global Positioning System (GPS)-based surveys form the base maps for Geographic Information Systems (GIS) maps, whose detailed, highly-accurate imagery of every course feature allows for accurate measurements and monitoring of a wide range of activities, including vehicle traffic, irrigation, chemical applications and pace of play.
- Standardized soil lab procedures and analyses to provide accurate and comparable information no matter where testing is done.
- Weather stations and instant weather data through satellite systems or computer programs.
- Hyper spectral imaging, the latest technology, which uses an airplane with sophisticated on-board sensors and software to take readings at 288 different wavelengths of light in order to make detailed stress maps of turf so superintendents can identify where and when their turf is in trouble before symptoms appear.

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[i] **The National Golf Foundation, www.nga.com, 2001**

RESEARCH

One of the first steps in any design process is the research of prior art. Research provides the team with background information as well as the information needed to develop design criteria. A design team must analyze the state of the art for the necessary development of a product in any field. Without investigating the solutions developed by others, the Senior Capstone Design Group would not be able to develop a successful design solution. This section of the report will present the most relevant findings of the Senior Capstone Design Group's research. The following are abstracts of similar devices from the files of the United States Patent Office.

US Patent Number 5,662,533: Golf ball locator apparatus, Chadwell September 2, 1997[ii]

A golf ball locating system and a method of applying a reflective coating to the golf ball. The apparatus involves a handheld device which locates a wayward golf ball and identifies its relative position to the handheld apparatus. The device has two components: the first is a handheld apparatus that fits into a user's pocket; the second is a shaft arrangement which has two extendable wings to form a "T" shape. The pocket sized apparatus has a forward facing window to direct a beam from the apparatus. The beam of radiation reacts with a clear coating on the golf ball and is sensed by the apparatus which then illustrates, via a display, the relative location of the golf ball. The "T" version has antennas embedded into the wings which emit a field which are disturbed by the coating on the golf ball; lights associated with the antennas are illuminated to show the operator which antenna is in the closest proximity to the golf ball. The coating on the golf-ball is applied through a variety of techniques and preferably covers the entirety of the golf ball. One methodology uses an impregnated cloth to wipe the golf ball immediately prior to placing the ball in-play. This assures a coating on the golf ball during each play.

US Patent Number 5,132,622: Method and apparatus for locating and retrieving a golf ball having a metal center, Valentino July 21, 1992[iii]

A method for locating and retrieving a golf ball and an apparatus therefore is provided, the method of finding the golf ball involving the use of a metal detection means in connection with a golf ball having a metal center, the method for retrieving the golf ball involving the use of a retrieval scoop mounted on a telescopic arm extendible from the apparatus; the apparatus of the size and shape of a conventional golf club so that it may be conveniently placed within a golf bag and carried by a golfer along with the golfer's other golf clubs.

[ii] **US Patent Office, http://patft.uspto.gov, 2001**
[iii] **US Patent Office, http://patft.uspto.gov, 2001**

US Patent Number 5,228,697 Glow-in-the-Dark Golf Ball, Gulick July 20, 1993

A phosphorescent golf ball, which emits a glow of light, is provided, for ease of finding the ball in the dark. A method of manufacture is also provided. In the preferred embodiment, the golf ball includes a flexible core member having phosphorescent glow-in-the-dark glowing means to generate a glow of light and for emitting the glow of light that is visible in a dark environment after receiving at least one of light and heat energy and a transparent cover means encircling the flexible core member with its phosphorescent glow-in-the-dark glowing means for permitting the phosphorescent glow to pass through the transparent cover means to make the golf ball more visible. A phosphorescent core for a glow-in-the-dark golf ball is also disclosed which comprises a mixture of phosphorescent glow-in-the-dark materials and a flexible material such as rubber.[iv]

Golf Ball Composition

We randomly selected a variety of golf balls and analyzed their costs and compositions. Please refer to Appendix.

Conclusion

The development of any product or process begins with the state of the art. This section of the report presented the most relevant findings of the Senior Capstone Design Group. The goal of the research was to provide the design team with enough information to develop a set of design criteria. The design criteria will be developed, presented and discussed in the next section of this report.

[iv] **US Patent Office, http://patft.uspto.gov, 2001**

Initial Design Concepts

Based on the design criteria developed in earlier sections, we are now presenting 7 possible design/application concepts that we have analysed as possible foundations for the Golf Ball Detector. The concepts considered are:

1. Capacitance
2. Radiation
3. Infrared Spectroscopy
4. Radio-Frequency Identification
5. Electronic Article Surveillance
6. GPS
7. Gas Sniffers

Capacitance Detection

The Qprox capacitance detector is a newly developed device with a wide range of applications ranging from fluid level control to switches without moving parts. However, its possibilities are limitless. The detector is a circuit capable of sensing minute changes in capacitance, including the difference in the of ordinary objects, people, liquids, etc. It might be possible to adapt this technology to locating lost or hidden golf balls. Everything has a certain natural capacitance, and the Qprox sensor could detect the difference in capacitance between the plant life in the rough areas of the golf course, and the golf ball. Theoretically, the golf ball itself would be detectable without any modifications, assuming the plastics and rubber used in the golf ball have an appreciably different capacitance from plant life. If the ball itself is not detectable, a tiny metal tag, perhaps a kind of tape, could be affixed to the ball.

The capacitance detector has many advantages and disadvantages. First of all, the sensing equipment is relatively compact, and would easily fit inside a hand-held detector. One of the kits available from the manufacturer is intended for replacing switches in household appliances, just to demonstrate the size of the average setup. The most expensive kit costs approximately $600, but there are many options within the set price range of this project. Another benefit of this device is that it would be able to locate the golf ball without adding any electronic components to the ball. This is a definite bonus, especially since it was once said that no electronic device could survive the impact of a golf club from the inside of a golf ball. Solving this problem would take a great deal of time and effort, and the completion of a golf ball locator would be greatly simplified without the problem of placing microchips in the ball. This device may even be capable of finding golf balls without any modification to the ball. The main drawback of this device is the range of the sensor. The goal of this project is to develop a device capable of locating golf balls from a distance of 10 yards, or 30 feet. However, the capacitance sensor is useful only within a maximum distance of two to three feet. Unfortunately, this makes the capacitance sensor an unwise choice for this project.

Geiger Counter

Radiation Detection

Another possible solution is the use of weak radioactive materials to aid in the detection of lost golf balls. One of the design constraints is that the device must not be harmful to the user or to the environment, but low levels of radiation are present in everyday life for many people. Many household objects emit low levels of radiation which are not harmful to people. One common source of radiation is so-called “glow in the dark” material. Most glow in the dark material will emit light only after being charged by a light source. The material absorbs energy from the light, its particles

become excited, and it will emit low levels of light as the particles return to their "resting" state. These materials will only glow for a short time. Glow in the dark materials that do not need charging are mixed with a mildly radioactive material, usually radium. The amount of radiation emitted by glow in the dark items, microwaves, and certain types of orange glazed pottery are quite safe as long as the material is not ingested or inhaled.

Perhaps coating the ball in mildly radioactive paint and using a Geiger counter to find it would provide a cheap and simple solution. Of course, the radioactive material would have to be as weak as possible for safety purposes, and the detector would have to be relatively cheap for cost constraints.

There are benefits of using radiation to locate golf balls. The radioactive material would only have to be applied once to any golf ball, and this could be done safely by the golfer. Again, there is no need to alter the weight or the balance of the golf ball by inserting electronic devices into the ball. The capabilities of the detector would not be hindered by weather conditions, as they would with some chemical detection devices considered for this purpose. Geiger counters are generally small, light and accurate. However, the price of a radiation detector usually determines its accuracy and sensitivity. For the price range set in the goals of the project, the maximum price for the golf ball detector would be $300. A Geiger counter at this price would not be able to detect a weak radiation source at a distance of 10 yards. The reaction of the counter would improve exponentially as it came closer to the radiation source, but at so great a distance it is likely the counter would not detect the source at all. The combined constraints of cost and safety make radiation an unwise solution for this application.

Radio-Frequency Identification

A basic RFID system consists of an antenna or coil, a transceiver with a decoder, and a transponder (RF tag) that is electronically programmed with unique information. The antenna emits radio signals to activate the tag and read and write data to it. The reader emits radio waves in ranges of anywhere from one inch to 100 feet or more, depending upon its power output and the radio frequency used. When an RFID tag passes through the electromagnetic zone, it detects the reader's activation signal. The reader decodes the data encoded in the tag's integrated circuit, which is a silicon chip, and the data is passed to the host computer for processing.

The most important advantage of all types of RFID systems is that neither contact nor line of sight is required for detection. Tags can be read through a variety of obstacles such as snow, fog, ice, paint, crusted grime, and other visually and environmentally challenging conditions. RFID tags can also be read at remarkable speeds, in most cases responding in less than 100 milliseconds. The read/write capability of an active RFID system is also a significant advantage in interactive applications such as work-in-process or maintenance tracking. Although it is a more expensive technology compared to, for instance, bar codes, RFID has become indispensable for a wide range of automated data collection and identification applications that would not be possible otherwise. Passive RFID tags are rumored too be virtually

indestructible, which makes them a candidate for implantation in a golf ball. The golf ball itself could become an electronic beacon for a hand held reader. The capstone group eventually decided that this technology was best suited as a means to locate lost balls.

Infrared Spectroscopy

Infrared spectroscopy is most often used by the military, environmental groups and research organizations. IR spectroscopy, specifically, fourier transform infrared spectroscopy, is a very accurate and precise method for detecting and identifying vapors and gaseous chemicals. There are devices for analysis and for detection. Analysis of vapors is usually performed by large and ponderous machines with an incredibly high accuracy. Detection of chemicals can be done by both active and passive systems, at ranges of up to a mile in cases of clear calm weather. Active detection usually requires two machines, one on each side of the location observed for gases or vapors, and detection is done by interferometry. Passive systems are generally used by the military as early warning devices in areas where chemical weapons may be present. These are the most expensive and also the most capable devices. The detection of chemicals is done by reading the energy emitted from the vibrations of certain covalent bonds in atoms. Diatomic bonds are not detectable by this method, making normal air transparent, but other types of bonds, such as the C-N bond in cyanide or the C-H bonds in hydrocarbons or alcohols, are readily visible. To utilize this method, the golf ball would have to be coated with a volatile chemical. Volatile in this case means evaporating readily, not harmful or flammable. The golf ball, after landing in the rough, would create around itself a small cloud of vapor, which would be detectable by the device.

The only drawbacks to this method are the effect of high winds or rain on the vapor cloud, and the cost of these devices. Range and sensitivity are, as usual directly proportional to cost, and it is likely that the combination of capabilities necessary to fulfill the design constraints is also outside of the price range for this project. However, this is a very versatile technique, and future advancements may bring down costs, making this a more feasible solution.

Global Positioning Systems

Global Positioning System is one of the possible solutions for the project. The first GPS satellite was launched in 1978. The current system is composed of second generation GPS satellites, called Block II. The first Block II satellite was launched in 1989. The GPS system consists of satellites and receivers. There are currently 24 earth-orbiting satellites, which transmit signals to the receivers on the ground. The GPS receivers passively receive the satellite signals, bur they do not transmit them.

The data the GPS satellites transmit indicates its location and the current time. All of the existing GPS satellites synchronize operations so that all the signals are transmitted at the same time. The signals sometimes arrive at a GPS receiver at slightly different times because some satellites are farther away from each other. The distance from the GPS

receiver to the satellites can be determined by estimating the amount of time it takes for their signals to reach the receiver. Once the receiver estimates its distance from at least four GPS satellites, it can calculate its position in three dimensions.

The information that is transferred from the satellites to the receivers is included in the satellite transmissions. This is how the GPS receivers know the location of the satellites. The receiver estimates how far away the satellite is, and it knows that it is located somewhere on the surface of an imaginary sphere centered at the satellite. After this, the receiver determines the size of each sphere, one around each satellite. The location of the receiver is where all these spheres intersect.

There are a variety of GPS receivers. The accuracy of the receivers changes depending on the type of the receiver. Most of the hand-held receivers have 10-20 meters of accuracy. Some of these systems use a method called Differential GPS, which has much higher accuracy. DGPS need a fixed additional receiver at a known location nearby. They have an accuracy of greater than 1 meter. Before the Block II system was created, timing errors were inserted into GPS transmissions to limit the non-military receivers to about 100 meters. This was removed on May 2000.

GPS systems are used in various applications. They are mostly used for vehicle tracking, hiking, surveying, fishing, and for military use. Below is a picture of a GPS receiver as fishing equipment. The portable GPS receivers weigh about the same and have about the same dimensions so that the receiver would be ergonomically comfortable to be used, and easy to handle and hold.

. GPS Receiver for fishing

GPS are generally very delicate. Forces much smaller than that of a club head on the ball could damage the chip. All of the golf balls deform to a certain extent in response to the impact from the club. If there is a chip inside the ball, the deformation of the ball is likely to damage a GPS chip.

Existing GPS chips are not small enough to be placed inside a golf ball in a way that will not change the properties of the ball. One of the goals of this project is to make the device applicable to any type of golf ball. Some of the golf balls have titanium or tungsten cores and these materials are harder than rubber. Therefore, these materials cannot be replaced with the GPS chip while preserving the mechanical properties of the ball. As a result GPS systems do not provide a feasible solution in the Golf Ball Detector project.

GAS SNIFFERS

Gas sniffers are used to check work environments for a wide variety of noxious, poisonous or combustible gasses. These devices come in a wide variety of configurations, including hand-held, stationary, and multi-location. Gas sniffers provide continuous monitoring, and they can trigger visual and auditory alarms if safe gas concentration levels are exceeded.

Gas sniffers are usually used indoors to detect any type of poisonous gas. Some types are used outdoors to detect leaks from pipes. Several sensors would be placed near a suspected leak in a pipe and send information to the portable receivers. These detectors have a high accuracy but are not readily portable. The detectors used indoors are hand-held yet not as accurate because they are designed to perform in enclosed spaces with higher concentrations of target gases.

Almost all gas detectors need 1-2 minutes of start up and warm up time. The response time ranges between 20 seconds and 1 minute. This response time is not fast enough to detect the material that evaporates off of the golf ball. It is assumed that golfers have more important things to do than wait for their ball-finder to warm up, and therefore the arbitrary maximum response time is 5-10 seconds. Environmental conditions will also affect the way the gas detector works. For instance, the speed of the wind might affect the way the gas molecules travel in the air. This aspect of gas sniffers invalidates their use on windy days. The image below shows a typical gas detector.

SUMMARY OF THE INVENTION:

The design group has determined that the most feasible solution is the implantation of a passive RFID tag in the golf ball. This strategy provides an accurate and reliable method to locate hidden golf balls.

RFID COMPONENTS

A basic RFID system consist of two components:

- Reader (interrogator)
- transponder (commonly called an RF tag) that is electronically programmed with unique information

Handspring Visor Modules for RFID tags

Reader

The antenna emits radio signals to activate the tag and read and write data to it. Antennas are the conduits between the tag and the transceiver, which controls the system's data acquisition and communication. Antennas are available in a variety of shapes and sizes; they can be built into a door frame to receive tag data from persons or things passing through the door, or mounted on an interstate toll booth to monitor traffic passing by on a freeway. The electromagnetic field produced by an antenna can be constantly present when multiple tags are expected continually. If constant interrogation is not required, the field can be activated by a sensor device.

