

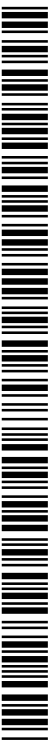


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(54) Title: DIGITAL VERIFICATION OF SINGLE STROKE ACHIEVEMENT

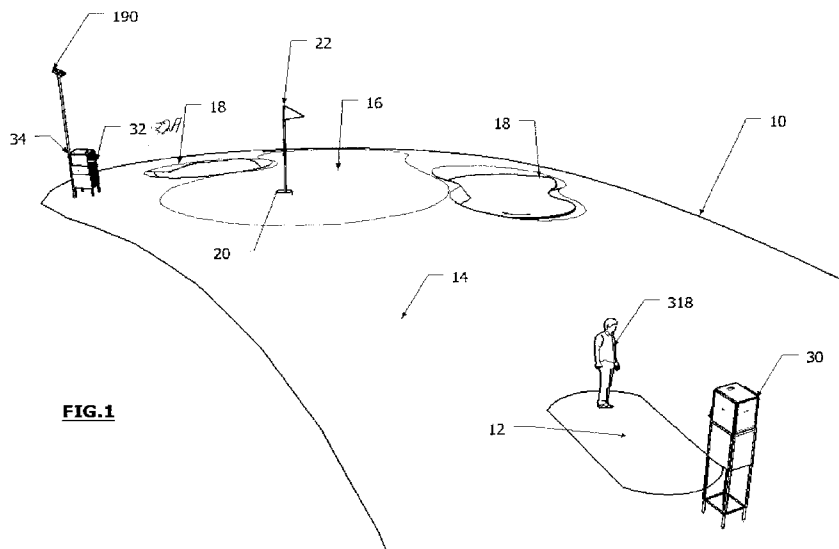


FIG. 1

(57) Abstract: A single golf stroke achievement is forensically validated with minimal observer influence by digitally or electronically identifying a golfer and a golf ball, producing video recordings of the golf stroke, a subsequent flight of the ball, and arrival of the ball (if this occurs) at a target area which contains a golf cup, and detecting and recording entry of the golf ball into the cup (if this occurs).

DIGITAL VERIFICATION OF SINGLE STROKE ACHIEVEMENTBACKGROUND OF THE INVENTION

[0001] This invention relates to a system for evaluating a golfer's claim of a single stroke achievement such as a hole-in-one, a nearest-to-the-pin, or other single stroke performance, and to a method of forensic identification giving effect to the system while minimising observer impact.

[0002] The rules of golf allow a player to accept a prize for a hole-in-one without a limit in the value of the prize and, in the case of an amateur player, without affecting the player's amateur status. Since a prize for an achievement such as a hole-in-one may include a substantial cash amount, a car, a boat, a holiday and a house (by way of example) the importance of being able to verify a player's claim of this type of achievement is evident.

[0003] Generally, in a golf game, only other players or witnesses to an event can substantiate or repudiate a player's claim of a particular achievement. Due to human factors a player's claim or a witness report of a particular event can vary or be in error.

[0004] It is therefore desirable to be able, with forensic reliability, to identify an achievement and substantiate or repudiate a player's claim with empirical evidence using scientific observation techniques without introducing an observer effect or non-standard equipment into a golf game.

[0005] Various attempts have been made to address the aforementioned situation. In the applicant's view such earlier attempts can, conveniently, be categorised as follows:

(1) Driving range systems – prior art in this category teaches observation systems and methods that are not suitable for regular golf courses. The prior art includes US5370389, US5445374, US5653642, US6012987 and US6607123.

(2) Practice systems – prior art in this category teaches observations in which the influence of observers is increased due to the use of non-standard equipment, or equipment which is only suitable for practising the game of golf. The prior art in this category includes US5743815, US6398670, US20030005004 and US8398500.

5 (3) Human verification – prior art in this category teaches human intervention processes such as manual measurements, manual entries into recording devices or post evaluations by third parties. Such techniques are subject to human error or confirmation bias. Examples of prior art in this category include US4880232, US20010021673, US20050250590, US20060084529 and US20110034223.

10 (4) Blind verification – prior art in this category relies on switches and sensors which perform object detection but which do not necessarily provide a conclusive means of distinguishing between a foreign object and a golf ball in play. The prior art in this category includes US3104879, US4922222 and US5354052.

(5) Visual verification – prior art in this category complements the use of switches and sensors with photographic evidence. However the applicant is unaware of any prior art in this category which  
15 discloses a technique of uniquely identifying a standard golf ball – an aspect which is considered to be essential in addressing a situation in which a foreign golf ball could be introduced into a target area either intentionally or inadvertently. The prior art in this category includes US4934705, US5102140, US5413345, US5884913, US20030195052, US20040166948, US20050192124 and US20090305803.

[0006] A need exists for a technique which can evaluate a golfer's claim of a single stroke  
20 performance and which can be implemented with minimal observer influence on a game. According to the rules of golf no achievement is possible while a golf ball is in flight or in motion. In practice, in the current context, this implies that a fundamental requirement of an effective evaluation system must include a forensically reliable capability for validating the identity of a standard golf ball before, and after, a stroke in which the ball is addressed, and of identifying a single stroke achievement.

SUMMARY OF THE INVENTION

[0007] The invention addresses the aforementioned requirements through the use of various techniques and hardware.

[0008] In the first instance the invention provides a system for monitoring a stroke by a golfer who, with the stroke, drives a golf ball from a launch area towards a golf cup at a target area, the system including:

- (i) a golf ball identifier mechanism for detecting and recording at least one characteristic on a surface of the golf ball which is unique to the golf ball,
- (ii) a launch monitor which produces a video recording, at least, of the stroke at the launch area,
- (iii) at least one target monitor which produces a video recording, at least, of the target area, including the golf cup, at least for a defined first time period which is dependent on the time of the stroke at the launch area, and
- (iv) a golf cup monitor at the target area which, at least, detects a status change of or in the golf cup, or which produces an image of a status change of or in the golf cup.

[0009] Preferably the system includes a flight monitor which produces a video recording, at least, of a space above and adjacent the target area, and of the target area, at least for a defined second time period which is dependent on the time of the stroke at the launch area.

[0010] The system may include a timing arrangement for controlling operation of, at least, the launch monitor, the target monitor and the golf cup monitor according to a predetermined timing schedule.

[0011] The timing arrangement may be used for recording, on a time basis, operation of at least the launch monitor, the target monitor and the golf cup monitor.

[0012] The launch monitor may include at least one camera that produces a video feed for a video recorder.

[0013] The launch monitor may include a global positioning system (GPS) module.

[0014] The launch monitor may include a storage unit for storing, at least, data relating to the video  
5 feed.

[0015] The system may incorporate a central control unit and respective communication links may be established between the launch monitor and the central control unit, and between at least one target monitor and the central control unit, and between the golf cup monitor and the central control unit.

[0016] A communication link may be established between the golf ball identifier mechanism and the  
10 central control unit.

[0017] Similarly a communication link may be established between the central control unit and the flight monitor.

[0018] Although it falls within the scope of the invention for such communication links to be established by means of conductors (wires) it is preferred to make use of radio techniques to minimize  
15 impact of the system on the normal play of golf. In this respect it is preferred to make use of direct or dedicated radio links between the respective components in the system.

[0019] A primary application of the invention lies in providing a capability to evaluate a player's claim of achieving a hole-in-one. However the principles of the invention can be used with equal effect in making a determination of any similar event e.g. a nearest-to-pin stroke. To give effect, at least, to the  
20 latter aspect the system of the invention may include at least two target monitors at or near the target area and each target monitor may produce, at least, a respective video recording of the target area

during a time period in which golf ball movement is expected. Through the use of appropriate digital techniques the distance between the position of a golf ball that lands, and which is stationary, at the target area, and a golf cup at the target area, can be calculated automatically from images produced by the monitors. Such calculation can be validated if appropriate by means of manual measurements.

5 **[0020]** According to a different aspect the invention provides a golf ball identifier mechanism which includes structure defining a golf ball path, an inlet to the golf ball path, an outlet from the golf ball path and at least one sensor positioned to detect at least one mark on a surface of the golf ball as it moves along the golf ball path from the inlet to the outlet.

10 **[0021]** The golf ball identifier mechanism may include at least one marking device and the golf ball path may be configured to direct the golf ball as it moves along the golf ball path into contact with the marking device whereby the marking device imparts an identifier mark to the surface of the golf ball.

15 **[0022]** The identifier mark may be of any suitable nature. The mark may be invisible in that the mark may only be discerned by the human eye, with the aid of external assistance. For example the mark may be made with a fluorescent ink which only fluoresces when it is subjected to excitation at an appropriate frequency e.g. by the use of a suitable radiation emitting device such as a fluorescent tube or a selected light emitting diode. These aspects are exemplary and non-limiting.

