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(71) Applicant *(for all designated States except US)*: **PURE GAME SOLUTIONS LTD** [IL/IL]; Kibbutz Magal, 38845 D.N Hefer 38845 (IL).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **LIDOR, Noam** [IL/IL]; Kibbutz Magal, 38845 D.N Hefer (IL). **LEKACH, Ori** [IL/IL]; Kibbutz Givat Haim Meuhad, 38930 Givat Haim Meuhad (IL). **STERN, Tal** [IL/IL]; Kibbutz Givat Haim Meuhad, 38930 Givat Haim Meuhad (IL). **CHEN, Yoav** [IL/IL]; Kibbutz Givat Haim Meuhad, 38930 Givat Haim Meuhad (IL).

(74) Agent: **REINHOLD COHN AND PARTNERS**; P.O. Box 13239, 61131 Tel Aviv (IL).

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(54) **Title**: SPORTS TIMEKEEPING SYSTEM

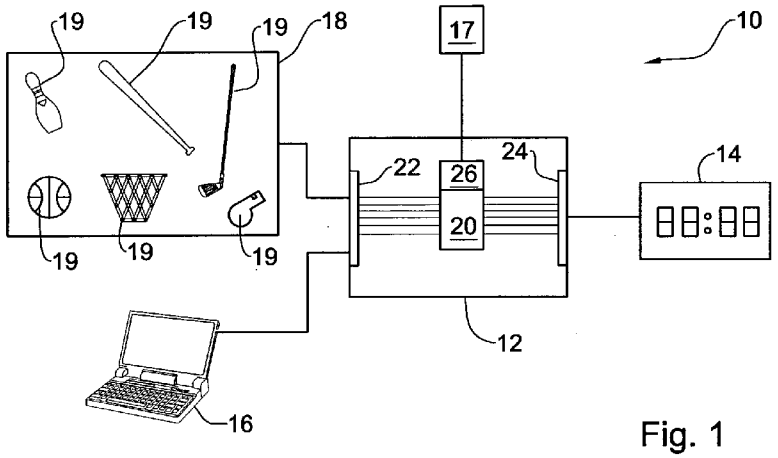

Fig. 1

(57) **Abstract**: A system configured for facilitating timekeeping during the sports game is provided, comprising one or more sensors, a clock configured to display time during the game, and a controller. The sensors are each configured to sense a predefined signal associated with one or more game events during the sports game. The controller is configured to receive information from the sensors regarding a sensed signal, to determine, at least based on the information, that a game event has occurred, and to interface with the clock and control the running thereof, at least in response to the determination of a game event.

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SPORTS TIMEKEEPING SYSTEM

FIELD OF THE INVENTION

This invention relates to game and sports equipment, and in particular to equipment related to timekeeping.

BACKGROUND OF THE INVENTION

In many timed sports, seconds and even fractions of a second become critical for the final outcome of the game. For example, in basketball, a goal which may determine the outcome may be achieved very close to the end of the game, and whether or not it was achieved within regulation time becomes a critical determination. Thus, referees and other game officials must observe the game extremely closely, and often must resort to a video replay to arrive at the correct determination. Even so, the human eye is limited with respect to the precision with which it can make such a determination.

SUMMARY OF THE INVENTION

According to one aspect of the present invention, there is provided a system comprising:

- one or more sensors, each configured to sense a predefined signal associated with one or more game events during a sports game;
- a clock configured to display time during the game; and
- a controller configured to:
    - receive information from the sensors regarding a sensed signal;

- determine, at least based on the information, that a game event has occurred; and
- interface with the clock and control the running thereof, at least in response to the determination of a game event;

wherein the system is configured for facilitating timekeeping during the sports game.

It will be appreciated that herein the specification and claims, the term "game event" refers to any event during the game which affects the clock or score, for example an inbound pass, a goal, an out-of-bounds, the release of a ball, the blowing of a whistle, etc.

One or more of the sensors may be:

- integrated with equipment configured for use in playing the game; and
- configured for detecting a game event associated with the equipment.

The sports game may be basketball. The equipment may comprise a goal, a game event associated with the goal being achieving a score. The goal may comprise a backboard, a rim, a net, and at least two of the sensors constituting goal sensors. The controller may be configured to determine that a score has occurred when the at least two sensors sense a signal in a predetermined sequence.

In particular, the goal may comprise:

- a first goal sensor configured to sense a signal associated with the game ball approaching the backboard;
- a second goal sensor configured to sense a signal associated with the game ball passing through the rim; and
- a third goal sensor configured to sense a signal associated with the game ball passing through the net;

the controller being configured to determine that a score has occurred when:

- the first goal sensor senses the signal before the second goal sensor senses the signal; and
- the second goal sensor senses the signal before the third goal sensor senses the signal.