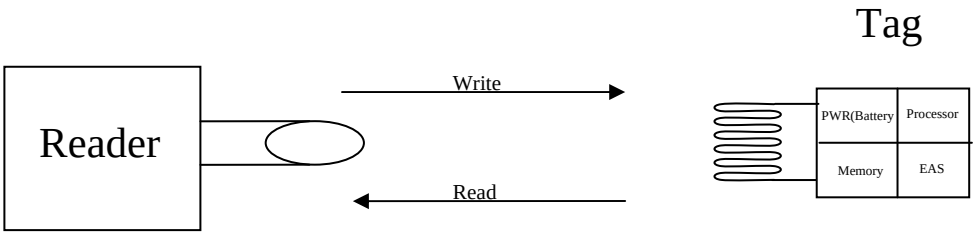
Often the antenna is packaged with the transceiver and decoder to become a reader (interrogator), which can be configured either as a handheld or a fixed-mount device. For our design, the reader would be handheld. The reader emits radio waves in ranges of anywhere from one inch to 100 feet or more, depending upon its power output and the radio frequency used. When an RFID tag passes through the electromagnetic zone, it detects the reader's activation signal. The reader decodes the data encoded in the tag's integrated circuit (silicon chip) and the data is passed to the host computer for processing.

RFID tags come in a wide variety of shapes and sizes. Animal tracking tags, inserted beneath the skin, can be as small as a pencil lead in diameter and one-half inch in length. Tags can be screw-shaped to identify trees or wooden items, or credit-card shaped for use in access applications. The anti-theft hard plastic tags attached to merchandise in stores are RFID tags. In addition, heavy-duty 5- by 4- by 2-inch rectangular transponders used to track intermodal containers or heavy machinery, trucks, and railroad cars for maintenance and tracking applications are RFID tags.

RFID Tags

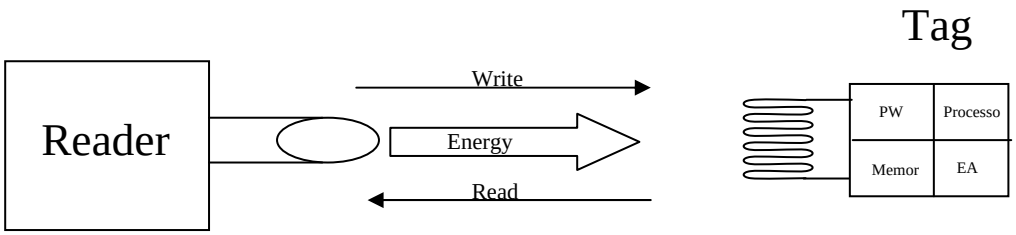
RFID tags are categorized as either active or passive

Active Tags

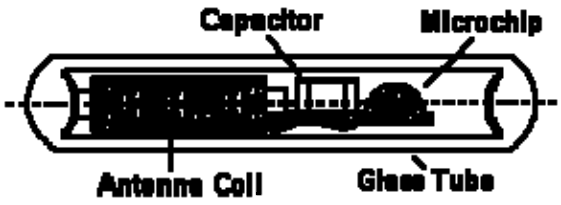


Active RFID tags are powered by an internal battery and are typically read/write, i.e., tag data can be rewritten and/or modified. An active tag's memory size varies according to application requirements; some systems operate with up to 1MB of memory. In a typical read/write RFID work-in-process system, a tag might give a machine a set of instructions, and the machine would then report its performance to the tag. This encoded data would then become part of the tagged part's history. The battery-supplied power of an active tag generally gives it a longer read range. The trade off is greater size, greater cost, and a limited operational life (which may yield a maximum of 10 years, depending upon operating temperatures and battery type).

Passive Tags



Passive RFID tags operate without a separate external power source and obtain operating power generated from the reader. Passive tags are consequently much lighter than active tags, less expensive, and offer a virtually unlimited operational lifetime. The trade off is that they have shorter read ranges than active tags and require a higher-powered reader. Read-only tags are typically passive and are programmed with a unique set of data (usually 32 to 128 bits) that cannot be modified. Read-only tags most often operate as a license plate into a database, in the same way as linear barcodes reference a database containing modifiable product-specific information.



Passive Tag Circuitry

Passive Tags

Please refer to Appendix B for specification sheets sample readers, passive and active tags.

GOLF BALL DETECTOR R.F.I.D. DESIGN CRITERIA

ACTIVE	PASSIVE
UHF Range	125 KHz
315 MHz - 2.45 GHz	13.56 MHz
Radio transmitter with battery	No battery
long range (up to 100 m)	short range (up to 5m)
limited lifetime (battery)	unlimited lifetime (no battery)
3cm x 3cm x 1cm	5mm x 5mm x 1mm
dependent of environment	independent of environment
expensive ($10)	inexpensive ($0.50)
X	√

The above table which compares active RFID tags to passive tags. To implement RFID technology into the detection of golf balls, a tag would have to be integrated into the golf ball and detected by the golfer using a handheld device (reader). Taking physical (diameter & weight) and economic (price) limitation of golf balls into consideration, the Senior Capstone Design Group has decided to use passive RFID tags. Passive ID tags are relative cheaper to active tags. For consumers, it would also be more realistic in implant $0.50 tags into $4.50 golf balls. Due to the size limitation of golf balls, it would be virtually impossible to use active tags.

However with technological advances, it would one day be possible to integrate active tags into golf balls and other appliances.

The following section will discuss design implementation of our Senior Capstone Design. It will discuss important physical and chemical properties of golf balls, their limitations and the 'physics of golf'.

RFID: GOLF APPLICATIONS

With reference to our problem statement (see Introduction), RFID technology can be applied to two areas in the golf industry, driving ranges and on-course.

Driving Ranges

In the US alone, there are over 10000 driving ranges. Most are accessible to the public. Golfers can "rent" golf ball in numbers ranging from 50 up to 200 golf balls. The cost is fairly affordable. For instance, the Top Golf Driving range in Saugus, MA charges $9.75 for a large bucket of approximately 100 balls.

Golf Balls Used

Range ball vary slightly from regular golf balls. Range balls generally have stripes and the word Range stamped on them. They are utilized at golf driving ranges for practice. As opposed to regular golf balls, range balls are bought in bulk volume (100s). Range balls are also less expensive compared to regular golf ball can exceed $50 per dozen (i.e. Titleist Pro V1). Following is a price list for range balls obtained from www.golfballs.com:

Ball Types	**Pack of**	**Price**	**Avg. Price per Ball**
3rd Quality Srixon Range White Regular	50	14.95	$0.30
New TopFlite Super Range White Range	300	137.5	$0.46
New TopFlite Super Range Yellow Range	300	137.5	$0.46
New Taylor Made Range Balls White Regular	900	337.5	$0.38
New Taylor Made Range White Regular	50	24.95	$0.50
New Taylor Made Range White Regular	300	129.95	$0.43
New Cayman Range White Range	12	12.95	$1.08
New Cayman Range White Range	300	239.95	$0.80
New Cayman Range Yellow Range	12	12.95	$1.08
New Cayman Range Yellow Range	300	239.95	$0.80
New Sunset Floater Range Red Stripe Range	12	12.95	$1.08
New Sunset Floater Range Red Stripe Range	300	249.95	$0.83
New Misc. Brands Red Stripe Range	50	25.95	$0.52
New Misc. Brands Yellow Range	12	6.95	$0.58
New Misc. Brands Black Stripe Range	50	25.95	$0.52
Refinished Misc. Brands Range	50	19.95	$0.40
Refnished Misc. Brands Range Black Stripe	50	19.95	$0.40
3rd & 4th Quality Mixed Range Used	50	17.95	$0.36
	AVERAGE COST		**$0.61**

Problem Statement

As with any other establishment, driving range owners have to endure various expenses.

- Facility costs
  - Material
  - Labor costs
  - Utility Expenses
- Range
  - Mats

    - Rubber Tees
    - Ball Dispensers
    - Buckets

All these costs are recurring costs that are anticipated. Aside from these expenses, all driving ranges across the world are faced with an unwanted problem, prohibited removal of range balls. Based on a survey conducted at various driving ranges in the Boston Area (see appendix), the average driving range loses more than a thousand of balls per month. With the average cost of range ball at $0.50, $500 worth of range balls is lost every month. Not including damaged, lost or unplayable range balls.

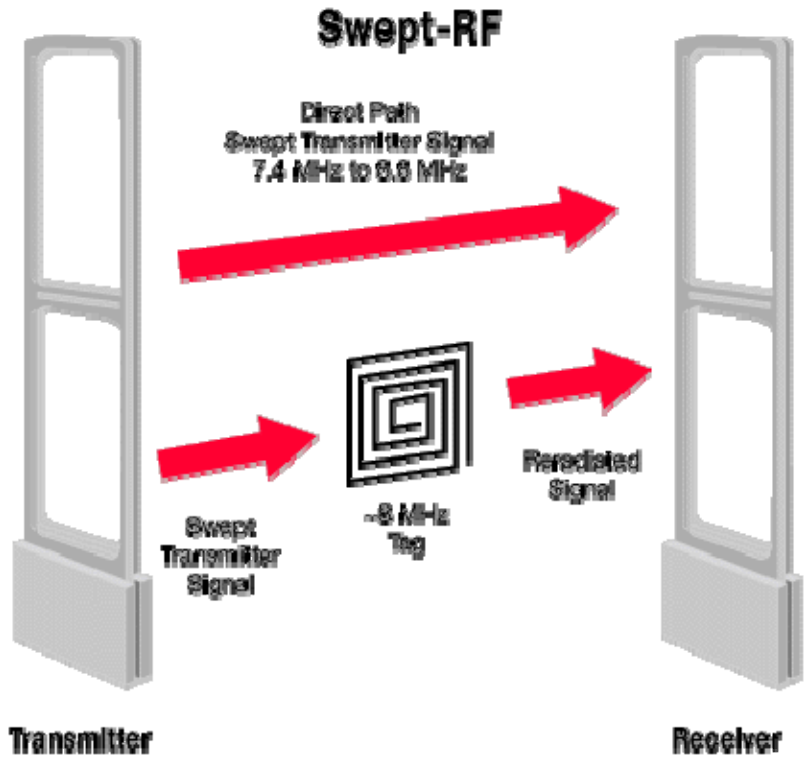
Electronic Article Surveillance (EAS) systems have been proven to protect your merchandise against shoplifters. Small passive security tags, applied to range balls, alert range owners when ‘shoplifters’ try to remove range balls through electronic sensors at exit doors. Similar to a handheld golf ball locator, a driving range golf ball security system consists of two components:

- Security Gate
    - Transmitter
    - Receiver
- Transponder

Solution: Radio Frequency EAS Systems

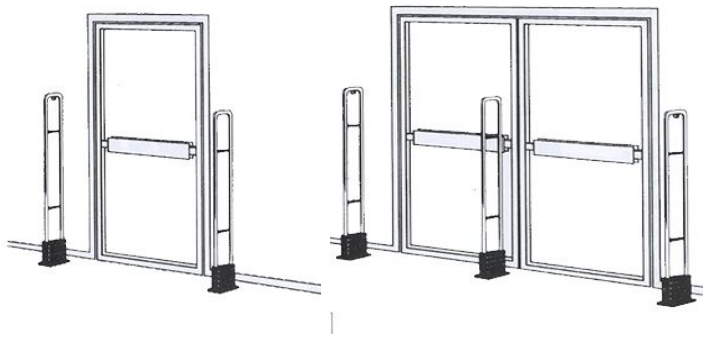
Radio Frequency (RF) Systems are the most widely used systems in the United States today and RF tags and labels are getting smaller all the time. A passice RFID tag imbedded into a golf responds to a specific frequency emitted by a transmitter antenna (usually one pedestal of the entry/exit gate). The response from the tag is then picked up by an adjacent receiver antenna (the other pedestal). This processes the label response signal and will trigger an alarm when it matches specific criteria. The distance between the two gates, or pedestals, can be up to 80 inches wide. Operating frequencies for RF systems generally range from 2 to 10 MHz (millions of cycles per second); this has become standard in many countries. Most of the time, RF systems use a frequency sweep technique in order to deal with different label frequencies.

Sometimes both the transmitter and receiver are combined in one antenna frame -- these are called mono systems and they can apply pulse or continuous sweep techniques or a combination of both. According to Tag Point Ltd. experts, mono systems could be effective for you if your store's entry is small. The mono system is used with hard tags, which are slightly more expensive than paper tags used with RFID sweep techniques.



Sensors (gates/pedestals) made by Checkpoint Systems, one of the largest manufacturers of EAS products, emit a low-energy RF pulse, which "listens" for the tag. This technology, known as digital signal processing, actually "learns" about its surroundings so that it can accurately distinguish between the tag signal and extraneous noise. This method is often preferred by store employees as it virtually eliminates false alarms. The following section describes sensor gates manufactured by Control Electronic Security (http://www.controlelectronic.com/).

Driving Range: EAS Sensor



Radio Frequency proves to be the most reliable electronic article surveillance system. Improved tab and label detection provides unique signal processing. This provides additional reliability to the system. The system can be configured to protect any exit configuration. Following lists three EAS gates provided by Control Electronic Security.

Various exit configurations

Commander

$1775.00

Challenger

$1750.00

Elite

$2575.00

The table below lists the characteristics of the three RF-EAS gates:

System Technology RF (radio frequency) Antenna
Height: 60" - 152.4cm
Width: 11 1/4" - 28.6cm
Depth: 1 1/4" - 3.2cm
Weight: 35 lbs - 15.9kg per system
Colors
Classic: Almond, Grey, Black
Commander: Black
Challenger: Stainless Steel
Elite: Clear Acrylic
Antenna Separation
Spacing between antennas can create aisles up to 6' (1.83m), depending on tags and labels used.
Power Supply
Standard 100/120/240 VAC
1/4 amp 50/60 Hertz
Note 1: Type of supply must be designated
Note 2: Individual power supplies can be used for each antenna

Optional Baseplate
Creates 36" (91.5cm) aisle between antennas
Size: 20"x40" - 50.8cm x 101.6cm
Weight: 39lbs - 17.7kg
Finish: Black, ribbed rubber mat
External Devices
Optional. Systems can be used to turn on a variety of remote equipment like alarms, cameras, etc.
Tags & Labels Systems are compatible with virtually all types of RF tags and labels

How Much Does An EAS System Cost?

Experts say there are large differences in cost depending on the system, the size of the store and the amount of merchandise to be protected. By using state-of-the-art equipment such as digital signal processing and customized locks that can't be released by common detachers, theft can be reduced by about 60 percent. Considering that store personnel will have more time for assisting shoppers (instead of watching for potential thieves), a reliable EAS system can pay for itself in 1 1/2 to 2 years. Please refer to the Cost-benefit section for more information.