20 **[0023]** Two or more marks may be applied to the golf ball surface. Each mark may be applied by a respective marking device. The marking devices may be spaced from one another along the golf ball path. An intention in this respect is that markings which are applied to the golf ball shall be at random locations on the golf ball surface.

**[0024]** Through the use of the golf ball identifier mechanism a golf ball is marked prior to a stroke being played and, after the stroke has been played, if a particular achievement is claimed, it is possible

to validate the identity of the golf ball in question by examining the golf ball surface for the appropriate markings.

**[0025]** As an alternative or additional approach the golf ball marking device may sequentially change markings which are applied to successive golf balls. For example the marking device may increment  
5 numerically so that a first number is applied to a first golf ball, a second different number is applied to a second golf ball, and so on. These approaches and techniques can be adapted to enhance the marking of the golf ball in a manner which can be used to establish a unique identity for a given, standard golf ball.

**[0026]** Further at least one sensor may be responsive to at least one mark on the surface of the golf  
10 ball. The mark may for example be selected from the following: a dimple arrangement on the golf ball surface, a manufacturer's marking on the golf ball surface, a spatial relationship between the manufacturer's marking and a dimple arrangement on the golf ball surface, wear and tear marks on the golf ball surface, and at least one identifier mark which is applied to the golf ball surface e.g. as it traverses the golf ball path moving from the inlet to the outlet.

**[0027]** The golf ball identifier mechanism may include at least one camera which records one or more  
15 images of the golf ball surface or a succession of images of the movement of the golf ball in such a way that surface features of the golf ball are visible and are recorded in at least one image.

**[0028]** Additionally the golf ball identifier mechanism may include a sensor arrangement for  
20 determining at least one of the following: the mass of the golf ball, the volume of the golf ball and the density of the golf ball.

**[0029]** One benefit of the invention lies in the fact that a conventional golf ball can be employed. This is due to the use of the aforementioned golf ball identification process. Various techniques can be

employed, alone or in any appropriate combination, in this respect. Thus, in one approach, the temperature of a golf ball is measured before and immediately after play and a variation in the temperature of the golf ball, as a result of airflow across the surface of the golf ball during flight, is used as a control parameter.

5 **[0030]** As indicated surface characteristics which may exist on a golf ball or which may be applied, for the purpose, to the golf ball can be used with benefit in establishing an identity for a golf ball. It also falls within the scope of the invention for the number of dimples in an area on the golf ball surface to be determined. This is conveniently done through the use of one or more cameras that scan the golf ball surface. Through the use of suitable computer-implemented character recognition techniques each  
10 dimple can be "identified" or categorized as to its nature, and the dimples in a given area on the golf ball surface can be counted. Processing techniques such as de-skewing, de-speckling, binarisation, normalizing aspect or scale with character isolation, and pattern or matrix matching, constrained by an application specific lexicon, can be used to enhance recognition processes.

**[0031]** The fluorescent or other index marks that may be applied to the golf ball surface, prior to  
15 playing a stroke, may be detected and recorded through the use of an appropriate sensor. The position of such a mark may be compared with the location of a manufacturer's marking applied to the golf ball surface and may be viewed against a background of surface dimples in order to establish unique identification parameters.

**[0032]** The sensors which are used in the golf ball identification mechanism may be responsive to  
20 other surface characteristics such as impact marks, scuff marks or discolouration which may arise from wear and tear during normal play or from other causes. Through the use of Circle Hough Transform (CHT) techniques, typically carried out on a pixel by pixel basis, a unique image of all or a part of a golf ball surface can be created and recorded and can be used as a reliable control parameter.



[0033] According to another aspect the invention also provides a golf cup structure which includes a hole liner with a mouth and a camera which in use is positioned below the mouth of the liner and which is orientated for producing an image or images, e.g. a video record, of events above the camera.

[0034] A transparent partition may be located between the camera and at least a part of the hole liner.

5 [0035] The golf cup structure may include a flagstick mounting support. The golf cup structure may also include a load sensor for providing a measure of the mass of an object that enters the hole liner through the mouth. The golf cup structure may include a communication module for establishing a communication link between, at least, the camera and an external control unit.

[0036] The invention also provides a method of controlling and monitoring play by a golfer who strikes  
10 a golf ball at a launch area thereby to drive the golf ball from the launch area towards a golf cup in a target area, the method including the steps of:

- (1) establishing an identity for the golfer,
- (2) detecting at least one mark on a surface of the golf ball which is unique to the golf ball,
- (3) if a first-defined status prevails at the launch area and a second-defined status prevails at the  
15 target area then allowing the golfer to play the stroke at the launch area,
- (4) producing a first video recording at least of the golfer's stroke at the launch area,
- (5) producing at least one video recording of the target area including the golf cup, during a first defined time period which is dependent on the time of the golfer's stroke at the launch area, and
- (6) monitoring the golf cup to detect a status change of or in the golf cup during at least a second  
20 defined time period which is dependent on the time of the golfer's stroke at the launch area.

[0037] The invention may include the step of producing a video recording of, at least, the flight of the golf ball after the golfer's stroke at the launch area.

[0038] Each video recording should commence at the latest at the time the golfer plays the stroke. Preferably though each video recording commences before the stroke is played and continues thereafter for a time period which is long enough to ensure that movement of the golf ball (due to the stroke) has ceased, before the video recording terminates. Compliance with this requirement is achieved through the use of a centrally located timing mechanism that ensures that the operations of the video recordings are effectively and reliably synchronized.

[0039] The period of time taken by a golf ball to travel from the launch area to a location at or near the target area provides a useful and reliable control parameter and can be used to ensure authenticity of results. For example each target monitor could produce a video recording at least for a defined first time period after the stroke at the launch area. However, each video recording may extend from the time the ball is stroked at the launch area, or from some time instant before then. To ensure synchronous operation a timing arrangement may be initiated to ensure that video recordings are produced to cover all relevant time periods before, during and after a player's stroke, and to ensure that these video recording are made against a single time line.

[0040] The principles of the invention, which to a substantial extent are implemented through the use of timing and telemetry techniques for control and synchronization purposes, and through the use of camera and video machines for visible, reviewable record purposes can be used to monitor play by a single player at a single hole or at a plurality of holes, or play by a plurality of players at a single hole or at several holes or during regular or match play. The method can be implemented at one golf course or at each of a plurality of golf courses, during controlled, predetermined time periods to enable challenge events to be contested.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0041] The invention is further described by way of example with reference to the accompanying drawings in which :

- Figure 1 illustrates in perspective from above a single golf hole at a golf course at which the invention is  
5 implemented,
- Figure 2 depicts a launch monitor that is used at a launch area at the golf hole,
- Figure 3 depicts components of a golf ball identifier mechanism that is used in the invention,
- Figure 4 is an exploded view in perspective of components of a golf cup monitor used in the invention,
- Figure 5 is a block diagram representation of components included in the launch monitor of Figure 2,  
10 Figure 6 is a block diagram representation of components that are included in a target area monitor used in the invention,
- Figure 7 is a block diagram representation of components of a flight monitor that is used in implementing the invention,
- Figure 8 illustrates diagrammatically aspects of the golf ball identifier mechanism of Figure 3.
- 15 Figure 9 illustrates schematically various aspects of the golf cup monitor shown in Figure 4,
- Figure 10 is a block diagram representation of the system of the invention,
- Figure 11 illustrates steps which are carried out during the implementation of the method of the invention, before a golf stroke is played, and
- Figure 12 depicts steps that occur after a golf stroke has been played.

## 20 DESCRIPTION OF PREFERRED EMBODIMENTS

[0042] Figure 1 of the accompanying drawings illustrates in perspective and from above a portion of a golf hole or green 10 in which the system of the invention is implemented. The green is of a conventional construction and includes a tee-off location referred to herein as a launch area 12, a fairway 14 and a putting green which is referred to herein as a target area 16.

[0043] The target area 16, which is flanked by bunkers 18, contains a golf cup 20 which, in normal play, accommodates a flagstick 22.

[0044] The aforementioned aspects are conventional.

[0045] A launch monitor 30 is located at the launch area 12 and a first target monitor 32 and a flight  
5 monitor 34 are positioned at the target area 16.

[0046] Figure 2 illustrates external aspects of the launch monitor 30 while Figure 5 illustrates, in block diagram form, various components of the launch monitor.

[0047] The launch monitor 30 includes a housing 40 with a card-input slot 42, a control device 44, in  
10 this example in the form of a key-activated lock which can be used to put the launch monitor 30 into an operational condition or to place it in an inoperative condition, a viewing window or aperture 45 for a camera 46 (Figure 5), and an audio/visual display screen 50.