*It should be noted that due to limited funds made available to our design group by the College of Engineering. We were unable to build a prototype RF-EAS system. Cost of a working RF-EAS system would be over $1500.

On-Course

Based on these criteria's and extensive market research, the design group chose Intersoft. Intersoft has been developing and manufacturing solutions for identification and control since 1991. The company is based in Tennessee and has provided customers worldwide with competitive technology. The company's aim is to provide easy to use and inexpensive identification devices to the small and medium size company, which proved to be essential. Our design group experienced major difficulties in obtaining RFID related products as major corporations (like Checkpoint Systems and Tag Point) were reluctant to accept small scale purchases.

Over the course of this project, our design group made two purchases from Intersoft:

1. RFID Demo Kit-1 @ $199(see right figure) which included:
    i. a fully functional reader/decoder with antenna in an attractive desktop enclosure
    ii. passive read-only RFID tags (sampling of tags, 9 in all)
    iii. a 9V battery adapter for hand-held applications
    iv. simple software with source code examples. Software code can be used for application.
    v. user manual with detailed instructions and antenna winding examples
2. GLT12x2RO Passive Tags (15 tags @ $2.40 each)
    i. 12mm x 2 mm, cylinder

ii. Operating Frequency: 125 kHz ± 6

iii. Modulation, Encoding: Amplitude Shift Keying, Manchester

iv. Memory size: 64 bit read only

v. Read Speed: 1.953 k bits / second (35 ms read time, [50 ms average])

vi. Serialization: 40 bit number (1,099,511,627,776 combinations), laser fused

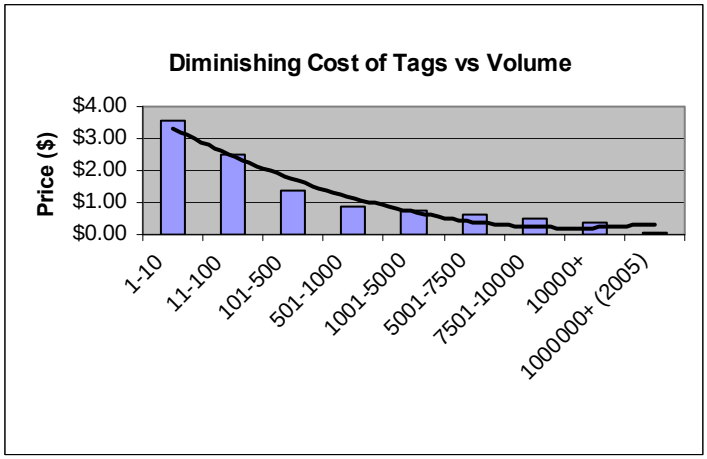
We chose Intersoft tags as their chemical and physical characteristics were suitable for our purpose. Amoung these:

- Tags can be hidden (embedded) in most materials
- No batteries needed
- Different shapes and sizes
- No line of sight required
- No wear
- Tags can be read even if covered with dirt or even submerged
- Tags are almost indestructible
- Unalterable permanent serial code prevents tampering

Cost Benefit: Golf Ball Locating System

With an RFID based solution, it is unavoidable that the cost of golf ball will increase due to the cost of the tag and additional manufacturing costs. The cost of passive RFID tags is volume dependent. The following table and graph illustrate the relationship between tag cost per volume purchased (estimates from Intersoft):

Quantity	Price
1-10	$3.55
11-100	$2.47
101-500	$1.38
501-1000	$0.90
1001-5000	$0.74
5001-7500	$0.61
7501-10000	$0.49
10000+	$0.37
1000000+ (2005)	$0.05



For both golf applications, the design group decided that the additional cost for golf balls is $0.37. It is also assumed that both systems have 90% efficiency.

Driving Range

The following is a proposed RF-EAS Driving Range System for McGolf Inc. Mcgolf is a friendly driving range located along Route 1 in Saugus MA. It currently has 30 hitting bays in a two tier hitting facility. Golfers purchase buckets of balls that range from small, medium to large at the following cost:

- Small ($7.00)
- Medium ($8.50)
- Large ($9.75)

McGolf used Top-Flite range balls that have are currently marketed with red stripes. According to a survey conducted at McGolf (see appendix), approximately 1000 golf balls are stolen each month. The Following table is illustrate the cost benefit for a driving range that has a RFID based golf balls and a single security gate.

Driving Range	
Description	$
12000 stolen balls/year	$3,000.00
RF-EAS System	$2,000.00
$ Recovered (90% eff.)	$5,400.00
Additional Cost (RF-Balls)	$4,440.00
Annual saving (1st year)	$1,040.00
Annual savings (>1yr)	$960.00

With a one time investment of $2000 for a RF-EAS security system, McGolf could profit from their investment after the first year, $960 annually.

On-Course Golf Ball Locator

According to the NGA, the average golfer plays 22 round of golf per year and loses around 5 balls per 18 holes of golf, 110 golf balls per year. We assumed $2.50 as the average cost a typical golf balls and an optimal recovery rate of 90%. The Following table illustrates the cost benefit for the average golfer.

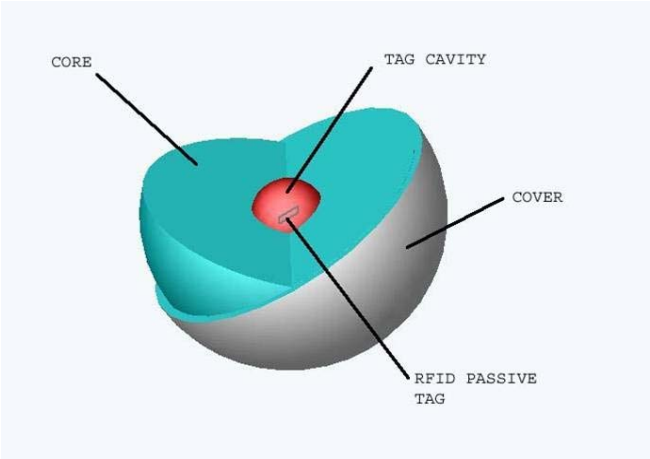
On-Course	
Description	$
110- lost balls/year	$275.00
RF Ball Locator	$300.00
$ Recovered (90% eff.)	$247.50
Additional Cost (RF-Balls)	$40.70
Annual saving (1st year)	$93.20
Annual savings (>1yr)	$206.80

Similar to the McGolf driving range, with a one time investment of $300 for a RF-EAS security system, golfers would benefit financially from their investment after the first year, $206.80 annually.

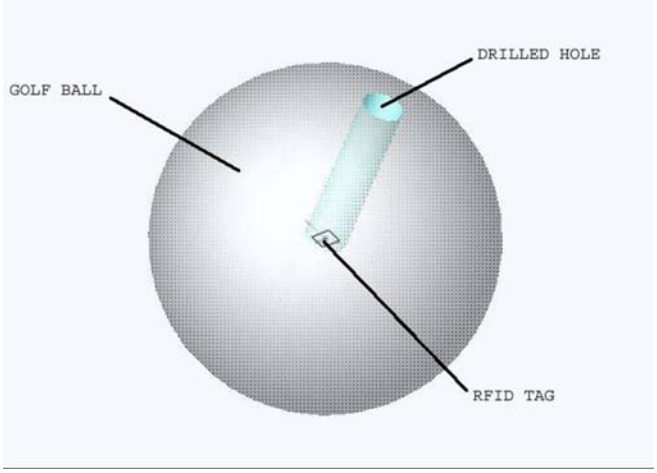
For every consumer, it is important that the opportunity cost of investing in technology is beneficial. Our design group has proven the financial benefit of investing in RFID golf applications and is confident that driving range and golfers feel equally. The next section will discuss the golf ball prototyping process in detail.

Prototype Design

One of the most important facets of this project is the implantation of the RFID chip inside the golf ball. There is no doubt at this point that the chip will be able to perform its function from inside the ball, but we must also ascertain that the ball will behave identically with and without the chip implant. Our prototype for testing will differ slightly from the final design. The prototype will be a golf ball altered to accommodate the chip, while in the final design, the chip would be encased in the polybutadiene core of the golf ball during manufacturing, leaving no additional seams on the outer casing and no discontinuities in the rubber core. Drawings of both the prototype and the final manufacturing design are shown below.



Manufacturing design



Prototype Ball

The prototype golf ball is made from parts cut out of two other golf balls, RTV silicon glue, and the RFID chip. At this point, Topflite XL 3 brand golf balls are being used because of their solid polybutadiene core and their reputation as an average to top-grade golf ball. The process of implanting the chip into the ball is relatively simple. First, a ball is cut with a cork borer, which is simply a piece of sharpened steel tubing. The ball is placed in a lathe and is cut with the corer until the core section separates from the inside of the ball. The remaining part of this golf ball is then discarded. A hole is drilled in the second golf ball to create a cavity in the center just large enough to accommodate the tag. The core section is also cut to the necessary length. The tag and a small amount of glue are placed in the cavity and the core section plugs the hole. The prototype will use a hole diameter of 0.266 inches. The hole will extend into the golf ball to a depth of approximately 0.85 inches, allowing for variation in the size of the golf ball and in the size of the chip. It would be simple to keep the weight of the ball within allowable limits, but the high rotational speed of the golf ball during flight

makes the moment of inertia particularly important. When hit by a driver, the ball has a backspin of 3600 rpms, which translates to a linear motion of 8m/s at the outermost circumference of the ball. A pitching wedge imparts a spin of 8000rpms, corresponding to 17.8 m/s along the surface. The effect of the tag on the center of gravity on the ball has not been calculated, but testing has shown that there is no qualitative difference in the behavior of the balls.

Testing

The United States Golf Association (USGA) performs various tests on golf equipment to verify the legality of new designs for clubs and balls. All balls eligible for tournament play must be subjected to and pass a certain array of tests. These tests are designed to simulate a professional quality golf swing and then analyze the movement of the ball immediately after the collision with the club. The USGA uses a robotic arm called "Iron Byron" and a real golf club to perform their tests, but a robotic arm does not fit within the budget of this project. The testing for the prototype must simulate the effects of a golf club without the need for an actual golf club strike. Among the properties of the golf ball that must be tested are: the strength of the thermoplastic covering, the moments of inertia, and the compressibility of the ball.

The compressibility of a ball is sometimes referred to through the coefficient of restitution (CoR). This number describes how much the ball deforms in response to an impact and how readily it returns to its original shape. Some investigators use a simple bounce test for this number, the square of the coefficient being the ratio of the height of the first bounce to the height from which the ball was dropped. A bounce test was also used to determine the effect of the tag on the behavior of the prototype. The accepted CoR for a golf ball is 0.84. The CoR of a Topflite golf ball was found to be 0.865, and the CoR of the prototype golf ball was 0.83. This is based on an average of 100 bounce tests.

The effect of the tag on the center of gravity on the ball was observed by hitting the prototype and a normal ball with a pitching wedge in an open field and observing the difference in the lengths of the shots. The prototype was found to behave almost identically to the normal ball. The field-testing also showed that the tags would function after an impact with a club. Of the three prototypes used in field-testing, the range of detection was unchanged for all the prototypes.

Testing has shown that the addition of a tag to the golf ball does not significantly change the mechanical behavior of the ball. In addition, a finite element analysis was performed using ANSYS.

Finite Element Analysis with ANSYS

The stress analysis on the regular golf ball and the prototype were performed by using ANSYS then both of the results were compared to check if the prototype passed or failed. First, the material properties of both the core and the cover were entered in ANSYS. The Modulus of Elasticity of the *core (Polybutadiene)* and the *cover (Urethane)* is *3864 MPa* and *2070 Mpa*, respectively with both having a Poisson's ratio of 0.3. Second, both of the layers of the ball were created, with an *inner diameter* of *0.03937 m* and an *outer diameter* of *0.040132 m*. For the prototype a hole with a *diameter* of *0.008 m* was created at the center of the golf ball. Third, a force of 15000 N was applied on the side with a constraint at the bottom of the ball. The constraint applied at the bottom of the ball represents the ground, since the ball is still sitting on the ground right when the club hits the ball. Last, the system was solved for stress analysis.

The results are shown below for both the regular and prototype golf balls.

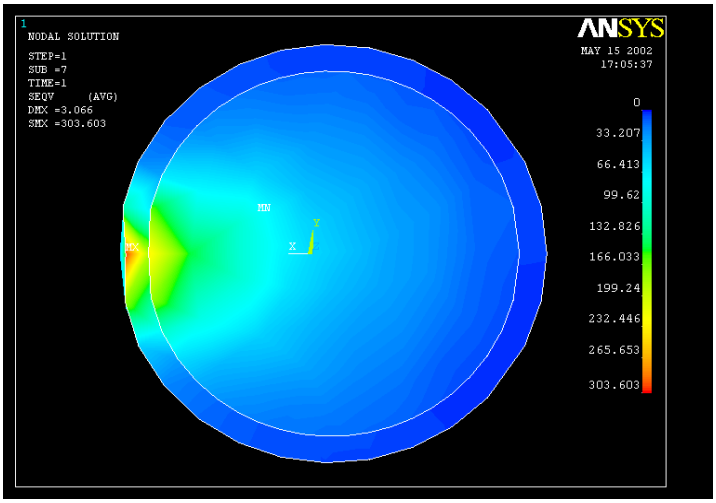


Figure 1 - Stress analysis on the regular golf ball

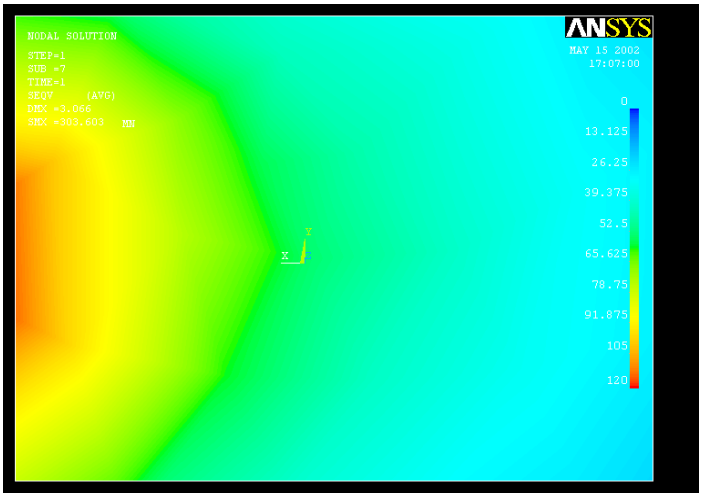


Figure 2 - Figure 1 zoomed in

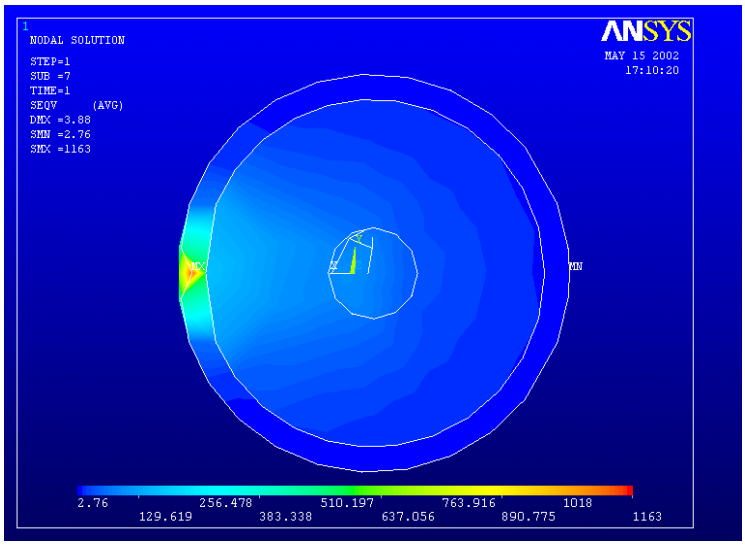


Figure 3- Stress analysis on the prototype golf ball

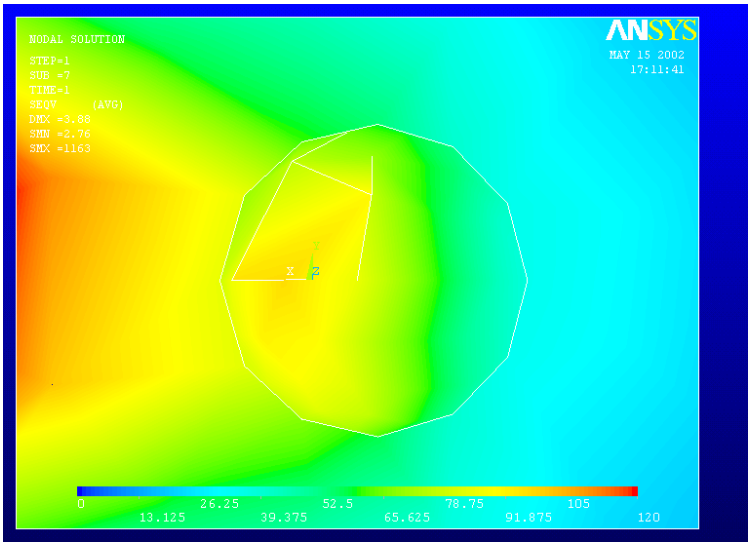


Figure 4- Figure 3 zoomed in

All of the figures above show one sliced half of both the regular and the modified golf ball. From the results obtained it is concluded that the built prototype passes the finite element test, and therefore neither the modified golf ball nor the tag inside will experience fracture. The *maximum stress at the surface* (on the Urethane cover) is *303.603 MPa* and *maximum stress at the center* is *63 MPa* for the regular golf ball. The modified golf ball with the hole has a *maximum stress of 1163 MPa at the surface* (on the Polybutadiene core) and *86 MPa at the surface of the center* of the ball. The maximum yield stress of Urethane cover is 441600 MPa (6.40487 x 10^7 psi) and the Polybutadiene core is 97 MPa

(1.40106×10^4). The comparison of the ANSYS calculated stress values and the theoretical stress values it is observed that the calculated values are a lot smaller than the theoretical values, which means that neither of the layers will fail. The table below also shows a comparison of the regular golf ball with the modified ball.

	Regular Ball	Prototype Ball
Max Stress (Calculated) at the center (MPa)	63	86
Max Stress (Calculated) at the surface (MPa)	303.603	1163
Yield Stress (Theoretical) at the center (MPa)	97	97
Yield Stress (Theoretical) at the surface(MPa)	441600	441600

Table 1- Stress Comparison of Regular and Modified Golf Ball

Conclusion

The design group has chosen to develop the use of Radio Frequency Identification to locate lost golf balls. While the range of the RFID tags is not high enough to create a working golf ball finder, the concept has been proven. In the future, the range of the passive tags will increase, and the price of the readers will decrease. While the golfers of the world wait for this to happen, the driving range owners can begin queuing up for their security systems that will save them thousands of dollars in lost golf balls every year. A process for the implantation of the tags inside the balls has been developed, and the technology is already compatible with the manufacturing processes of several golf ball manufacturers. The tags are also small enough and resilient enough to survive inside the golf balls, and for these requirements, they live up to their claim of being "virtually indestructible." The prototype golf balls were tested for mechanical behavior, and there was no significant difference in the behavior of the prototypes. The reader purchased from Intersoft worked consistently in detecting passive tags that were embedded into prototype golf balls. Detection distance with our reader is incongruously low at less than two inches. The device meets all of the design criteria except for the range, and until RFID makes the necessary advances to compensate, this technology can be applied to solve other problems in the wide world of golf.

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APPENDIX A

(Charts, Patents, Tables, Supplementary Information)

Fees Up 3%, Equipment Down Slightly for 1999 Golf Spending

[NOVEMBER 2, 2000] - Golf-related consumer spending reached $22.2 billion in 1999, according to a recent study by the National Golf Foundation (NGF). The report, *Golf Consumer Spending in the U.S/2000 Edition*, shows that green fees and dues (at both public and private courses) accounted for 73% of spending ($16.3 billion), followed by golf club purchases with 11% ($2.5 billion). Soft goods ranked third with 4% ($979 million). Also included in the report are golf ball purchases and range ball rentals (on-course and stand-alone).

While fees were up about 3% over 1998 figures, equipment sales were down by 2%. Breaking it down by player segments, Avid golfers (25+ rounds annually) make up the smallest player segment (25%), but account for 53% of all golf-related spending. The average Avid golfer spent $222 on clubs, while a Moderate player (8 to 24 rounds annually) spent $118 on average for clubs. The Occasional golfer (less than 8 rounds annually) spent a mere $16.

Overall, golf club spending was down 6.6% from 1998 purchases, but club sales are expected to rebound this year and next as the replacement cycle for clubs (particularly titanium woods) sends golfers shopping. Soft goods spending, which includes bags, gloves and shoes, was also down (-3.7%).

Distribution of Golf Consumer Spending by Category
Total $22.2 billion

The report includes further analysis of consumer spending by various topics:

- Rounds played
- Average score
- Private club membership
- Years of golf experience
- Gender
- Household income

- Age
- Geographic region
- Channels of distribution

Highlights of Golf Consumer Spending in the U.S./2000 Edition:

Broken down by **average score**, golfers who score between 80 and 89 spent an average of $1,182 — the highest for any group. Golfers who score 80 to 99 represent 51% of golfers and accounted for 64% of spending.

Private club members make up only 15% of the U.S. golfing population, but account for 47% of spending.

Gender
Although female golfers make up only 19% of the golfer population, individually they spend nearly as much as men. On average, a male golfer spent $462 in the areas of golf clubs, balls, soft goods and public fees in 1999. His female counterpart spent $411.

Channels of Distribution
Off-course specialty stores continue to dominate golf product sales, followed by on-course shops, sporting goods retailers and mass merchandisers. These top four retail groups accounted for 83% of all golf-related equipment sales in 1999.

Definition of Terms:
Public fees -- includes green, cart and other fees (pull cart rental, tips, locker room, caddy, bag storage)
Private fees -- includes initiation fees and annual dues; green, guest, cart and other fees (pull cart rental, tips, locker room, caddy, bag storage)
Range balls on-course -- ball rentals at practice ranges located at golf courses
Range balls stand-alone -- ball rentals at golf practice ranges located off course
Clubs -- drivers, fairway woods, iron sets, wedges and putters (second-hand purchases excluded)
Soft goods -- bags, gloves and shoes

About the NGF:
The National Golf Foundation is a non-profit membership organization specializing in golf market research and related information services. Founded in 1936, the NGF now has more than 6,000 members representing a broad cross-section of the industry. Members include golf equipment manufacturers; golf and consumer media; golf courses and golf ranges; golf course architects, builders and developers; golf retailers; golf associations and turf maintenance suppliers.

The Growth of U.S. Golf

	1970	1975	1980	1985	1986*	1987*	1988*	1989*	1990*	1991*
Golfers (millions)	11.2	13.0	15.1	17.5	19.9	21.3	23.0	24.2	27.8	24.8
Rounds Played (millions)	266	309	358	415	419	431	484	469	502	479
Golf Facilities**	10,188	11,370	12,005	12,346	12,384	12,407	12,582	12,658	12,846	13,004
Daily Fee	4,248	5,014	5,372	5,573	5,585	5,583	5,748	5,833	6,024	6,272
Municipal	1,321	1,586	1,794	1,912	1,912	1,926	1,937	1,963	2,012	2,046
Private	4,619	4,770	4,872	4,861	4,887	4,898	4,897	4,862	4,810	4,686
Golf Courses	10,848	12,306	12,849	13,254	13,353	13,436	13,626	13,738	13,951	14,136
Daily Fee	4,513	5,473	5,741	5,968	6,004	6,025	6,203	6,296	6,497	6,764
Municipal	1,461	1,748	1,957	2,090	2,098	2,122	2,135	2,166	2,222	2,259
Private	4,874	5,085	5,151	5,196	5,251	5,289	5,288	5,276	5,232	5,113

**The estimated number of golfers and rounds played for 1986 through 2000 are based on golfers aged 12 and over, and are not directly comparable to previous estimates that are based on golfers aged 5 and over.*
***A golf facility contains at least one nine-hole course and may include different types of courses, such as a regulation-length course, executive-length course, and par 3-length course.*

	1992*	1993*	1994*	1995*	1996*	1997*	1998*	1999*	2000*	
Golfers (millions)	24.8	24.5	24.3	25.0	24.7	26.5	26.4	26.4	26.7	
Rounds Played (millions)	505	499	465	490	477	547	528	564	586	
Golf Facilities**	13,210	13,439	13,683	14,074	14,341	14,602	14,900	15,195	15,487	
Daily Fee	6,552	6,803	7,126	7,491	7,729	7,984	8,247	8,470	8,759	
Municipal	2,090	2,144	2,190	2,259	2,306	2,361	2,402	2,440	2,438	
Private	4,568	4,492	4,367	4,324	4,306	4,257	4,251	4,285	4,290	
Golf Courses	14,375	14,648	14,939	15,390	15,703	16,010	16,365	16,743	17,108	
Daily Fee	7,080	7,370	7,732	8,142	8,416	8,716	9,012	9,290	9,637	
Municipal	2,308	2,363	2,415	2,489	2,541	2,596	2,645	2,693	2,698	
Private	4,987	4,915	4,792	4,759	4,746	4,698	4,708	4,760	4,773	

Detailed Patent Information

United States Patent ***5,132,622***
Valentino **July 21, 1992**

Method and apparatus for locating and retrieving a golf ball having a metal center

Abstract

A method for locating and retrieving a golf ball and an apparatus therefore is provided, the method of finding the golf ball involving the use of a metal detection means in connection with a golf ball having a metal center, the method for retrieving the golf ball involving the use of a retrieval scoop mounted on a telescopic arm extendible from the apparatus; the apparatus of the size and shape of a conventional golf club so that it may be conveniently placed within a golf bag and carried by a golfer along with the golfer's other golf clubs.

Inventors: **Valentino; Peter J.** (510 E. 27th St., Paterson, NJ 07514)
Appl. No.: **641181**
Filed: **January 15, 1991**
Current U.S. Class: **324/326**; 473/286; 473/353; 473/409
Intern'l Class: G01V 003/08; G01V 003/10; A63B 043/00
Field of Search: 324/326-329 276/213

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4359686	Nov., 1982	Wherry.
4423377	Dec., 1983	Podhrasky.
4660039	Apr., 1987	Barricks et al.

Primary Examiner: Snow; Walter E.

Claims

What is claimed is:

1. A method of locating a golf ball having a metal center comprising the steps of:

holding an elongated finder retriever apparatus, with a finder end having a metal detector means therein, the finder end held remote from the user of the apparatus;

moving the metal detector means in the finder end over an area to locate a golf ball;

reversing the finder retriever apparatus to present the retrieving end of the finder retriever apparatus remote from the user of the apparatus;

extending a telescoping apparatus to enlarge the length that the retrieving end extends from the user of the apparatus; and

contacting and lifting the located golf ball with the retrieving end of the finder retriever apparatus.

2. The method of claim 1, further comprising, after the step of reversing the finder retriever apparatus, the step of extending collapsible scoop basket members from a circular scoop frame to form a scoop basket at the retrieving end of the apparatus.

3. A golf ball finder and retriever for locating and retrieving a golf ball having a metal center comprising:

a head;

a handle;

a shaft interconnecting said head and said handle, said shaft being of a length and of a diameter similar to a golf club shaft;

metal detection means disposed in said head for detecting the location of a golf ball having a metal center;

signal means for notification of the detection of a golf ball having a metal center;

a removable cap disposed on said handle; and

retrieval means for retrieving the located golf ball, said retrieval means being disposed within said shaft and accessible upon the removal of said removable cap, said retrieval means comprising a telescoping arm anchored within said shaft, and extendible therefrom, and a scoop means mounted on the unanchored end of said telescoping arm.

4. The golf ball finder and retriever of claim 3 wherein said head is of a size similar to the head of a conventional golf club.

5. The golf ball finder and retriever of claim 4 wherein said head comprises a flat disk bottom having transmitting and receiving coils therein for detection of golf balls having metal centers.

6. The golf ball finder and retriever of claim 3 wherein said handle comprises a hand grip means for providing a non-slip gripping surface.

7. The golf ball finder and retriever of claim 6 wherein said hand grip means comprises a rubber strip extending the circumference of said handle.

8. The golf ball finder and retriever of claim 3 wherein said removable cap is threadably engageable with said handle and has the exterior shape of a half-sphere with a dimpled surface to provide for the easy recognition of said apparatus in a golf bag.

9. The golf ball finder and retriever of claim 3 wherein said scoop means comprises a circular frame and a plurality of scoop basket members, said scoop basket members being collapsible from a plane perpendicular to said circular frame for scooping, to a plane defined by the circular frame for storage of said retrieval means within said shaft.

10. The golf ball finder and retriever of claim 3 wherein said apparatus further comprises means for attachment of an umbrella for protection from sun and/or rain during the step of moving the metal detection means.

11. A combination golf ball having a metal center and a golf ball finder and retriever apparatus for locating lost golf balls having metal centers and retrieving the same, comprising:

a head of a size similar to the head of a conventional golf club;

a handle;

a shaft interconnecting said head and said handle, said shaft being of a length and of a diameter similar to a golf club shaft;

metal detection means disposed in said head for detecting the location of a golf ball having a metal center;

signal means for notification of the detection of a golf ball having a metal center; and

retrieval means for retrieving the located golf ball, said retrieval means being disposed within said shaft and accessible upon the removal of said removable cap, said retrieval means comprising a telescoping arm anchored within said shaft, and extendible therefrom, and a scoop means.

12. The golf ball finder and retriever of claim 14 wherein said head comprises a flat disk bottom having transmitting and receiving coils therein for detection of golf balls having metal centers.

13. The golf ball finder and retriever of claim 14 wherein said handle comprises a hand grip means for providing a non-slip gripping surface.

14. A golf ball finder and retriever of claim 13 wherein said hand grip means comprises a rubber strip extending the circumference of said handle.

15. The golf ball finder and retriever of claim 14 wherein said removable cap is threadably engageable with said handle and has an exterior shape of a half-sphere with the dimpled surface of a golf ball for easy recognition of said apparatus in a golf bag.