[0048] In this form of the invention the launch monitor 30 includes, as an integral element, a golf ball  
15 identifier mechanism 52 (not shown in Figure 5) but aspects of which are shown in Figure 3 and in Figure 8. It is convenient to provide the golf ball identifier mechanism 52 in combination with the launch monitor 30 but this is not essential. These elements could be provided as separate or stand-alone constructions.

[0049] The launch monitor 30 (see Figure 5) includes a processor 60, a GPS unit 62, a power supply  
20 64, a player identifier component 66, the camera 46 (already referred to), a memory unit 68 for data storage, an audio visual construction which includes a loudspeaker system 70 and which is coupled to the display screen 50, and a communication module 72 which includes a transmitter/receiver. An antenna 74 of the communication module 72 is embodied in the housing 40.

[0050] The player identifier component 66 is linked to the card-input slot 42. A player who wishes to participate in the system is beforehand issued with an encoded card or such credentials 320 that uniquely identify the player. This is exemplary only. In other forms of the invention use may for example be made of biometric techniques which validate a player's fingerprints or the player's iris or facial features, or the like.

[0051] The housing 40 is orientated so that the camera 46 faces directly onto the launch area 12 (Figure 1). The camera 46 is operable under the control of the processor 60 to record video images (moving images) and to supply a video feed to the memory unit 68 in which data pertaining to the images is stored. Additionally the video feed is routed via the processor 60 to the communication module 72 for transmission to a central control unit 80, referred to hereinafter with particular reference to Figure 10.

[0052] The GPS unit 62 provides precise geographical co-ordinates of the location of the launch monitor 30. This is to ensure that the launch monitor 30 can be used only at an authorized launch area. If the launch monitor 30 were to be placed at a different location it could not be placed into an operative condition without prior controlled authorization

[0053] As indicated, in this instance, the launch monitor 30 is provided integrally with the ball identifier mechanism 52 shown in Figures 3 and 8. The housing 40 has an inlet 84 to a conduit 86 that defines a golf ball path 88 on which a golf ball is guided for movement, inside the housing, and which terminates in an outlet 90 at a lower region of the housing. The conduit, inside the housing, is transparent or light transmissive. A golf ball 92 pushed into the inlet 84 is movable under gravity action through the conduit along the path 88 to the outlet 90. The mechanism 52 is used to establish a unique identity for a conventional golf ball 92 which a player might be using. This is an important feature of the invention in that there is no requirement for a dedicated or distinct golf ball, which might have been engineered for the purpose, to be used. The conduit 86, as shown in Figure 3, has at least two right angle bends 96

and 98 respectively. A marking device 100 is fixed to the conduit 86 at a strategic position at the bend 96, and a second marking device 102 is fixed to the conduit at the bend 98 at a strategic position (Figure 8).

**[0054]** The conduit 86 is configured so that the golf ball 92, moving under gravity action along the path 88, will strike the marker 100 and then move away from the marker 100 and then into contact with the marker 102, moving at all times under gravity action. The markers 100 and 102 are identical. Each marker 100, 102 includes a respective reservoir of fluorescent ink 104 and a pad 106 which is moistened by the ink. The pad 106 is positioned so that when the golf ball 92 impacts the pad 106, a quantity of fluorescent ink is transferred to an external surface of the golf ball 92. Movement of the golf ball 92 along the path 88, although dictated by gravity action, is in one respect random in that no control is exercised over which areas on the golf ball surface will strike the ink pads 106 of the markers 100 and 102.

**[0055]** Fluorescent light sources 110 and 112 are used to illuminate the golf ball path 88. Cameras 114 and 116 are positioned to produce video images on a continuous basis of the golf ball 92 during its passage along the path 88. The images that are produced by the cameras 114, 116 are applied to a processor 118 that makes use of appropriate software 120 to carry out a character recognition process which, without being restrictive, monitors practically all surface features on the golf ball surface. These features include, at least, the following: a manufacturer's markings, dimple shape and density on the golf ball surface, markings on the golf ball surface which may be due to external wear and tear, the fluorescent markings referred to, and the like. Of particular importance is that the software 120 is capable of distinguishing the size and shape of a mark on the golf ball surface and the position (spatial location) of a mark relative to any other mark on the golf ball surface. The data produced from this examination process is used as an identifier that in effect uniquely establishes the identity of the golf ball 92. Data pertaining to the golf ball's identity is stored in a memory 124.

[0056] As a further identification factor the mechanism 52 includes a temperature monitor 128 that detects the temperature of the golf ball 92 when it reaches the outlet 90. At this stage the golf ball 92 is momentarily held stationary and a load cell 130 is used to measure the mass of the golf ball 92. The mass and temperature measurements are loaded into the processor 118. Thereafter the golf ball 92 is released from the outlet 90 by the action of a solenoid 132 and falls into a cage 134, see Figures 2 and 3, so that the golfer can collect the golf ball 92.

[0057] Data collected by the golf ball identifier mechanism 52 can be transmitted to the central control unit 80 (Figure 10) via a communication module 138. Similarly, data can be transmitted from the central control unit 80 to a receiving element in the module 138. In this way effective control over the operation of the golf ball identifier mechanism 52 can be exercised from a central location.

[0058] The golf ball identifier mechanism 52 can include an on-board power supply (not shown) or can be powered from the supply 64 shown in Figure 5.

[0059] The target area monitor 32 shown in Figure 1 has several similarities to the launch monitor 30. Components of the target area monitor 32 are shown in block diagram form in Figure 6. The monitor 32 includes a power supply 150, a processor 152 which works under the control of software 154, a memory module 159 which is used for the storage of data supplied to or collected by the monitor 32, a GPS unit 158, a communication module 160 which is connected to an appropriate antenna 162, and at least one video camera 164. The target area monitor 32 is orientated so that the camera 164 faces the target area 16 but it is positioned so that it cannot interfere with normal play at the target area 16. The various components shown in Figure 6 are mounted inside a housing 170. The camera 164, under the control of the processor 152, produces a constant video recordal of images of events that take place in the locality of the target area 16.

[0060] The invention optionally includes a second target area monitor 32A that is not shown in Figure 1. For practical purposes the second target area monitor 32A is identical to the monitor 32 and for this reason its construction is not further described.

[0061] The invention preferably makes use of the flight monitor 34. In Figure 1 the flight monitor 34 is shown attached to the target area monitor 32. This is convenient but it is not necessarily the case. The purpose of the flight monitor 34 is to record, as far as is possible, an image of the movement of a golf ball 92, in flight, as it leaves the launch area 12 and travels towards the target area 16. For this reason, see Figure 7, at least a camera 190 of the flight monitor 34 is positioned at an elevated location and is angled to follow what would be a normal trajectory of a golf ball leaving the launch area 12 and travelling towards the target area 16. The flight monitor 34 includes a power supply 192 although, if the flight monitor 34 is provided in combination with the target area monitor 32 the flight monitor 34 could make use of the power supply 150.

[0062] The monitor 34 further includes a processor 194 which works under the control of software 196, a GPS unit 198, a data storage module 200 and a communication structure 202 which includes a transmit and receive facility and which is connected to an antenna 204.

[0063] As indicated the camera 190 is directed generally towards the launch area 12 but specifically towards a space above and adjacent the target area 16, including a location at which the golf cup 20 is mounted.

[0064] Positioned inside the golf cup 20 is a golf cup monitor 220, see Figures 4 and 9. The golf cup monitor 220 includes a tubular hole liner 222 which has a mouth 224. Internal dimensions of the hole liner 222 comply with standard specifications of a golf cup. The liner 222 is located in a hole 226 in the ground 228 at the target area 16.



[0065] The golf cup monitor 220 includes a transparent base 230 which has a centrally positioned formation 232 which receives a flagstick 22 with a ferrule 234 secured to the base 236 of the flagstick 22 shown in Figure 1. A disc 240 that, in use, is positioned below the base 230, accommodates a lens assembly or focal section 242 of a digital camera 244 which is mounted to a board 246 which, in use, is located inside the disc 240. Electronic components in the golf cup monitor 220 are protected against the effects of weather and, in particular, against the ingress of moisture (rain or irrigation water) which might enter the golf liner.

[0066] The camera 244 faces upwardly and, working in conjunction with the lens assembly 242 can monitor events that take place above the transparent base 230 generally within the confines of the surrounding liner 222.

[0067] A battery 248 powers the electronic components in the golf cup monitor 220. Apart from the camera 244 these components include a load cell 250, a sensor 252, a processor 254 which is connected to a memory unit 256, a GPS unit 258, and a transmitter/receiver 260 that is connected to an antenna 262. Software 264 is used to control the functioning of the processor 254.

[0068] The load sensor 250 is responsive to the effect of a mass of an object coming into contact with an upper surface 266 of the transparent base 230. The sensor 252 is used to detect a characteristic of a golf ball 92 which enters the liner 222 through its mouth 224 and, in one embodiment, comprises a temperature sensor which detects and measures the temperature of a golf ball 92 entering the liner 222.