16. The golf ball finder and retriever of claim 14 wherein said scoop means comprises a circular frame and a plurality of scoop basket members, said scoop basket members being collapsible from a plane perpendicular to said circular frame for scooping, to a plane defined by the circular frame for storage of said retrieval means within said shaft.

17. The method of claim 14 wherein said apparatus further comprises means for attachment of an umbrella for protection of the golfer from sun and/or rain during the step of moving the metal detection means.

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention pertains in general to a method for locating and retrieving a golf ball and an apparatus therefore. More specifically, the invention provides a method and apparatus for locating and retrieving a golf ball having a metal center.

2. Related Art

This invention provides a method for locating and retrieving a golf ball having a metal center and an apparatus therefore. Efforts have been made to provide a system to locate golf balls, but none provide the ease and convenience of use of the present invention. Examples of such efforts are: U.S. Pat. No. 3,782,730; 4,359,686; 4,423,377; and 4,660,039. None of these patents, taken either singly or in combination, are thought to provide the benefits of the present invention.

U.S. Pat. No. 3,782,730 discloses a golf ball having an electronic signaling means in its center. The signaling means is an oscillator circuit. The signal is picked up by a radio receiver tuned to the proper frequency.

U.S. Pat. No. 4,359,686 discloses a metal detection apparatus having a basket at its end to facilitate recovery of metal objects, especially under water. This metal detection apparatus is unsuitable for use with a golf ball because the scoop is designed to be dug into the soil underlining water to recover metal objects imbedded within the soil whereas a golf ball would be located on top of the soil.

U.S. Pat. No. 4,423,377 discloses a compact metal detector of the bound induction type and of a planer assembly. It also has a low battery voltage indicator circuit. There is no disclosure relating to the retrieval of objects.

U.S. Pat. No. 4,660,039 discloses a system for locating a sports object, particularly a golf ball, wherein the object has its inductive strip on its outer surface and the user has a transmitter. In operation, the transmitter generates a signal, and when in the vicinity of the object with the conducting means, the load on the signal generating means is changed, causing an increased power output detectible by the transmitter.

SUMMARY OF THE INVENTION

Golf is a very popular sport--enjoyed by both professionals and amateurs. One of the problems encountered by golfers of all ability levels is lost golf balls. Lost golf balls are particularly troubling to golfers because not only do lost golf balls result in a penalty to the golfer's score, it is also financial loss. Further, time lost on fruitless searches for lost golf balls serve to frustrate both the golfer and his golfing companions.

This invention relates to a Method for Locating and Retrieving a Golf Ball and Apparatus Therefore. More specifically, this invention provides a method for locating a golf ball having a metallic element therein, a method for retrieving the golf ball after it is located, and an apparatus for use in location and retrieval of the golf ball.

The method of finding the golf ball involves the use of a metal detection means in connection with a golf ball having a metal center, while the method for retrieving the golf ball involves the use of a retrieval means, both the metal detection means and the retrieval means being formed as part of the golf ball finder apparatus.

The apparatus for use in locating and retrieving the golf ball is of a size and shape similar to a conventional golf club so that it may be conveniently placed within a golf bag and carried by a golfer along with the golfer's other golf clubs. The apparatus, like a golf club, includes a head portion, a shaft portion and a handle or grip portion. The detection means is disposed in the head of the apparatus. Mounted on the shaft is a speaker which emits an audible signal upon location of the golf ball. On the handle is a removable cap, removal of the which permits access to the retrieval means. The retrieval means comprises a scoop having collapsible scoop basket members mounted on a telescoping arm. The entire retrieval means is mounted within the shaft of the apparatus and is extendable out of the shaft for effecting retrieval.

The apparatus and method of this invention is useful for locating and retrieving golf balls that are lost because of any of a number of reasons including balls in submerged water traps, balls buried in sand traps and balls in wooded areas with underbrush, and even areas of rough where there may be the possibility of tick infestation which could cause Lyme disease.

Accordingly, it is an object of this invention to provide a method for the location and retrieval of a golf ball that can be easily and conveniently used by golfers.

It is also an object of this invention to provide an apparatus approximately the size of a golf club for locating and retrieving golf balls, so that the apparatus is able to fit into a golf bag.

It is still another object of this invention to provide a method of, and apparatus for, locating and retrieving a golf ball which is capable of locating and retrieving a golf ball that is submerged in water or buried in sand or deep in the rough.

Yet another object of this invention is to provide a method for locating and retrieving a high performance golf ball having a metal center.

It is a further object of this invention to provide an apparatus for locating and retrieving golf balls which has a joint means to allow for the attachment of other items to the apparatus, such as an umbrella.

It is still another object of the invention to provide an apparatus for locating and retrieving golf balls which is light in weight.

It is yet another object of this invention to provide an apparatus for locating and retrieving golf balls which is reliable and easy to use.

A further object of this invention is to provide an apparatus for locating and retrieving golf balls which can be carried along with golf clubs in a golf bag.

Still a further object of this invention is to provide an apparatus for locating and retrieving golf balls located on land or under water.

Yet even another object of this invention is to provide an apparatus for locating and retrieving golf balls which is battery operated and easy to use.

Still another object of this invention is to provide an apparatus for locating and retrieving golf balls which may be easily stored.

These, as well as further objects and advantages of this invention, will become apparent to those skilled in the art when they review the accompanying detailed description of the embodiment, reference being made to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 depicts the apparatus for locating and retrieving golf balls being used for locating a golf ball.

FIG. 2 is a side view of the apparatus for locating retrieving golf balls with the cover for the power supply and PC board open.

FIG. 3 shows a golf ball having a metal center.

FIG. 4 is a view taken along line 4--4 of FIG. 3.

FIG. 5 is a fragmentary view of the apparatus for locating and retrieving a golf ball with the cap removed, the retriever shaft extended and the scoop basket members positioned for retrieval.

FIG. 6 is a schematic diagram of the metal detector assembly.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGS. 1 and 2, the apparatus for locating and retrieving a golf ball, or the "golf ball finder" 10, is configured to generally resemble a golf club. As such, it comprises a head portion 21, a shaft portion 12 and a handle portion 50. The dimensions of the components are substantially similar to those of a conventional golf club to allow, among other things, the golf ball finder to be conveniently placed into a golf bag and carried by a golfer along with the golfer's other clubs.

The golf ball finder carries a detection means in its lower end or head portion 21. Typically, the detection means comprises a metal detection apparatus. FIG. 6 presents a schematic diagram of the metal detection apparatus. Essentially, a PC board 26 operates a transmitter and receiver means located in disk 22. The metal detection device is powered by battery supply 32. Upon movement of the disk into the proximity of metal, an audible signal is emitted from speaker 24.

Generally, as seen in FIG. 1, the disk 22 forms the bottom surface of the head 20. The speaker 24 may be positioned in any convenient space. In the preferred embodiment, it is mounted on the shaft 12 near head 20. Also provided near the head 20 and within the shaft 12 is the battery supply 32 and PC board 26. In the preferred embodiment a cover 28 is provided to allow for easy access to the battery supply 32 and the PC board 26. While all the components of the detection system may be located anywhere within the golf ball finder 10, it is desirable to position the components in one area in the head portion 21 of golf ball finder 10 to minimize opportunities for possible submergence of the electrical components during retrieval of a golf ball submerged in water.

Extending from the head portion 21 to the handle portion 50 of the golf ball finder 10, is shaft portion 12. Shaft portion 12 is generally cylindrical in shape, and hollow in construction. In the preferred embodiment it is of a length such that overall length of the golf ball finder 10 is approximately 3 feet 9 inches.

The handle portion 50 of the golf ball finder 10 comprises a hand grip 52 typically made of rubber to provide a slip free gripping surface, and at the top of the handle, a removable cap 54. In the preferred embodiment, the cap 54 resembles the surface of a golf ball so that the golf ball finder 10 may be easily identified when placed with other golf clubs in a golf bag.

The cap 54 may be removed from the golf ball finder 10 by unscrewing it therefrom. Its removal permits access to a golf ball retriever apparatus, as shown FIG. 5. The golf ball retriever apparatus comprises a telescoping arm 56, one end of which is anchored within the shaft portion 12. When not in use, the arm 56 is collapsible and fits within the hollow shaft 12 of the golf ball binder 10. In use, the telescoping arm 56 is extendable from the golf ball finder 10--up to 9 feet in the preferred embodiment. While the construction of the telescoping portion of the retriever apparatus may be varied, generally the telescoping arm 56 is no greater than 1/2 inch in diameter and comprises no more than three telescoping segments.

At its unanchored end, the retriever apparatus is provided with a retriever scoop 60, which comprises a circular frame 62 and a plurality of collapsible scoop basket members 64. When the retriever apparatus is not in use, and positioned within shaft 12, the collapsible scoop basket members 64 are rotated to the plane of the circular frame 62, and the scoop assembly fits within the handle portion 50 of the golf ball finder 10. In use, the scoop basket members 64 are rotated out from the circular frame 62 to form retriever scoop 60, the retriever scoop being sized to support and carry a golf ball. Alternatively, the retriever apparatus could comprise a pincer means for grabbing a golf ball, or a rake means for retrieving a golf ball.

The method for locating and retrieving a golf ball involves the use of the golf ball finder 10 in connection with a golf ball having a metallic or conductive element. In the preferred embodiment, shown in FIGS. 3 and 4, the golf ball 80 comprises a metal center 82, surrounded by a solid resilient inner material 84, encased in a hard outer plastic skin 86. Not only does the metal center 82 lend to the golf ball 80 an ability to be located with a metal detector, but also adds weight and stability to the golf ball in flight and results in a truer accuracy of the golf ball. It is important to note though the golf ball 80 having a metal center is preferred, the method of locating and retrieving a golf ball may also be used in connection with a golf ball having metallic or conductive elements disposed in or on any location of the golf ball.

In use, when a golfer looses a golf ball, the golfer goes to the general area where he or she thinks the golf ball is, removes the golf ball finder 10 from his or her golf bag, turns the detection unit on by means of switch 30 and proceeds to travel slowly across the general area while gently swinging the golf ball finder 10 from side to side, the disk 22 of the head 20 facing the ground and positioned a few inches above the ground.

When the detection unit comes into a close proximity with the golf ball, the speaker 24 emits an audible signal to alert the golfer of the find. This method for locating a golf ball works in all types of environments including heavy brush, leaves, and rough, and even works with golf balls submerged in water, or buried under sand.

After the location of the golf ball is determined, the golf ball must be retrieved. Retrieval can be effected manually if the golf ball is no in a particularly hazardous or awkward position. If, however, the golfer's access to the golf ball is blocked by some physical barrier such as heavy brush or water, the golfer may use the retrieval means to retrieve the golf ball. First, the golfer unscrews the cap 54 of golf ball finder 10, positions the scoop basket members to scooping position, and extends the telescoping retrieval shaft to a desired length. Then, the golfer extends the scoop basket to the golf ball and scoops up the golf ball, thereby completing retrieval. The retrieval apparatus of the golf ball finder allows the golfer to retrieve balls from a distance of up to approximately 9 feet from the golfer.

Optionally , the golfer may carry in his or her golf bag other items which may be used in connection with the golf ball finder. Such items may be attachable to the golf ball finder 10 by means of the threaded engagement means on the handle portion 50, which is accessible upon removal of the cap 54. An example of such and item is an umbrella having a specially adapted handle to threadably engage the threaded engagement means of the golf ball finder. Thus, one could be protected from rain or sun while finding a lost golf ball.

Having thus described my invention in detail, it is understood that the foregoing description is not intended to limit the spirit and scope thereof. What is desired to be protected by Letters Patent is set forth in the appended claims.

* * * * *

United States Patent *5,228,697*
Gulick , et al. **July 20, 1993**

Glow-in-the-dark golf ball

Abstract

A phosphorescent golf ball, which emits a glow of light, is provided, for ease of finding the ball in the dark. A method of manufacture is also provided. In the preferred embodiment, the golf ball includes a flexible core member having phosphorescent glow-in-the-dark glowing means to generate a glow of light and for emitting the glow of light that is visible in a dark environment after receiving at least one of light and heat energy and a transparent cover means encircling the flexible core member with its phosphorescent glow-in-the-dark glowing means for permitting the phosphorescent glow to pass through the transparent cover means to make the golf ball more visible. A phosphorescent core for a glow-in-the-dark golf ball is also disclosed which comprises a mixture of phosphorescent glow-in-the-dark materials and a flexible material such as rubber.

Inventors: **Gulick; James D.** (Peoria, AZ); **Hollingsworth; H. Lee B.** (Easton, PA)
Assignee: **Sports Glow, Inc.** (Scottsdale, AZ)
Appl. No.: **823150**
Filed: **January 21, 1992**
Current U.S. Class: **473/200**; 273/DIG24; 473/353
Intern'l Class: A63B 043/06; A63B 037/12; A63B 037/06
Field of Search: 273/220,218,235 A,DIG. 24,213

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Primary Examiner: Marlo; George J.
Attorney, Agent or Firm: Weiss; Harry M.

Claims

The embodiments of an invention in which an exclusive property or right is claimed are defined as follows:

1. A spherical, two-piece, phosphorescent glow-in-the-dark golf ball comprising:

a spherical, solid core including a resilient material having phosphorescent glow-in-the-dark glowing means mixed throughout said core material for receiving at least one of light and heat energy to generate a glow of light and for emitting said glow of light that is visible in a dark environment after receiving said at least one of light and heat energy; and

a spherical, transparent cover means encircling said flexible core for permitting the phosphorescent glow of said core to pass through the transparent cover means to make the golf ball more visible.

2. The phosphorescent glow-in-the-dark golf ball of claim 1 wherein said transparent cover means is a layer of clear, translucent plastic material.

3. The phosphorescent glow-in-the-dark golf ball of claim 1 wherein said core comprises a mixture of at about 100 parts of said resilient material and at least about 25 parts of phosphorescent glow-in-the-dark materials.

4. The phosphorescent glow-in-the-dark golf ball of claim 3 wherein a range of from about 25 to about 80 parts of said phosphorescent glow-in-the-dark material sis mixed with said resilient material.

5. The phosphorescent glow-in-the-dark golf ball of claim 1 wherein said resilient material is rubber.

Description

RELATED PATENT AND PATENT APPLICATION

This application is related to U.S. Pat. No. 5,077,647 which issued Apr. 16, 1991, title GOLF BALL AND METHOD OF MAKING SAME, inventor James D. Gulick, and is also related to the U.S. patent application Ser. No. 07/660,278, filed Feb. 22, 1991, entitled "GLOW-IN-THE-DARK GOLF BALL AND METHOD THEREFOR", inventor James D. Gulick.

FIELD OF THE INVENTION

This invention generally relates to golf balls and methods of manufacture thereof, and in particular this invention relates to glow-in-the-the dark golf balls and fabrication methods therefor.

BACKGROUND OF THE INVENTION

The conventional prior art golf ball usually includes a flexible (usually rubber) core member and a relatively hard (usually plastic) cover portion disposed over the flexible core member.