[0069] Figure 10 is a block diagram representation of a system 280, according to the invention, for evaluating a golfer's claim of a single stroke achievement such as a hole-in-one, a nearest-to-the-pin stroke, or any other single stroke performance that might be achieved or carried out at the golf green shown in Figure 1. The system 280 includes the central control unit 80, already referred to, the launch

area monitor 20, the golf ball identifier mechanism 52, the target area monitor 32, optionally the second target area monitor 32A, the flight monitor 34 and the golf cup monitor 220.

5 [0070] The central control unit 80 includes a processor 290, a power supply 292, a memory module 294, controlling software 296 which regulates the operation of the processor 290, a GPS unit 298 which provides accurate geographical co-ordinates of the location of the central control unit 280, a communication module 300 and a timer 302.

10 [0071] Figure 11 illustrates in diagram form steps that are carried out during the implementation of the method of the invention before a golf stroke is played. Figure 12 depicts, in similar form, steps that occur after a stroke is played. These Figures are largely self-explanatory and thus are not described in detail hereinafter.

15 [0072] An inspection of Figure 11 shows that preliminary stages carried out before the striking of a golf ball include a player identification stage 310, a golf ball identification stage 312, a stage 314 in which the status of the golf ball 92 and of the golf cup 20 are assessed, and a stage 316 in which the status of the target area is assessed and which is implemented subject to clearance of the stages 310, 312 and 314.

[0073] In the stage 310 a player 318 presents his credentials 320 using the slot 42 (Figure 2) to enable the player's identity to be established. If this exercise is properly carried out and validated then a play session is initiated ( block 322).

20 [0074] The player 318 is then requested to present a golf ball 92 to the golf ball identification mechanism 52 (Figures 3 and 8). The golf ball 92 is placed in the inlet 84 and passes along the path 88. During this passage data pertaining to the identity of the golf ball 92, which is a standard golf ball, is detected and recorded in the memory 124. A test is done to ensure that the golf ball 92 is not already in use (block 326).

[0075] The camera 46 in the launch monitor 30 records video footage of the player 318 after player identification has been successfully carried out in the stage 310. The central control unit 80 then requests the golf ball's 92 status and identity in the stage 312. If the resulting report indicates that the golf ball 92 in question is already in use i.e. it has a signature similar to that of a recently scanned golf ball, then the player 318 is asked to replace the golf ball 92 and to repeat the scanning/identification stage 312 process.

[0076] If all is clear then the stage 314 is implemented. The central control unit 80 transmits a signal to the golf cup monitor 220 to establish its status (no golf ball in the cup) and to ensure that it is open for play. The presence of the flagstick 22 is also detected by the software 264 that processes images produced by the upwardly facing camera 244. If all is clear then the golfer 318 is notified that play can continue. Non-compliance with any of these predetermined situations leads to a disallowed condition.

[0077] The central control unit 80 then requests a status check from the first target area monitor 32, the second target area monitor 32A (if used) and the flight monitor 34. In essence these monitors must reflect operationally sound conditions, and must show, at least, the target area 16 to be cleared of personnel.

[0078] All relevant data on the identity of the golf ball 92, the status of the golf cup monitor 220, the status prevailing at the target area 16 and on the identity of the player 318 is recorded in the memory 294 of the central control unit 80.

[0079] The player 318 is thereafter asked to play a stroke (block 340). Conveniently this is done by an announcement on the loudspeaker system 70 and by a corresponding message that is presented on the visual display 50. The monitors 20, 32, 32A, 34 and 220 remain in constant operation and continuously monitor (block 341) all relevant aspects to determine any change of status which could affect the integrity of the authentication system. Video footage of all observation areas is obtained, recorded and transmitted, as appropriate, to the central control unit 80 for storage in the memory 294.

All events are time logged through the use of the timer 302. Thus a time base is kept for each video recording. These recordings cover events at the launch area 12, the flight of the ball 92 (via the monitor 34), the arrival of the ball at the target area 16 (the monitors 32 and 32A) and entry of the ball 92 (if this occurs) into the golf cup 20 (by means of the camera 244).

5 [0080] If the player 318 has completed his stroke his credentials 320 are withdrawn and all monitor units are asked to report any status changes that may have occurred. For example, if a golf ball 92 has entered the golf cup 20 and has been detected by the golf cup monitor 220 then the golf ball 92 is subjected to a golf ball identification process by the golf cup monitor 220 and a comparison is made of the signature of the golf ball 92 previously recorded by the golf ball identity mechanism 52 and of the  
10 signature of the newly arrived golf ball now identified by the golf cup monitor 220.

[0081] If the signature i.e. the identity, of the golf ball 92 is confirmed, then a hole-in-one is assumed.

[0082] If a hole-in-one was not achieved but a golf ball 92 is detected in the target area 16 then a comparison is made of the signature of the golf ball 92 previously recorded in the golf ball identity mechanism 52 and of the signature of the newly arrived golf ball in the target area 16. The target area  
15 monitors 32 and 32A are used to obtain a measure of the distance of the newly arrived golf ball 92 from the golf cup e.g. in a nearest-to-the-pin competition. This measurement can be done electronically using data produced by the cameras of the target area monitors 32 and 32A.

[0083] All relevant data is transmitted using suitable telemetry techniques to, and then stored in, the memory module 294.

20 [0084] After play by a particular golfer the determined result of the player's stroke can be broadcast to a number of parties using any suitable network or protocol. The forensic evidence collected by the system, and the observation data such as video and audio data, golf ball mass, golf ball temperature

and the like, can be made available for public or private screening according to requirement or fed to a broadcasting authority for viewer consumption and public scrutiny.

[0085] A particular benefit of the invention lies in its capability to associate a unique identifier with a conventional golf ball. There is no requirement to fabricate or engineer a golf ball that can be used in a hole-in-one competition, for example. Player identity is also of cardinal importance. A full visual and, where appropriate, an audio, record is kept of all relevant events preceding a stroke, during a stroke, and thereafter. All data recorded is time and date stamped through the use of the timer 302 at the central control unit 80. Given that the flight of a golf ball from the launch area 12 to the target area 16 must occur within predetermined time the video records which are taken by the target area monitors 32 and 32A, by the flight monitor 34, and where applicable by the camera in the golf cup monitor, must fall into particular time slots in order for a genuine hole-in-one achievement to be validated. The system is effectively automatically implemented and although the launch monitor 30 and the target area monitors 32, 32A are visible they are not obtrusive. The effect of human intervention is minimized for the need for a human observer at the launch area 12 and at the target area 16 is obviated.

[0086] If a golfer succeeds with a hole-in-one or a similar single stroke achievement then the arrival of a golf ball 92 in the golf cup 20 within a predetermined time period after the golf stroke was played, is a first indicator of success. However, a validation process is thereafter carried out in that the identity of the golf ball in the golf cup must be matched to the identity of the golf ball that was presented to the golf ball identity mechanism 52. Also, the video recordings of all relevant events can be scrutinized by a public audience to ensure that nothing untoward took place.

[0087] Figure 12, which is largely self-explanatory, depicts events which could occur after play of a golf stroke at the launch area 12. Thus in a stage 340 the status of the golf cup monitor is evaluated. Golf ball identification techniques are carried out, when necessary, in a stage 342. All results are

evaluated (344) and stored (346) as necessary, and publication (348) of relevant results occurs in any of the indicated manners.

CLAIMS

1. A system of monitoring a stroke by a golfer who, with the stroke, drives a golf ball from a launch area towards a golf cup in a target area, the system including:
- 5 (i) a golf ball identifier mechanism for detecting and recording at least one mark on a surface of the golf ball which is unique to the golf ball,
- (ii) a launch monitor which produces at least a video recording of the stroke at the launch area,
- (iii) at least one target monitor which produces at least a video recording of the target area, including the golf cup, at least for a defined first time period which is dependent on the time of  
10 the stroke at the launch area, and
- (iv) a golf cup monitor at the target area which detects a status change of or in the golf cup, or which produces at least one image of a status change of or in the golf cup.
2. A system according to claim 1 which includes a flight monitor which produces a video recording, at least, of a space above and adjacent the target area, and of the target area, at least for a defined  
15 second time period which is dependent on the time of the stroke at the launch area.
3. A system according to claim 1 which includes a timing arrangement for controlling operation of, at least, the launch monitor, the target monitor and the golf cup monitor according to a predetermined timing schedule.
4. A system according to claim 1 that includes a timing arrangement for recording on a time basis  
20 operation of at least the launch monitor, the target monitor and the golf cup monitor.
5. A system according to claim 1 wherein the launch monitor includes at least one camera that produces a video feed for a video recorder.

6. A system according to claim 5 wherein the launch monitor includes a global positioning system (GPS) unit.
7. A system according to claim 5 wherein the launch monitor includes a storage unit for storing, at least, data relating to the video feed.
- 5 8. A system according to claim 1 which includes a central control unit and respective communication links between the launch monitor and the central control unit, the target monitor and the central control unit, and the golf cup monitor and the central control unit.
9. A system according to claim 8 that includes a communication link between the golf ball identifier mechanism and the central control unit.
- 10 10. A system according to claim 2 that includes a central control unit and a communication link between the central control unit and the flight monitor.
11. A system of monitoring a stroke by a golfer who, with the stroke, drives a golf ball from a launch area towards a golf cup in a target area, the system including:
- (i) a device for recording the identity of the golfer;
  - 15 (ii) a mechanism for recording the identity of the golf ball, and
  - (iii) at least one monitor for producing at least one video recording of the stroke, the launch area and the target area for a time period which is dependent on the time of the stroke.
12. A golf ball identifier mechanism which includes structure defining a golf ball path, an inlet to the golf ball path, an outlet from the golf ball path, and at least one sensor positioned to detect at least one  
20 mark on a surface of the golf ball as it moves along the golf ball path from the inlet to the outlet.

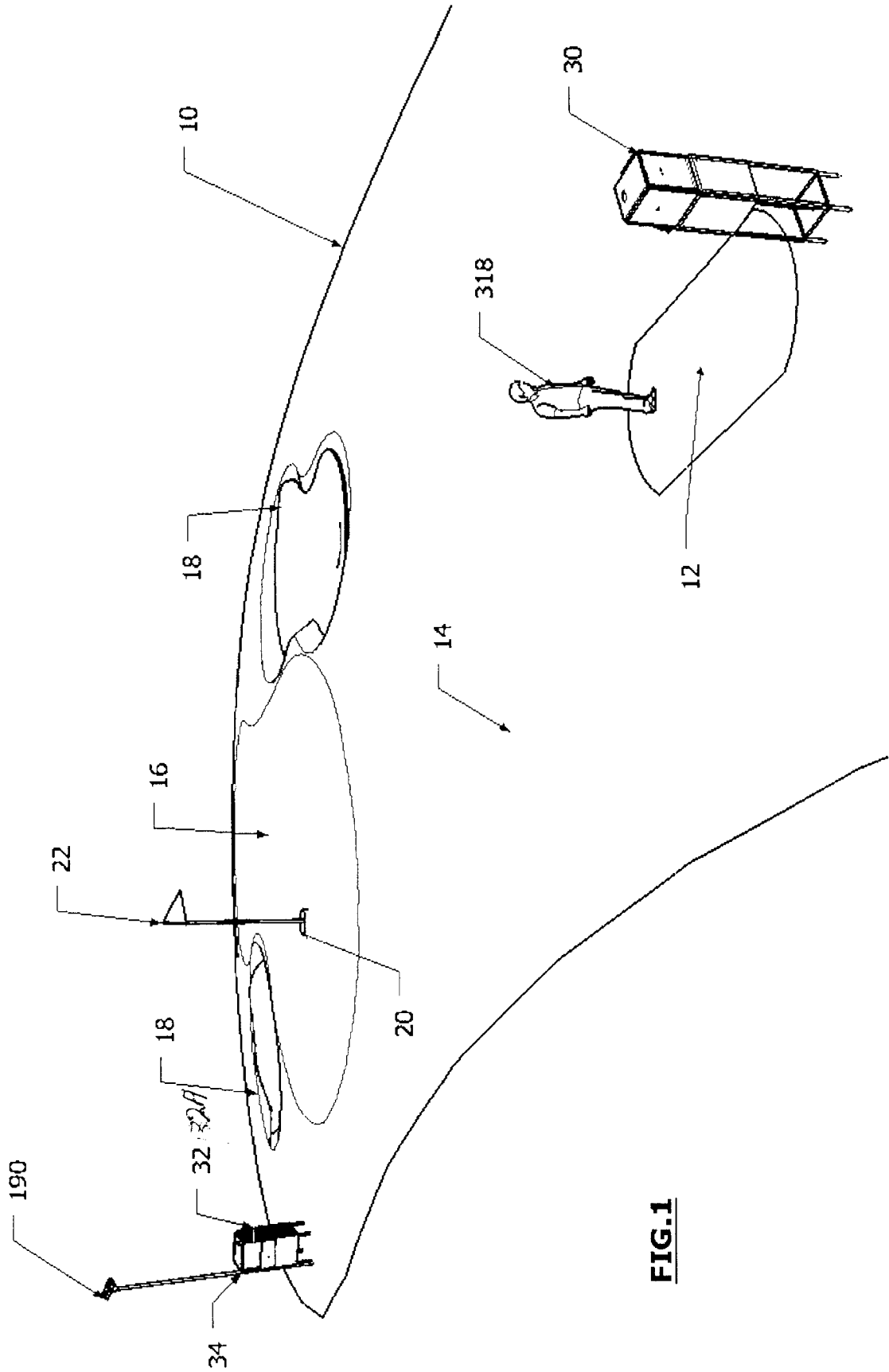


13. A golf ball identifier mechanism according to claim 12 which includes at least one marking device and wherein the golf ball path is configured to direct the golf ball as it moves along the golf ball path into contact with the marking device whereby the marking device imparts an identifier mark to the surface of the golf ball.
- 5 14. A golf ball identifier mechanism according to claim 12 wherein the at least one sensor is responsive to at least one mark on the surface of the golf ball, which mark is selected from the following: a dimple arrangement on the golf ball surface, a manufacturer's marking on the golf ball surface, a spatial relationship between a manufacturer's marking and a dimple arrangement on the golf ball surface, wear and tear marks on the golf ball surface, and at least one identifier mark which is  
10 applied to the golf ball surface as it traverses the golf ball path moving from the inlet to the outlet.
15. A golf ball identifier mechanism according to claim 12 that includes a sensor arrangement for determining at least one of the following: the mass of the golf ball, the volume of the golf ball, and the density of the golf ball.
16. A golf ball identifier mechanism which includes at least one sensor for detecting at least one  
15 mark on, or for recording an image of at least a part of, a surface of the golf ball, and a storage device for storing data, related to such detection, produced by the sensor.
17. A golf ball identifier mechanism according to claim 16 which includes at least one marking device for applying at least one identification mark to the surface of the golf ball.
18. A golf ball identifier mechanism according to claim 17 wherein the at least one identification  
20 mark is applied to the surface at a random location on the surface.
19. A golf ball identifier mechanism according to claim 17 or 18 wherein the at least one identification mark differs from an identification mark applied to any other golf ball by the marking device.

20. A golf cup structure which includes a hole liner with a mouth and a camera which in use is positioned below the mouth of the liner and which is orientated for producing a video record of events above the camera.
21. A golf cup structure according to claim 20 that includes a transparent partition between the camera and at least part of the hole liner.
22. A golf cup structure according to claim 20 that includes a flagstick mounting support.
23. A golf cup structure according to claim 20 that includes a load sensor for providing a measure of the mass of an object that enters the hole liner.
24. A golf cup structure according to claim 20 that includes a communication module for establishing a communication link between, at least, the camera and an external control unit.
25. A method of controlling and monitoring play by a golfer who strikes a golf ball at a launch area thereby to drive the golf ball from the launch area towards a golf cup in a target area, the method including the steps of:
- (i) establishing an identity for the golfer;
  - (ii) detecting at least one mark on a surface of the golf ball which is unique to the golf ball;
  - (iii) if a first defined status prevails at the launch area and a second defined status prevails at the target area then allowing the golfer to play the stroke at the launch area;
  - (iv) producing a first video recording at least of the golfer's stroke at the launch area;
  - (v) producing a second video recording of the target area, including the golf cup, during a first defined time period which is dependent on the time of the golfer's stroke at the launch area.
- and