One problem with the conventional prior art golf ball is that it cannot be readily seen in the dark. Often, golfers seeking to finish a round of golf before darkness will try to rush through the last few holes in order to complete the round. In doing this, golfers will usually become frustrated because their rushed shots are generally not as good as their carefully stroked and planned shots. Also, golf balls are often lost because of darkness during attempts by golfers to finish their rounds.

One attempt to deal with this problem of playing golf at dark has been the development of a golf ball which had a hole drilled through the ball for the insertion therein of glow type material which made the golf ball easier to see at dusk or even during darkness U.S. Pat. No. 4,695,055 discloses this prior golf ball with a hole therethrough.

Various problems are associated with this type of a golf ball. First of all, a golfer usually has to use more than one of these glow type material inserts for this type of golf ball to fully complete 18 holes of golf. Furthermore, this type of golf ball is structurally changed thereby eliminating any chance of being approved by the U.S.G.A. (United States Golf Association) which is the official group that rules on which golf balls are acceptable as official golf balls to be used in golf tournaments. Also, people using this prior golf ball have indicated that they cannot hit the ball as far as conventional golf balls.

A number of other, non-related objects (not golf balls) have had phosphorescent materials applied such as disclosed in U.S. Pat. No. 3,445,551 covering a hollow, expanded ball, but not a golf ball.

Thus, a definite need existed for a phosphorescent glow-in-the-dark golf ball that could be approved by the U.S.G.A., and that can be hit as far as conventional golf balls, but which would be useful to golfers either seeking to finish their golf play at dusk, or for playing at night (with some exterior golf course lights to outline the general layout of the golf course including any ponds, trees, bushes, etc. to avoid injury to the golfer), or for playing golf where there are out of bound areas with relatively tall grass making normal (non-glowing) golf balls difficult to see, or for playing golf near water hazards such as small ponds that can conceal the location in the water of (non-glowing) golf balls, but might reveal the location of a glowing type golf ball.

SUMMARY OF THE INVENTION

Accordingly, it is an object of this invention to provide improved phosphorescent glow-in-the-dark golf balls and fabrication methods therefor.

It is a further object of this invention to provide improved phosphorescent glow-in-the-dark golf balls and fabrication methods therefor where these golf balls glow without structural changes thereto.

It is still another object of this invention to provide improved phosphorescent glow-in-the-dark golf balls and fabrication methods therefor which are capable of being approved by the U.S.G.A. for golf tournaments or as an official golf ball.

It is a still further object of this invention to provide improved phosphorescent glow-in-the-dark golf balls and fabrication methods therefor which utilize a phosphorescent glow-in-the-dark core and an encircling transparent cover which functions to permit light to pass through the transparent cover to energize the phosphorescent glow-in-the-dark core and to permit a phosphorescent glow of light to pass from the core out through the transparent cover to make the golf ball visible in a dark environment.

It is still another object of this invention to provide improved phosphorescent glow-in-the-dark cores for glow-in-the-dark golf balls and fabrication methods therefor.

According to one embodiment of the present invention, a glow-in-the-dark golf ball is provided which comprises a flexible core member having phosphorescent glow-in-the-dark glowing means for receiving at least one of light and heat energy to generate a glow of light and for emitting the glow of light that is visible in a dark environment after receiving at least one of light and heat energy, and transparent cover means encircling the flexible core member with its phosphorescent glow-in-the-dark glowing means for permitting the phosphorescent glow to pass through the transparent cover means to make the golf ball more visible.

According to another embodiment of the present invention, a method of providing a glow-in-the-dark golf ball is provided which comprises the steps of: providing a flexible core member having phosphorescent glow-in-the-dark glowing means for receiving at least one of light and heat energy to generate a glow of light and for emitting the glow of light that is visible in a dark environment after receiving at least one of light and heat energy, and forming transparent cover means encircling the flexible core member with its phosphorescent glow-in-the-dark glowing means for permitting the phosphorescent glow to pass through the transparent cover means to make the golf ball more visible.

A still another embodiment of this invention is a glow-in-the-dark core for a glow-in-the-dark golf ball which comprises a flexible core member having phosphorescent glow-in-the-dark glowing means for receiving at least one of light and heat energy to generate a glow of light and for emitting a glow of light that is visible in a dark environment after receiving at least one of light and heat energy.

The foregoing and other objects, features and advantages will be apparent from the following description of the preferred embodiment of the invention as illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an elevation view of a golf ball according to the invention;

FIG. 2 is a section view taken along line 2--2 of FIG. 1;

DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in FIGS. 1 and 2, a golf ball 10 is provided. Golf ball 10 has, like many conventional golf balls, a center ball type core 12 (see FIG. 2) and an exterior dimpled surface 14 (see FIG. 1). Thus, golf ball 10 has a flexible, resilient core or core portion 12 which is preferably made of a flexible (i.e. rubber) ball type material as further described below. The flexible core 12 comprises a sphere or spherical member preferably made of conventional rubber type material (polybutadiene) mixed with phosphorescent glow-in-the-dark materials such as disclosed in the above referenced James D. Gulick U.S. Pat. No. 5,007,647 which mixture of the rubber type material and the phosphorescent glow-in-the-dark materials are mixed together and compressed together into the flexible core sphere 12 shown in FIG. 2.

Golf ball 10 also includes a plastic exterior layer 16, which is composed of a translucent, transparent, clear plastic material such as the material sold under the tradename SURLYN by DuPont. This plastic material or layer 16 can be formed about the flexible core 12 by various known plastic forming techniques at elevated temperatures.

The advantage of the glow-in-the-dark or luminescent golf ball 10 of FIGS. 1 and 2 have been indicated above. Golf ball 10 is relatively easy to find in the dark, as during an evening golf game after sunset, because it emits a phosphorescent glow after light is used (such as from a flashlight or bulb) to activate the flexible core 12 which contains the phosphorescent glow-in-the-dark materials therein. Thus, the golf ball 10 can be made to provide a glow of light by applying an exterior light through the external transparent cover wherein the generated or exited glow from the flexible core 12 containing the phosphorescent materials will pass from the core 12 through the transparent, plastic layer 16 to thereby make the golf ball 10 visible at night or in a dark environment.

An advantage of the golf ball 10 is that the cost of producing such a golf ball is not very high considering the glow-in-the-dark feature thereof.

The flexible core 12 is made of a mixture of flexible material such as rubber (polybutadiene) with the phosphorescent glow-in-the-dark materials in a percentage ratio wherein the phosphorescent glow-in-the-dark material comprises a percentage of the mixture and the flexible material (such as rubber) is also a percentage of the mixture. In one embodiment, the phosphorescent glow-in-the-dark material comprised in the range of from about 25 to about 80 parts of the mixture, the flexible material was polybutadiene which was about 100 parts of the mixture and the remaining parts of the mixture was about 37 parts of Zinc Diacrylate and about 1 part of Peroxide. The phosphorescent glow-in-the-dark materials in the core mixture are generally designated by reference number 15 in FIG. 2

While the invention has been described in its preferred embodiments, it is to be understood that the words which have been used are words of description rather than limitation and that changes may be made within the purview of the appended claims without departing from the true scope and spirit of the invention in its broader aspects.

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United States Patent ***5,662,533***
Chadwell **September 2, 1997**

Golf ball locator apparatus

Abstract

A golf ball locating apparatus and a method of applying a reflective coating to the golf ball. The apparatus involves a handheld apparatus which locates a wayward golf ball and identifies its relative position to the

handheld apparatus. The handheld apparatus is structured in two preferred embodiments: the first is a handheld apparatus that fits into a user's pocket; the second is a shaft arrangement which has two extendable wings to form a "T" shape. The pocket sized embodiment has a forward facing window to direct a beam from the apparatus. The beam of radiation reacts with a clear coating on the golf ball and is sensed by the apparatus which then illustrates, via a display, the relative location of the golf ball. The "T" embodiment has antennas embedded into the wings which emit a field which are disturbed by the coating on the golf ball; lights associated with the antennas are illuminated to show the operator which antenna is in the closest proximity to the golf ball. The coating on the golf-ball is applied through a variety of techniques and preferably covers the entirety of the golf ball. One methodology uses an impregnated cloth to wipe the golf ball immediately prior to placing the ball in-play. This assures a coating on the golf ball during each play.

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Appl. No.: **343032**
Filed: **November 21, 1994**
Current U.S. Class: **473/353**; 473/131; 473/407
Intern'l Class: A63B 057/00
Field of Search: 273/213,32 B,58 G 324/326,234,243,239 473/353,131,407

References Cited [Referenced By]

U.S. Patent Documents

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Claims

What is claimed is:

1. A golf ball locating combination comprising:

a golf ball;

means for applying a coating to said golf ball;

a handheld locating apparatus having,

means for sensing said coating on said golf ball, and,

an operator interface means for identifying a location of said golf ball relative to said locating apparatus,

wherein said handheld locating apparatus includes a shaft portion having an operator handle on a first end thereof and two hinged wing portions swivelly attached to a second end of said shaft portion, each of said hinged wing portions having antenna means for sensing said coating.

2. The improved golf ball locating combination according to claim 1 further including:

a) auditory means, mounted to said shaft portion, for emitting an auditory signal; and,

b) control means, connected to said auditory means and each of said antennas in said hinged wing portions, said control means for monitoring the antenna means in each of said hinged wing portions and causing said auditory means to generate an auditory signal indicative of which antenna in said two hinged wing portions receives a stronger reflected signal.

3. The improved golf ball locating combination according to claim 2 wherein said control means include threshold means for inhibiting said auditory means until a signal from either of said antennas on said hinged wing portions exceeds a pre-selected level.

4. The improved golf ball locating combination according to claim 1 wherein each of said hinged wing portions contains N, N being an integer greater than 1, spaced apart antennas and N light emitting apparatus, and further including a control means connected to each of said antennas and each of said light emitting apparatus, said control means for activating one of said light emitting apparatus associated with an antenna receiving a strongest signal from said coating on said golf ball.

5. The improved golf ball locating combination according to claim 1 further including positional sensing means for disengaging said antennas within each of said winged portions when said winged portion is not in an extended position.

6. A handheld apparatus for locating golf balls having a coating thereon, said handheld apparatus comprising:

a) means for sensing said coating on said golf ball,

b) an operator interface means for identifying a location of said golf ball relative to said handheld apparatus,

c) means for emitting a signal being reactive with said coating,

d) means for applying a coating to a golf ball, and

e) the golf ball,

wherein said handheld apparatus is pocket sized and has a forward facing window for emitting said signal across a controlled range.

7. The improved golf ball locating combination according to claims 4 or 6 wherein said means for applying includes a liquid matter applied to said golf ball.

8. The improved golf ball locating combination according to claim 7 further including a fabric material impregnated with said liquid matter, and wherein said liquid matter is applied immediately before said golf ball is put in play by wiping said liquid matter onto said golf ball using said fabric material.

9. The improved golf ball locating combination according to claim 7 wherein said liquid matter substantially covers said golf ball.

10. The improved golf ball locating combination according to claim 9 wherein said liquid matter dries substantially clear.

11. The improved golf ball locating combination according to claim 10 wherein said liquid matter is reflective of a radiation at a selected frequency.

12. The handheld apparatus according to claim 6 further including a filter means disposed over said forward facing window for filtering signals reflected from said golf ball.

13. The handheld apparatus of claim 6 wherein

the sensing means is a CCD sensor,

the interface means includes a computer and a display that generates a locating light, and

the emitting means is an emitter that emits an array of light beams.

Description

BACKGROUND OF THE INVENTION

This invention relates to sporting goods and more particularly to instruments used in the game of golf.

As the game of golf has become more popular, a wide variety of aids have been developed to speed the game, assist various aspects of the game, or to assist the golfer in improving his or her score.

The game of golf is controlled by a large number of rules which dictate when "penalty strokes" must be added to the score. If these penalty strokes are minimized or eliminated, then the golfer's effectiveness can be improved.

One such rule relates to lost balls or balls that cannot be located because they are in the rough. The rules provide for the taking of penalty strokes when a ball cannot be found.

Further, golf balls themselves are no longer inexpensive and the loss of balls during the game can become an aggravating experience.

Numerous different apparatuses have been developed to assist the golfer in locating a wayward ball. These efforts have generally been divided between modifying the golf ball itself, and the development of instruments to locate the ball.

In the area of golf ball modification falls such examples as: U.S. Pat. No. 5,112,055, entitled "Golf Ball Including Sound Emitting Means" issued to Barnhill on May 12, 1992: U.S. Pat. No. 4,660,039, entitled "System for Locating a Sport Object" and issued to Barricks et al. on Apr. 21, 1987; and U.S. Pat. No. 5,228,697, issued to Gulick et al. on Jul. 20, 1993, and entitled "Glow-in-the-Dark Golf Ball". These devices, respectively, attempt to make the ball easier to find by: implanting beepers in the golf ball, applying reflective tape to the outside of the golf ball, and coloring the golf ball.

Although each of these techniques do provide a heightened level of "findability", they also are extremely disruptive to the traditional game of golf and require highly specialized and obvious equipment modification. Even more disturbing is the fact that these modifications to the golf ball have affects on the ball's flight characteristics which may cost the player more strokes than they save in penalties.

An example of the apparatus which have been developed in assisting in finding a golf ball include U.S. Pat. No. 5,132,622, entitled "Method and Apparatus for Locating and Retrieving a Golf Ball having a Metal Center" issued to Valentino on Jul. 21, 1992 (incorporated hereinto by reference). In this application, again the golf ball must be modified to include an iron or other metal center. This modification dramatically affects the golf ball's playing characteristic.

Further, this apparatus merely indicates when the end of the probe is "near" the ball rather than any true directional aid.

It is clear that there is a need for an effective golf ball locating apparatus.

SUMMARY OF THE INVENTION

The invention involves both a golf ball locating apparatus and a method of applying a reflective coating to the golf ball. The apparatus includes a handheld device which locates a wayward golf ball and identifies its relative position to the handheld apparatus.

The handheld apparatus is structured in two preferred embodiments: the first is a handheld apparatus that fits into a users pocket; the second is a shaft arrangement which has two extendable wings to form a 37 T" shape.

The pocket sized embodiment has a forward facing window to direct a beam from the apparatus. The beam of radiation from the window reacts with a clear coating on the golf ball and is sensed by the apparatus which then illustrates, via a display, the relative location of the golf ball to the handheld apparatus.

The "T" embodiment has antennas embedded into the wings which emit a field which are disturbed by the coating on the golf ball; lights associated with the antennas are illuminated to show the operator which antenna is in the closest proximity to the golf ball and thereby locate the exact position of the golf ball relative to the "T" embodiment.

The method of applying the coating to the golf-ball is accomplished through a variety of techniques and preferably covers the entirety of the golf ball. One methodology uses an impregnated cloth to wipe the golf ball immediately prior to placing the ball in-play. This assures a coating on the golf ball during each play.

The apparatus used to sense the presence of the ball utilizes a variety of techniques well known to those of ordinary skill in the art. The preferred embodiment generates a high-frequency electro-magnetic field and monitors this field for changes caused by ferrous or non-ferrous metal objects. In this application, a thin clear film of metal is applied to the entirety of the golf ball permitting the metal coating on the golf ball to change the field and thereby be detected. This technique is often referred to as metal detection due to its common usage in locating hidden metal objects.

Another technique is through the use of radar. A metal coating on the golf ball is reflective of radio waves while non-metal coatings do not reflect. This permits a radar unit to both detect and to establish distance based on the time for reflection.

Other techniques used for the detection include applying a selected clear coating onto the golf ball which reflects radiation (such as infra-red). The apparatus creates the radiation and then scans for its reflection using a filter and charge-coupled-device (CCD). The use of a CCD is preferred as it allows for not just sensing of the reflected rays but also the direction the reflection was received.

Those of ordinary skill in the art readily recognize other methodologies which serve this function.

In the preferred embodiment, the "T" shaped detector, when used in conjunction with the metal detecting technology, has multiple sensing antennas located throughout the two winged portions. Each antenna senses a unique field disturbance from the metal coating on the ball. Using these varying field disturbances, a computer, acting as a controller, is able to identify which antenna is closest to the ball. Using either a variable pitch buzzer, other auditory signal, or lights associated with the portion of the winged member associated with the antenna, the computer "directs" the user to the exact location of the metal coated ball.

The invention, together with various embodiments thereof, will be more fully described by the accompanying drawings and the following descriptions thereof.

DRAWINGS IN BRIEF

FIGS. 1A and 1B are front and side views respectively of the handheld pocket-sized embodiment of the detector.

FIG. 1C is a functional layout of the handheld pocket-sized embodiment of the detector.

FIG. 1D illustrates the preferred display used in the handheld pocket-sized embodiment of the detector.

FIGS. 2A, 2B, and 2C illustrate three different ways that a coating is put onto the golf ball.

FIG. 3 is a perspective view of the "T" shaped embodiment of the invention in use.

FIG. 4 is a close-up view of the "T" shaped embodiment showing the use of multiple antenna for locating a ball.

FIG. 5 is a flow-chart of the preferred embodiment illustrating the operation of the computer contained within the "T" shaped embodiment.

FIG. 6 is a flow-chart of the computer operation of the handheld pocket-sized embodiment of the invention.

DRAWINGS IN DETAIL

FIGS. 1A is a front view of the handheld pocket sized embodiment of the detector.

Operator 16 is able to hold locating apparatus 10 easily in his/her hand. Locating apparatus 10 also fits into a pocket of operator 16.

By depressing button 18, locating apparatus 10 is activated and a signal is emitted through window 12 as shown by arrow 15. Window 12 is structured such that the emissions from window 12 cover a selected forward view 13. As these emissions 15 contact the coating on golf ball 14, they are reflected and are picked up by a CCD-type sensor contained within locating apparatus 10. In some embodiments of window 12, a filter is used to control the type or amount of light received by the sensor (not shown).

A computer within locating apparatus 10 uses the signals from the CCD-type sensor and generates a locating light 13 on display 11. This locating light 13 gives both a direction and approximate distance from locating apparatus 10 to golf ball 14. Besides locating light 13, the computer additionally informs the operator 16 of the "sighting" of the golf ball 14 via a buzzing emitted by speaker 19.

In this manner, operator 16 is able to "sweep" an area listening for the audio alarm and then to "home in" on the golf ball 14 using display 11.

FIG. 1B is a side view respectively of the handheld pocket sized embodiment of the detector.

Locator 10 is thin allowing it to be stored in a pocket of the operator's clothes or golf-bag. Display 11 is slightly tilted relative to the case so as to provide for enhanced viewing. Window 12 is positioned at a forward end of the casing while battery supply cover 17 is located at the aft end. Batteries, not shown, are used to provide the power for the locator 10 and are inserted into the casing via battery supply cover 17.

FIG. 1C is a functional layout of the handheld pocket sized embodiment of the detector.

Inside locating apparatus 10 is an array of sensors/emitters 9 which both transmit the signals and sense the reflected signals. These sensors/emitters 9 are directed in unique angles for their operation. Returned signals are communicated to computer 8. Computer 8 is activated by operator depression of switch 18. In the preferred embodiment, computer 8 directs each sensor/emitter within array 9 to first transmit a signal and then sense if a reflected signal is perceived. The time lapse between the transmission and sensing is used to gauge distance. If a sensor within array 9 receives a reflected signal, this occurrence is communicated to computer 8 which uses the time delay from transmission to receipt to estimate the distance to the golf-ball and to light the appropriate light 13 in display 11 (not shown- refer to FIG. 1D); additionally, computer 8 also directs speaker 6 to emit a sound so as to alert the operator that the golf-ball has been sensed.

The sound from speaker 6 alerts the operator that the golf-ball has been located; the operator then is able to check the display to obtain an estimate of the relative direction and distance to the golf ball.

The entire system receives power from battery 7.

FIG. 1D illustrates the preferred display used in the handheld pocket sized embodiment of the detector.

Display 11 contains a fan-type array of lights. For ease of illustration, only one row of lights 4 is shown; each linear array of lights, such as 4, are aligned with one of the sensors/emitters 9 as described in FIG. 1C. The computer as shown in FIG. 1C, determines which light within array 4 corresponds to the estimated distance.

Although the light arrangement is not exact, its estimate and direction is sufficient to assist the operator in locating the golf-ball.

FIGS. 2A, 2B, and 2C illustrate three different ways that a coating is put onto the golf ball.

The preferred embodiment is shown in FIG. 2A in which a fabric material such as a towel 20 has been impregnated with a liquid material having the coating therein. As the towel is used to clean golf ball 14, a residue is left on the ball. The cleaning of the golf ball is usually done immediately prior to the ball being put in-play.

FIG. 2B illustrates another embodiment in which a clear liquid 22 having the metallic flakes or other reflective material suspended in the liquid, is sprayed from can 21 onto golf ball 14. This application is usually done once after the golf balls have been purchased and then as the coating is depleted.

In FIG. 2C, liquid 23 has reflective coating suspended and then the golf ball is dipped therein. The coating covers the entirety of the ball. This method provides for a thicker film than the other three techniques.

In all three techniques illustrated in FIGS. 2A, 2B, and 2C, the objective is to substantially cover the golf ball with the desired reflective coating. Since the entire ball is covered, the coating is better able to be sensed by the locating apparatus.

FIG. 3 is a perspective view of the "T" shaped embodiment of the invention in use.

User 34 holds the handle on shaft portion 30 after extending the wing portions 31A and 31B as illustrated by 32A and 32B respectively. Once so extended, wing portions 31A and 32B, in the preferred embodiment, include antennas which create a field affect. This field affect is disturbed by the coating on ball 14. The disturbance is measured by the sensing circuit (not shown) and an auditory alarm is emitted by speaker 33.

In the preferred embodiment of this locator apparatus, the auditory alarm is different depending on which of the winged portions 31A or 31B receive the largest disturbance to their fields. As example, if the golf ball is under winged portion 31A, more disturbance will be sensed by that winged portion resulting in a single beep being emitted. Alternatively, if winged portion 31B receives the greater disturbance, a dual beep is emitted.

In this way, user 34 is able to isolate and locate the ball.

Also note, in this embodiment of the invention, a single winged portion may be distended leaving the other in the up-right position. As example, if the area to be searched has a large number of bushes and tress, user 34 optionally lowers winged portion 31A and leaves winged portion 31B in the upright position. Either winged portion in the up-right position has its antennas deactivated.

During storage or transportation of the locating apparatus of FIG. 3, both winged portions are in the upright position creating a straight shaft which is easily stored in the golf-bag.

FIG. 4 is a close-up view of the "T" shaped embodiment showing the use of multiple antenna for locating a ball.

In this embodiment, multiple antennas (such as 41A and 41B) are located within each of the winged portions 31A. Although this illustration shows two antennas within the winged portion 31A, the invention contemplates any number, N, of antennas being positioned in the winged portion. N is an integer greater than one.

Each of the antennas generate a field as illustrated by 42A and 42B. As golf ball 14 interacts with these fields, the disturbance is sensed by computer/controller 40. By comparing the level of disturbance from each of the antennas, the antenna having the largest disturbance is determined as being nearest to the golf ball 14. Lights 45A and 45B are arranged to be proximate to antennas 41A and 41B respectively. In this illustration, computer 40 activates light 45B since antenna 41B records the largest disturbance.

The user, by monitoring the lights on the wings is able to identify the location of the golf ball to within a few inches.

Switch 43 monitors the position of the two winged portions and communicates an up/down status to computer 40 which monitors only the winged portion which is down and in the activated mode.

FIG. 5 is a flow-chart of the preferred embodiment illustrating the operation of the computer contained within the "T" shaped embodiment.

Once a start 50 has been encountered, the computer monitors the signals received 51. Note, as indicated in FIG. 4, if a winged portion is not in the downward activated state, as indicated by switch 43, no signal is received from that winged portion.

Of the signals received, the program identifies the largest signal 52A and then determines if it is past a predefined threshold 53. This decision 53 is used to filter out "noise" which might be caused by other objects which affect the field from the antennas but which are minor in nature.

If the threshold is passed, the proper light and or sound is made 52B so that the operator is able to locate the general location of the golf ball. The program then returns to monitor for the incoming signals.

FIG. 6 is a flow-chart of the computer operation of the handheld pocket-sized embodiment of the invention.

Once start 60 has begun, the next sensor/emitter is selected 61A. Initially this is the left most sensor/emitter and then sequences through the sensor/emitter array and returns to the left most sensor/emitter. A signal is transmitted 61B from the selected sensor/emitter and the time is recorded.

A return or reflected signal is then monitored 62A. If no signal is received, then a check is made to see if the monitoring should continue 62B. In the preferred embodiment, the monitoring of each sensor/emitter is for less than a tenth of a second meaning that an apparatus which has eight sensors/emitters will cycle through the entire array each second. If the time has not elapsed, 62B, then the program cycles back to continue to monitor for signals 62A; otherwise, the next sensor/emitter is selected 61A.

When a signal is received, 62A, the signal is checked to see if it is past a certain threshold 62C. If the signal is too weak, the next sensor/emitter is chosen 61A; otherwise, the program knows that the golf ball has been sensed.

In this case, the estimated distance is calculated 61C from the locating apparatus to the golf ball based upon the time for the signal to be reflected from the coating on the golf ball. Using this distance estimate, the proper light on the display panel associated with the sensor/emitter is illuminated 61D and the buzzer is sounded 61E. Afterwards, the program returns to choose another sensor/emitter 61A.

In this manner, the relative location and distance to the golf ball is established so as to permit the user to "home in" on the lost golf ball.

It is clear from the foregoing that the present invention creates an improved apparatus to locate a golf ball and an improved method of applying a coating to golf ball.

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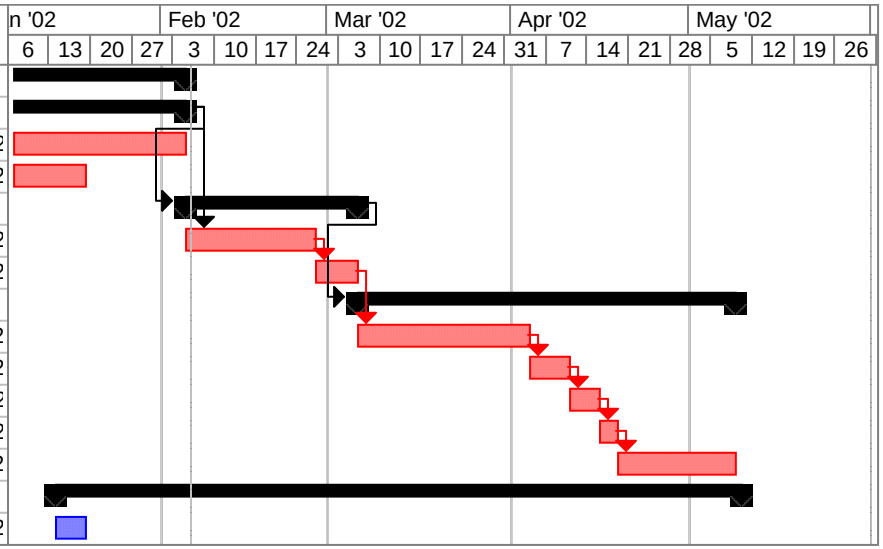
Golf Ball Comaprison

Brand	Ball	Type	Core	Casing	Cover	Prize
Titleist	Pro V1	3 piece	Polybutadiene	Ionomer	Urethane Elastomer	50
	Professional	Wound	Proprietary Liquid		Urethane Elastomer	50
	Tour Distance SF	Wound	Proprietary Liquid		Soft, Polymer Alloy	40
	NXT TOUR	2 piece	Polybutadiene		Fusablend™	30
	NXT Distance	2 piece	Polybutadiene		Na/Zn Surlyn® Blend	30
	DT Distance	2 piece	Polybutadiene		Na/Zn Surlyn® Blend	30
	HVC	2 piece	Polybutadiene		Na/Zn Surlyn® Blend	25
Strata	Strata Tour Ultimate® 2	3 piece	Tungsten Energy/Rubber	Acid Magnesium	Zynthane III	40
	Strata Tour Ultimate®	3 piece	Tungsten Energy/Rubber	Acid Mantle	Zynthane II	40
	Strata Tour Professional	2 piece	Ultra Soft High Energy Core	Ionomer Mantle Layer	Zynthane II	35
	Strata Professional Balata	2 piece	Soft Dilatent	Soft Ionomer	Soft HS Balata	30
	Strata Professional Distance		Soft High Molecular Weight		Resilient Zylin Cover	30
Callaway	HX Blue		Polybutadiene/Tungsten	Ionomer	Thermoset Polyurethane	40
	HX Red		Polybutadiene/Tungsten	Ionomer	Thermoset Polyurethane	40
	CTU 30 Blue		Polybutadiene/Tungsten	Ionomer	Thermoset Polyurethane	40
	CTU 30 Red		Polybutadiene/Tungsten	Ionomer	Thermoset Polyurethane	40
	CB1 Blue		Polybutadiene/Tungsten	Ionomer	Thermoset Polyurethane	30
	CB1 Red		Polybutadiene/Tungsten	Ionomer	Thermoset Polyurethane	30
Nike	Tour Accuracy		Polybutadiene	Ionomer	Polyurethane	40
	Control		Polybutadiene		Ionomer	40
	Power Distance Ti-Velocity	2 piece	Polybutadiene/Titanium		H.C Surlyn	20
	Power Distance Feel-Speed	2 piece	Polybutadiene/Nickel		N.C Surlyn	20
	Power Distance Hi-Launch	2 piece	Polybutadiene/Cobalt		L.C Surlyn	20

Project Schedule

ID		Task Name	Duration	Start	Finish
1		**Golf Ball Detector**	**21 days**	**Mon 1/7/02**	**Mon 2/4/02**
2		**Info Gathering & Research**	**21 days**	**Mon 1/7/02**	**Mon 2/4/02**
3		Detecting Methods & Te	21 days	Mon 1/7/02	Mon 2/4/02
4		Golf Ball Properties	10 days	Mon 1/7/02	Fri 1/18/02
5		**Design Research**	**21 days**	**Tue 2/5/02**	**Tue 3/5/02**
6		Design Options	16 days	Tue 2/5/02	Tue 2/26/02
7		Design Selection	5 days	Wed 2/27/02	Tue 3/5/02
8		**Design & Modeling**	**46 days**	**Wed 3/6/02**	**Wed 5/8/02**
9		Prototype Development	21 days	Wed 3/6/02	Wed 4/3/02
10		Testing Phase	5 days	Thu 4/4/02	Wed 4/10/02
11		Review Test Result	3 days	Thu 4/11/02	Mon 4/15/02
12		Design Reviews	3 days	Tue 4/16/02	Thu 4/18/02
13		Final Design	14 days	Fri 4/19/02	Wed 5/8/02
14		**Patenting Process**	**84 days?**	**Mon 1/14/02**	**Thu 5/9/02**
15		Exsisting Patent Research	5 days	Mon 1/14/02	Fri 1/18/02



APPENDIX B

(RFID specification sheets)

TrakTag PSD Datasheet

Description

TrakTag PSD is a passive RFID tag encased in polyvinyl chloride, which is the size of a credit card and has a three-meter read range. It can be used for hands free access control as well as for product tracking in retail stores. The TrakTag PSD remains in sleep mode until it enters a field with a frequency of 13.56 MHz, where it is charged. TrakTag PSD transmits its data at a selected frequency of 916.5 MHz, 868 MHz or 433 MHz. The tag has unique anti collision capabilities, which insures that the RFID Reader will always receive the data accurately.