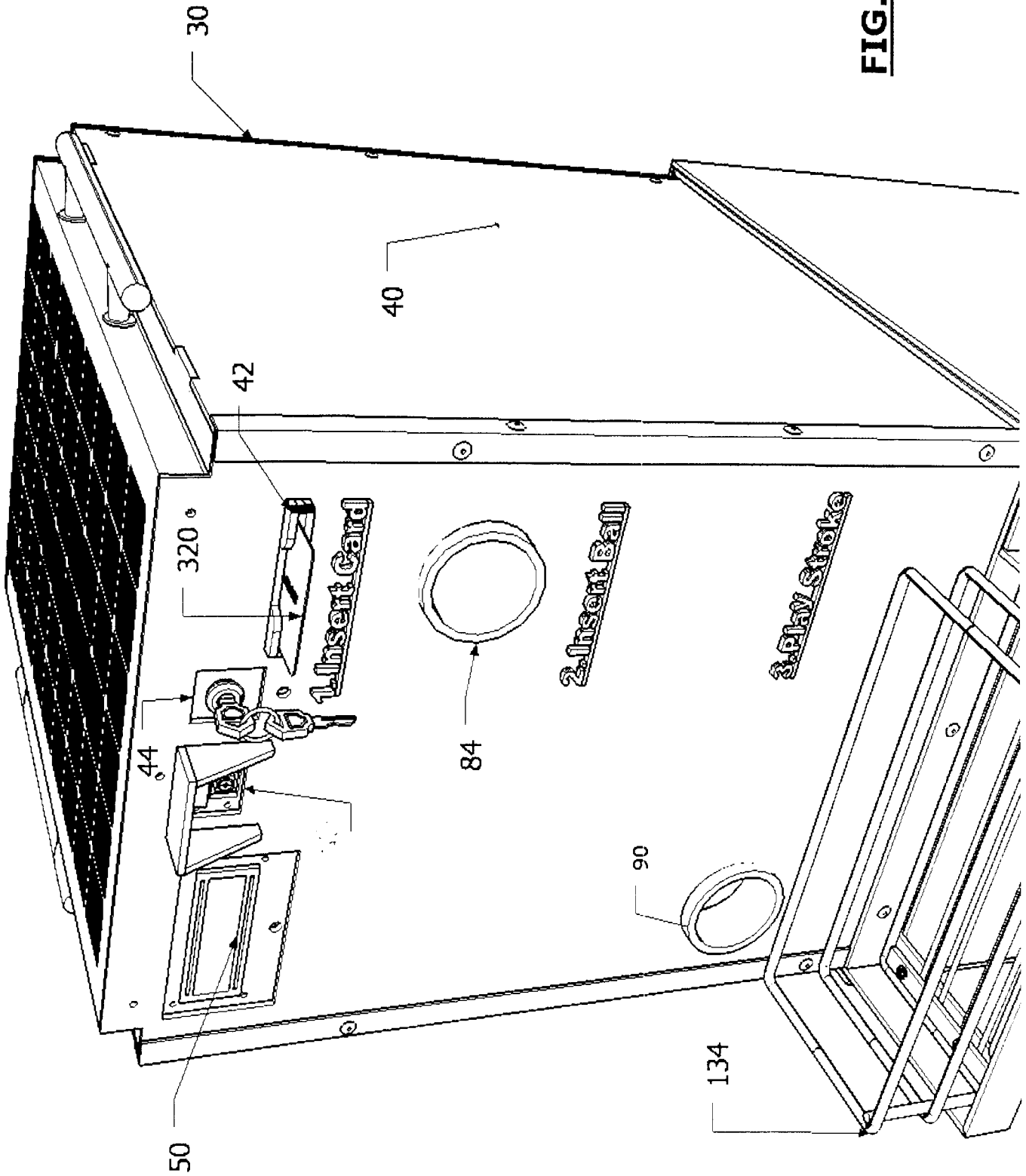
(vi) monitoring the golf cup to detect a status change of or in the golf cup during at least a second defined time period which is dependent on the time of the golfer's stroke at the launch area.

26. A method according to claim 25 which includes the step of monitoring the target area to detect a status change of or in the target area during at least a third defined time period which is dependent on the time of the golfer's stroke at the launch area.
- 5