Product Summary

Item
Description
Tag Type:
Passive single direction tracking tag
Applications:
Access control, tracking, ticketing, and retail use.
Part Numbers:
AWI-PS-TTAG-916.5-1
AWI-PS-TTAG-868-1
AWI-PS-TTAG-433-1

Specifications

Description
Specification
Functionality: Read Only
Memory (Bits)
32
Operating Frequency: 916.5 or 868 or 433 MHz
Multi-tag Capability: Yes
Charging Frequency: 13.56 MHz
Typical Read Range: Up to 3 meters
Operating Temperature: -35° C to + 70° C
Storage Temperature: -40° C to + 85° C
Case Material: PVC
The programmed information is not normally effected by EMC or X-rays.
Signal Penetration: Tag can be read through virtually any non-metallic material
Dimensions: 85.4 mm x 54.1 mm x 3.0 mm

Weight
30 grams

NOTE: The product information and specifications on this page are subject to change without notice.

Description

The TrakTag RFID Reader is designed for access control and tracking applications using TrakTag RFID tags. It receives its data through an RF link from the TrakTag RFID tag. After qualifying the data, the RFID reader will transmit it to the user's host database through an RS232 or RF link to the host. The RFID reader can maintain a small database that records all the latest activity of persons or items, where it can be validated without going to the host. The RFID reader sends the activity results to the host later in a background activity. This virtually eliminates the latency time associated with completely host dependent systems.

The TrakTag RFID reader is extremely easy to configure and install. Simply mount the TrakTag RFID reader on the wall. When the RFID reader is turned on, it will send a power up command to the RFID host, and the RFID host will send back a response with a new address for the TrakTag RFID reader. This address will be the TrakTag reader's address as long the power remains on. The communication from the RFID reader to the RFID host computer occurs through a bi-directional RF link eliminating the need for costing wiring and conduit.

Product Summary

Item Description
Type: RFID Tracking Reader
Applications: Access control, tracking
Part Numbers: AWI-T-RDR-RS232-916.5-1 AWI-T-RDR-RS232-868-1 AWI-T-RDR-RS232-433-1

Specifications

Description Specification
Functionality Tracking Reader
Memory (Bits) 10 Mega bits
Operating Frequency to RFID tag 916.5 or 868 or 433 MHz
Operating Frequency

to RFID host
RS232 or 2450 MHz

Multi-tag Capability
Yes

Wakeup Frequency
13.56 MHz

Power Source
12 Volt DC or 120/220 Volt AC

Typical Read Range
to/from Tag
Up to 33 meters

Typical Read Range
to/from Host

50 to 300 meters

Operating Temperature
-35° C to + 70° C

Storage Temperature
-40° C to + 85° C

Case Material
PVC

Dimensions
TBD

Weight
TBD

NOTE: The product information and specifications on this page are subject to change without notice.

Figure 0-1

TI-RFid
A TEXAS INSTRUMENTS TECHNOLOGY
RFID Technology Central
TEXAS INSTRUMENTS RADIO FREQUENCY IDENTIFICATION SYSTEMS

Handspring Visor Modules

Low and High Frequency

Handspring Visor Modules for RFID tags

Powerful Springboard modules are available for the Handspring Visor Personal Digital Assistant (PDA) for users who wish to rapidly and conveniently add the ability to read and write to all leading low and high frequency RFID tags and smart labels.

Software is provided within each module which automatically loads (and unloads) whenever a module is inserted (or removed); as a result, no complicated software set-up procedures or cables are required. A comprehensive developer's kit is also available to support the implementation of sophisticated Palm-based applications; this kit includes development tools, demonstration software, tag programming guides, sample tags/smart labels and a Handspring Visor with USB cradle.

Product Features

- **Powerful readers for all leading RFID tags and smart labels, which interface to the industry standard Handspring Visor PDA, based on the Palm operating**

system

- **High frequency module supports all leading 13.56MHz RFID tags and smart labels from Gemplus (FOLIO), OMRON (V720), Philips Semiconductors (I.CODE) and Texas Instruments (Tag-it)**
- **Low frequency module supports all leading 125kHz RFID tags from EM Marin, Metget, Microchip (series 200), Philips Semiconductors, Sokymat, Temic and Texas Instruments (TIRIS)**
- **Fully compatible with the Springboard expansion slot - each module contains the software drivers required for operation, with automatic loading of application software on insertion of a module**
- **Internal NiMH (AAA) rechargeable batteries for enhanced operating life and range**
- **Handspring Visor provides a large touch-sensitive display (160 x 160 pixels, with back-lighting); a cradle is available for data transfer to a remote computer**

Developer's Kits

Comprehensive developer's kits are available, comprising: a Handspring Visor PDA; data transfer cradle; Springboard module (low or high frequency); RFID development libraries; demonstration software and source code; tag programming guides; sample tags and documentation.

Ordering Information

P-7726 HF Handspring Interface Module
P-7725 LF Handspring Interface Module

Call for availability.

Technical Specifications

Handspring RFID Interface Specifications

Mechanical Dimensions	80.00 x 55.00 x 27.00mm (Springboard Module only)
Weight	55g (77g including batteries)
Power Supply Battery Type	2 x AAA NiMH rechargeable; not recharged via the cradle

Antenna Style

PCB, shielded (rdr-300/305); ferrite rod (rdr-295)

Dimensions

14.00 x 49.00mm (rdr-300/305)

RF Power Output

25mW (rdr-300/305)

Range Typical read

60mm (I.CODE 45 x 76mm tag); 60mm (v4050 30mm tag); 110mm (TIRIS card tag)

Handspring PDA Specifications

Processor Type

Motorola Dragonball EZ

Memory

2Mb (Visor Standard), 8Mb (Visor Deluxe)

Mechanical Dimensions

122.00 x 76.00 x 18.00mm (Visor only)

Weight

147g (Visor only)

Power Battery

2 x AAA alkaline batteries (included with Visor)

Software Environment Operating System

Palm OS 3.1

Product Type
Order Code
Description / Tags Supported

Handspring Interface
P-7725
rdr-295

Low Frequency tags from: **EM Marin** (H400 1/2/3/5, v4050, v4066), **Gemplus** (Gemfly), **Metget, Microchip** (series 200), **Philips** (hitag 1, hitag 2, PCF7930, PCF7931 PCF79736), **Sokymat** (Nova, Titan, Unique, Zodiac), **Temic** (e5530 and e5550 - standard configuration), **Texas Instruments** (TIRIS) and all other derived from these

P-7726
rdr-300

High frequency tags and smart labels from: **Gemplus** (FOLIO70), **OMRON** (V720), **Philips Semiconductors** (I.CODE) and **Texas Instruments** (Tag-it).

Call for availability.

Home | About Us | "RFID" Introduction | "RFID" Questions | "RFID" Market
"RFID" News | "RFID" Products | "RFID" Pricing | Evaluation Kits | "RFID" Documentation
Contact Us

References

[i] **The National Golf Foundation, www.nga.com, 2001**

Golfers Questionnaire (Sample)

1. How long have you been playing golf?

2. What is your handicap?

3. How many rounds of golf do you play per year?

4. What is the average amount of golf balls that you would lose over 18 holes?

5. How much money do you spend on golf balls?

6. What determines your choice of golf balls?

    a. Brand
    b. Cost
    c. Recommendation
    d. Packaging

7. Would you invest more in golf balls, if the manufacturer guarantees that through applied technology, you would be able to recover 'mishit' golf balls?

8. Do you feel comfortable hitting a golf ball that has an electronic chip embedded into it?

Driving Range: Questionnaire (Sample)

1. How long have you been in the driving range industry?

2. How many driving range booth (mats) do you provide?

3. How much do you charge your customers?

    a. 50 balls
    b. 100 balls
    c. 150 balls

4. During a week, what is the average number of golfers that attend your range?

5. What is your average (total) number of golf balls that you keep in circulation?

6. What determines your choice of golf balls?

    d. Brand
    e. Cost
    f. Recommendation

g. Packaging

7. In a month, how many golf balls do you have to replace (due to cracks, lost/stolen balls)?

8. Do customers frequently remove golf balls from the range? How many (per month)?

9. Would you invest in a security system that would prevent golfers to remove range balls?

10. Would you invest more in golf balls, if the manufacturer guarantees that through applied technology, driving range golf balls would be anti theft proof?

11. Do you feel comfortable hitting a golf ball that has an electronic chip embedded into it?

Various Tags offered by Intersoft

IT75RO	• **Large, label-like thin tag for long read range** • **Adhesive backing for easy installation** • **75mm x 1mm, square**	
IT30RO	• **For rugged use** • **Can be affixed with fasteners or adhesives** • **30mm x 6mm, disc**	
EPD20RO	• **Heat and chemical resistant** • **20mm x 0.8mm, disc**	
PETD22RO	• **General Purpose** • **Low Cost** • **22mm x 1.5mm, disc**	
PNL35x6RO	• **Easily embedded** • **Can be nailed into wood** • **35mm x 6mm, nail**	

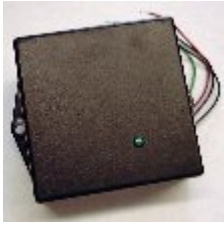
GLT12x2RO	• **Use where size is critical** • **12mm x 2 mm, cylinder**	
ETCMRO	• **For animal identification** • **Standard eartag, includes male stud** • **Numbering available**	
ISOROMAG ISOROCARD	• **For personnel identification, access control** • **Can be punched & printed** • **ISO standard size card**	
FOBRO	• **Use for access control, customer 'loyalty', ...** • **FOB for attaching to key ring** • **40mm x 30 mm x 4mm, key fob**	
WATCHRO	• **Use for access control, ticketing, ...** • **Easily attaches to wrist** • **250mm x 32mm, 'wrist watch'**	
CUSTOM TAG	▪ **Designed for your application** ▪ **Chemical resistance, heat, other features** ▪ **Prototype / low / high production volume**	

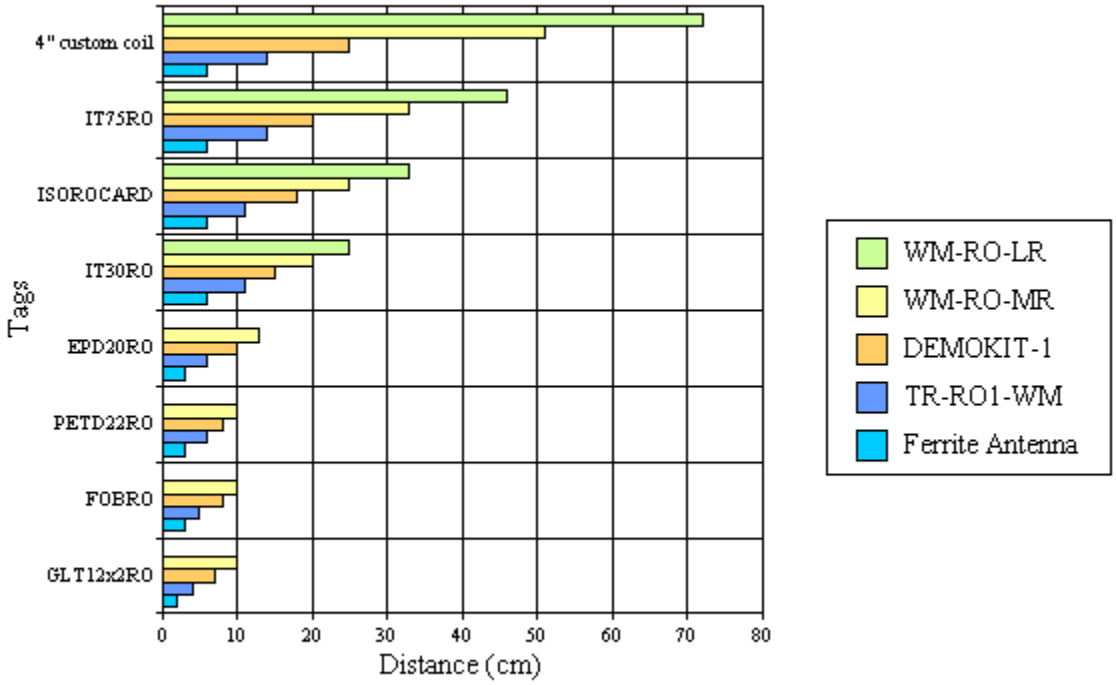
General Tag Specifications:

Operating Frequency	125 kHz ± 6
Modulation, Encoding	Amplitude Shift Keying, Manchester

Memory size	64 bit read only
Read Speed	1.953 k bits / second (35 ms read time, [50 ms average])
Serialization	40 bit number (1,099,511,627,776 combinations), laser fused

Various RFID Readers from Intersoft

WM-RO-LR	• **Long Range Reader** • **For parking garages, gateways, ...** • **51 x 51 x 3 cm**	
WM-RO-MR	• **Medium Range Reader** • **Rugged, sealed construction** • **20 x 20 x 3 cm**	
TR-RO1-WM	• **Reader/decoder for passive tags** • **Rugged, sealed construction** • **Easily attached to wall or conveyor** • **8 x 8 x 4 cm**	
HHR-RO1	• **Tethered Hand-Held Reader**	
TR-RO1-oem	• **Reader/decoder module board for oems** • **Perform all required functions** • **6 x 6 x 1.5 cm**	

TR-RO2-oem	• **Reader/decoder module board for oems** • **Small size** • **4 x 4 x 0.8 cm**	
CUSTOM READER	▪ **We can quickly customize any of our standard readers for your application.** ▪ **Or design and manufacture according to your specification.** ▪ **Contact us with your requirements.**	

Read Distance Achieved with Various Intersoft Readers