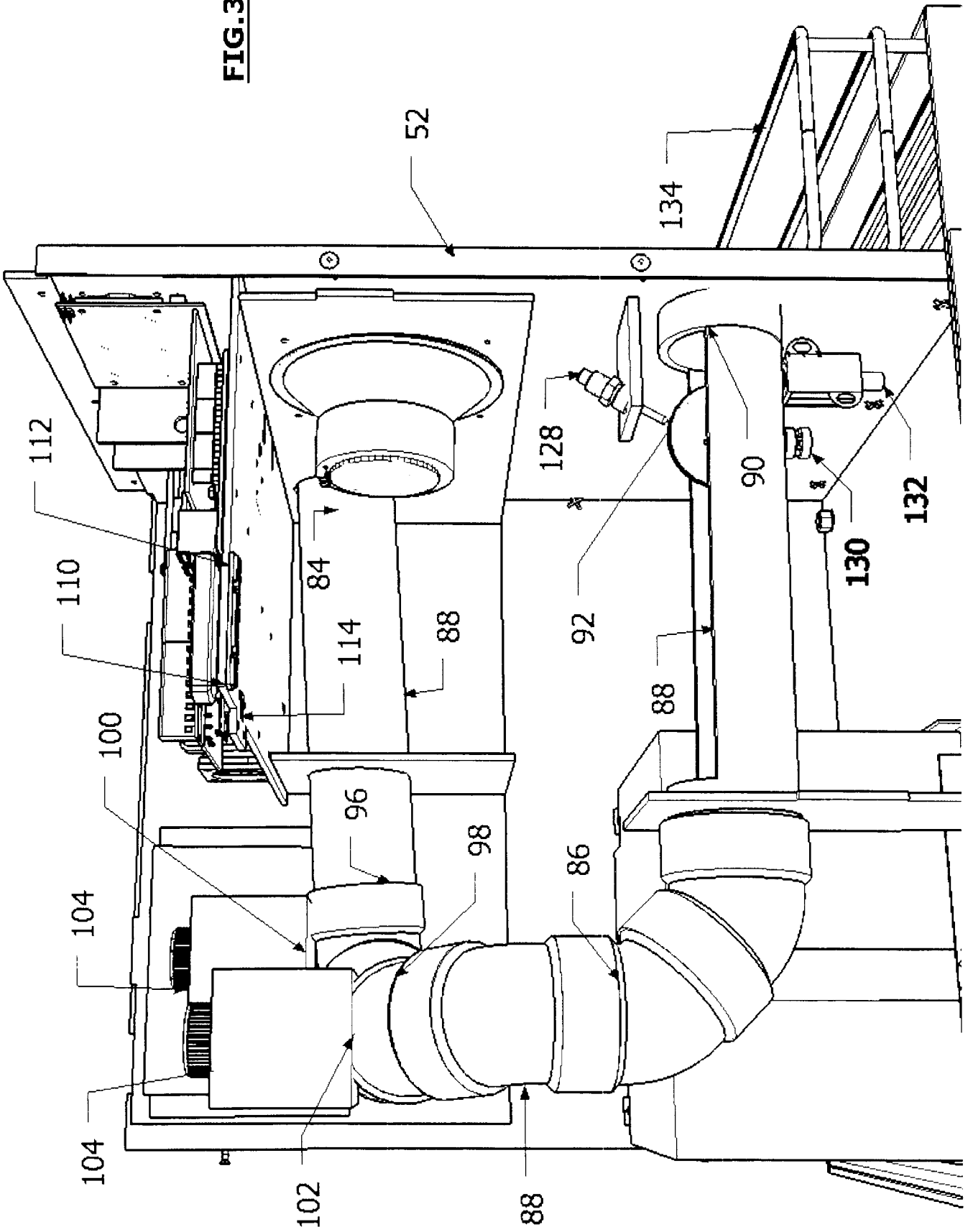


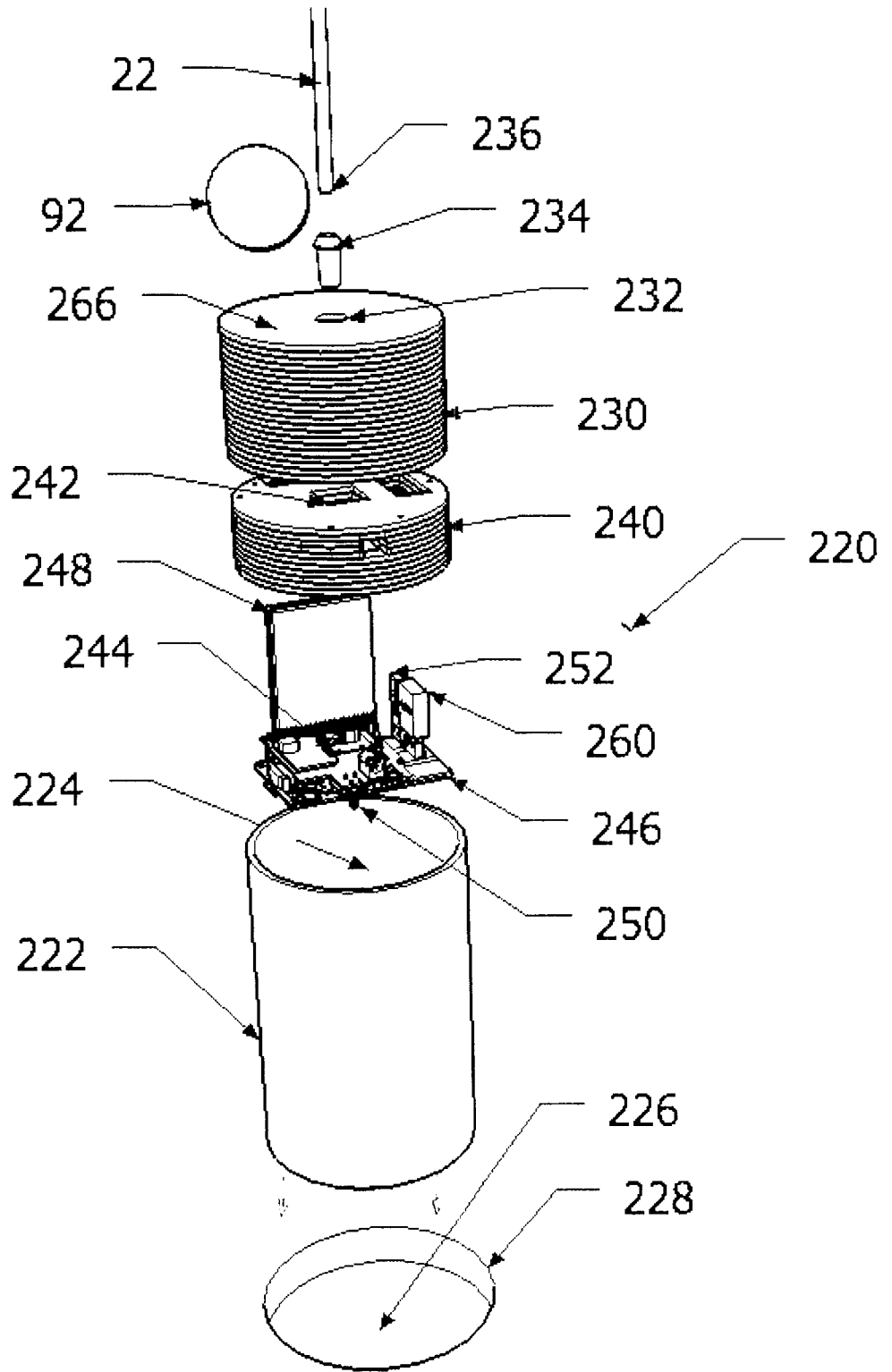
**FIG. 1**

**FIG. 2**

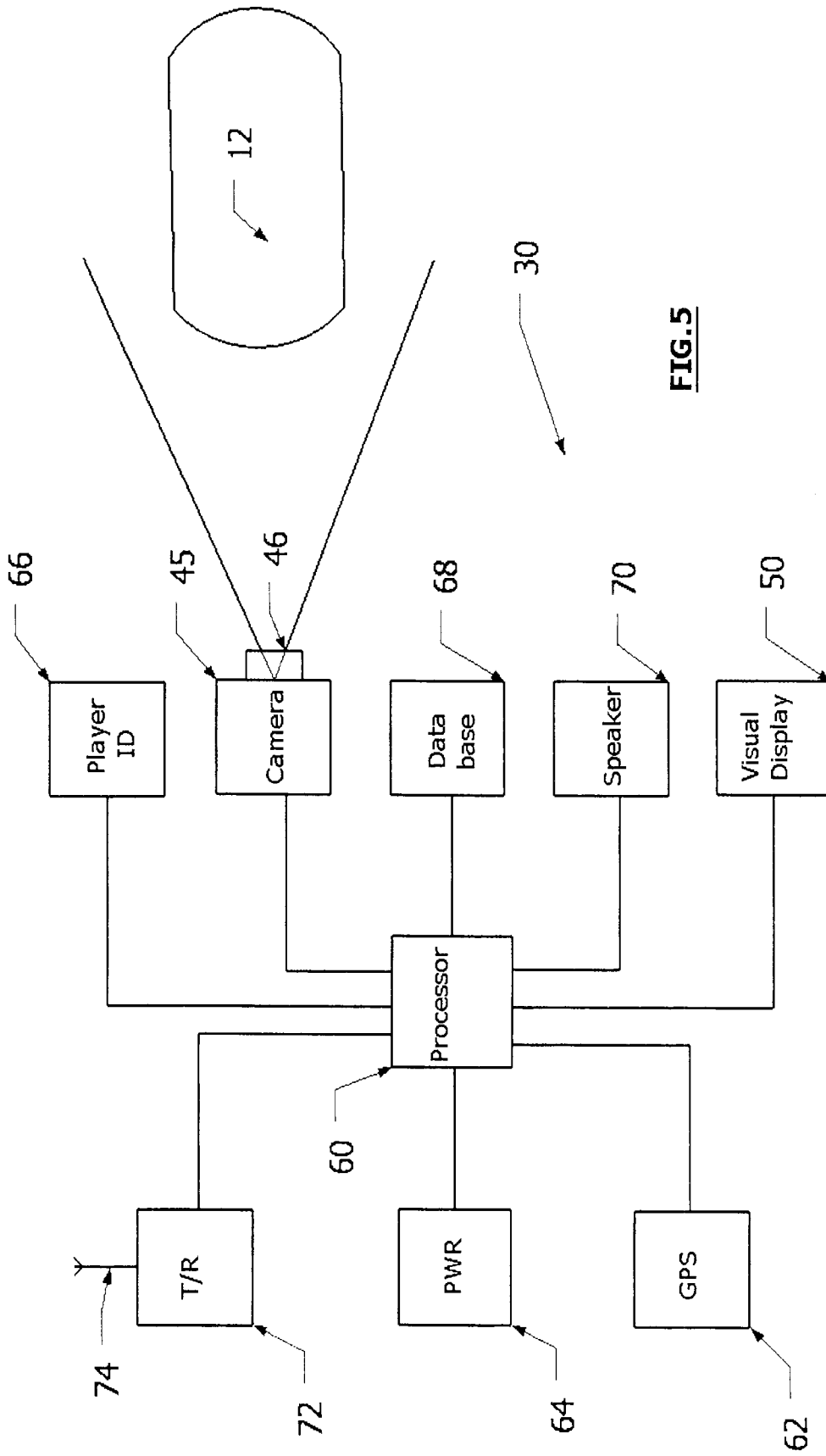


**FIG. 3**



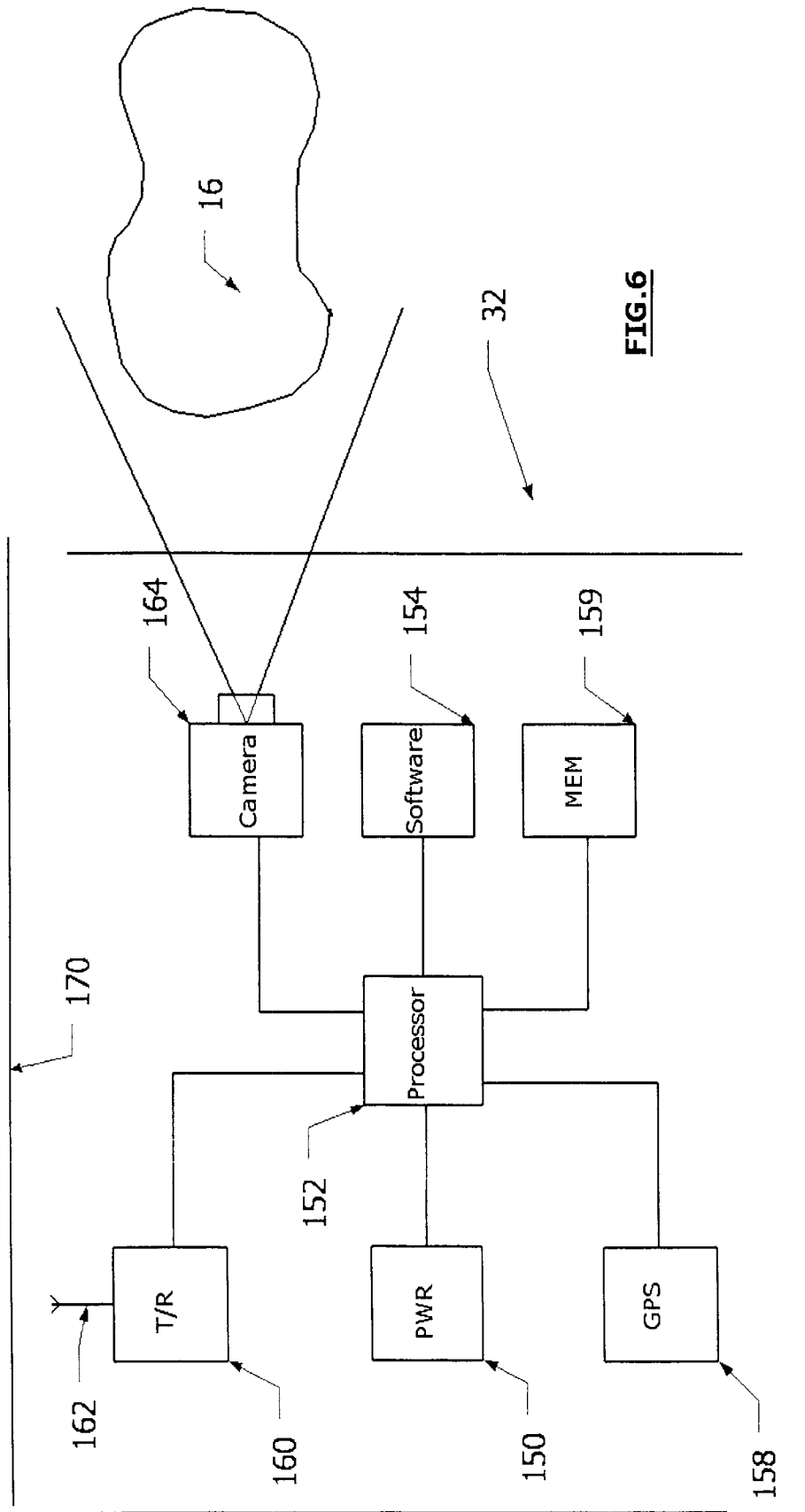


**FIG.4**

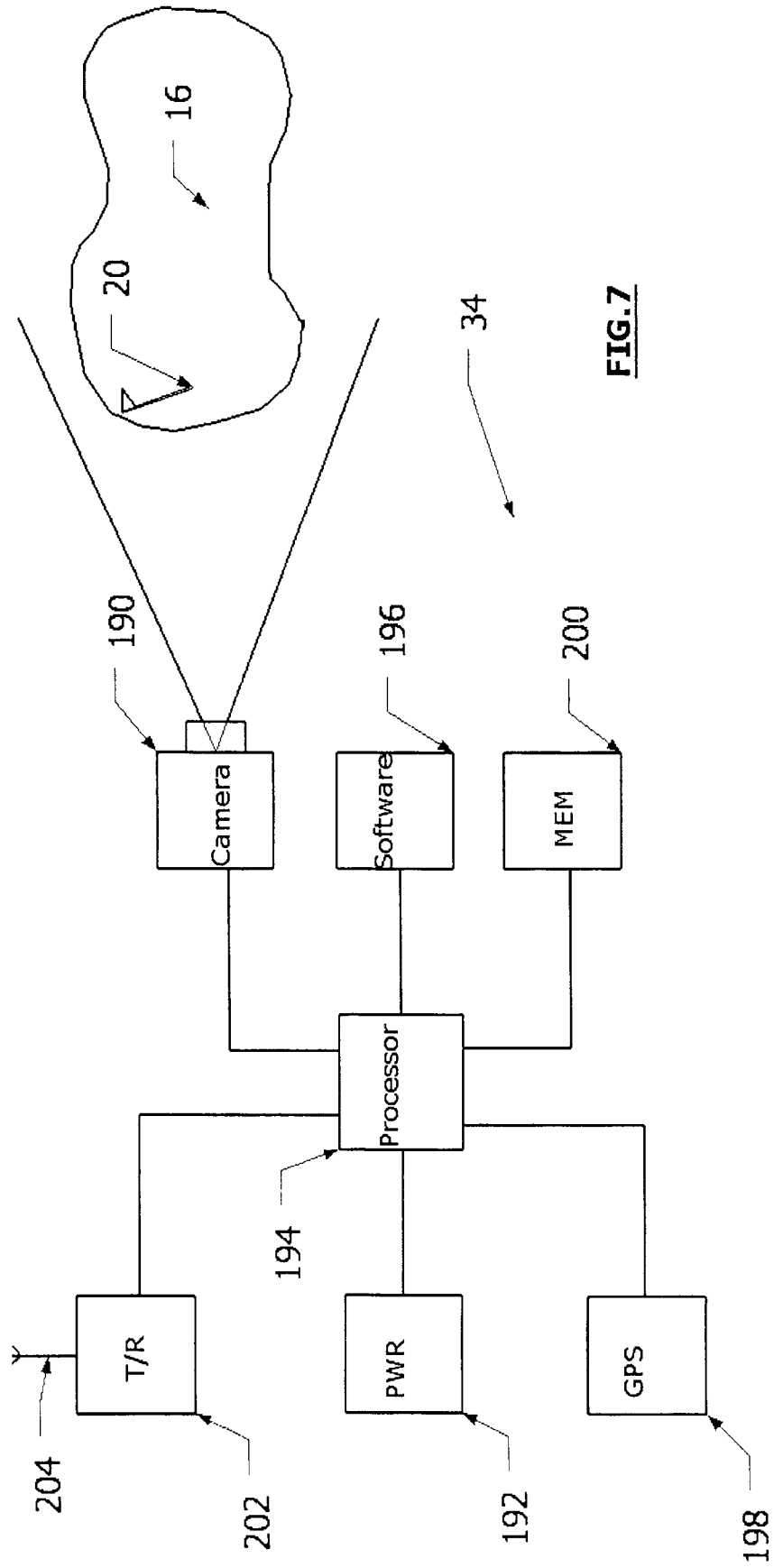


**FIG.5**



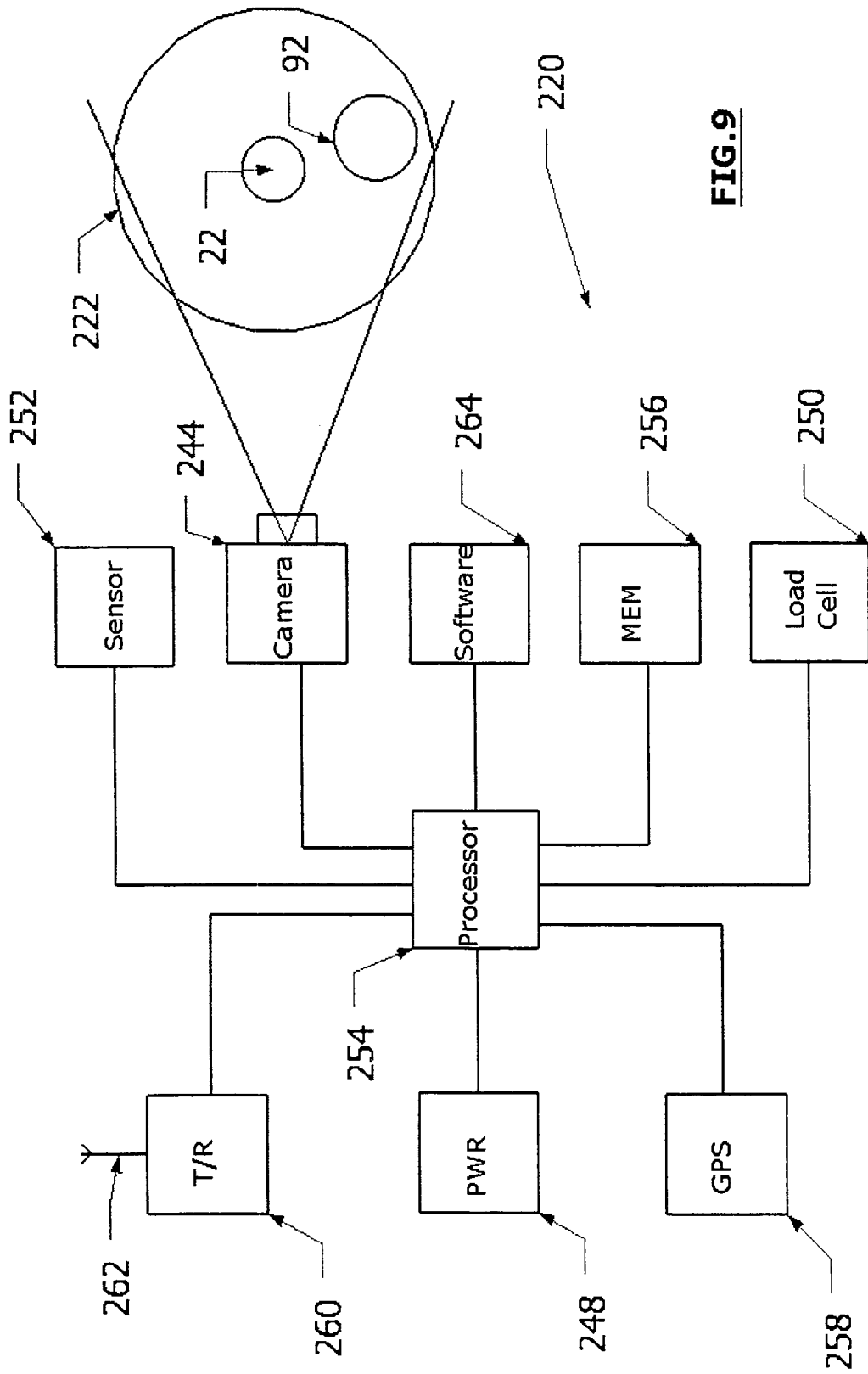


**FIG. 6**



**FIG.7**





**FIG. 9**

**FIG. 10**