The equipment may further comprise a ball. The ball may comprise one of the sensors constituting a ball sensor, the ball sensor being configured to sense contact or an impact with a foreign object. The ball sensor may comprise a pressure sensor configured to sense a change in internal pressure of the ball. The ball sensor may alternatively or additionally comprise a piezoelectric grid configured to detect changes in the shape of the ball.

The controller may be configured to determine the type of game event associated with the signal sensed by the ball sensor at least partially based on the magnitude thereof.

The ball may further comprise a wireless transceiver to pass information from the ball sensor to the controller. It will be appreciated that herein the specification and claims, the term "transceiver" is used in its broadest sense, including elements configured to both transmit and receive a signal, or only to perform one of those functions.

The equipment may further comprise a whistle. The whistle may comprise one of the sensors constituting a whistle sensor, the whistle sensor being configured to sense a blowing of the whistle.

The equipment may further comprise a court surface. The court surface may comprise one or more of the sensors constituting court sensors, the court sensors being configured to sense impact thereon of one or more of a ball and a player.

The court sensor may be configured to sense the location thereon of the one or more of a ball and a player.

The system may further comprise a video system in communication with the controller, the video system being configured to synchronize video

information of the sports game with game events determined by the controller. The video information may comprise a recorded video of at least a portion of the game.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to understand the invention and to see how it may be carried out in practice, embodiments will now be described, by way of non-limiting examples only, with reference to the accompanying drawings, in which:

Fig. 1 is a schematic illustration of a system according to the present invention;

Figs. 2A through **2C** are cross-sectional views of different examples of a ball of the system illustrated in Fig. 1;

Fig. 3 illustrates a goal of the system illustrated in Fig. 1;

Fig. 4 is a cross-sectional view of a whistle of the system illustrated in Fig. 1;

Fig. 5 illustrates court sensors of the system illustrated in Fig. 1;

Fig. 6 illustrates a video screen for use with the system illustrated in Fig. 1; and

Fig. 7 illustrates a data presentation unit for use with the system illustrated in Fig. 1.

DETAILED DESCRIPTION OF EMBODIMENTS

As schematically illustrated in Fig. 1, there is provided a system **10** for facilitating automated or semi-automated timekeeping in a sports match or game. The system comprises a controller **12** in communication with a clock **14** configured to display time during the game, at least one user (e.g., timekeeper) interface **16**, one or more articles of equipment **18** used for playing the match or game, and optionally one or more auxiliary sensors **17**. The equipment **18** is provided with sensors (schematically indicated by **19**) integrated therewith and

configured to sense a predefined signal associated with one or more game events, or a game event associated with the equipment, associated with its respective piece of equipment, during the sports game. Lines of communication indicated in Fig. 1 by solid lines may be embodied by wired or wireless connections, as are well known in the art.

The controller **12** is configured to receive instructions and/or signals from the user interface **16** and equipment **18**, and to control the operation of the clock **14**, at least partially based on the instructions/signals. Thus, it comprises a main processor **20**, an input interface **22**, and a command interface **24**.

The main processor **20** is configured to determine, based at least partially on information received, that a game event has occurred, and interface with the clock **14**, e.g., to start and/or stop it, based at least in response to the determination of a game event. In addition, it may comprise the main clock functionality, with the clock **14** itself constituting a "dumb" data presentation unit (i.e., circuitry or computer code to control the timekeeping functionality may be present in the main processor, with the clock **14** simply displaying time as determined by the main processor). The main processor **20** may comprise any suitable processor, and may have instructions hard-coded therein, or comprise a memory module **26**, such as flash or any other volatile memory device, associated therewith and containing appropriate instructions. It will be appreciated that the main processor **20** and the memory module **26** may be formed on a single integrated circuit.

The input interface **22** is configured to accept and optionally parse input received from the user interface **16** and equipment **18**, and pass it to the main processer **20**. Thus, it may comprise interfaces for wired and/or wireless connections. In addition, it may comprise an interface hardwired with the user interface **16**, for example if the user interface and main processor **20** are contained within a single unit. In addition to being designed for accepting input, it may be further configured for transmitting output relevant to the received

input, such as an acknowledge transmission control character (ACK), a negative-acknowledge character (NAK), or any other similar response message necessary in order to ensure a robust communications link between the main processor **20** and the user interface **16**/equipment **18**.

The input interface **22** may be further configured for processing input received from the user interface **16** and/or equipment **18** before passing it to the main processor **20**. For example, it may be configured to process data corresponding to a predetermined sequence of inputs, and pass a signal based thereon to the main processor **20**. This function may be alternatively performed by the controller, or in addition thereto, for example for verification.

The command interface **24** is configured to communicate with the clock **14**. Thus, it comprises one or more wired and/or wireless connections controlled directly by the controller **12**. Alternatively, a separate clock controller (not illustrated), in communication with the controller **12** and one or more multiple clocks, may be provided. In such a case, the controller **12** interfaces with the clock controller as if it were a clock, with the clock controller being configured for synchronizing the various clocks. The command interface **24** may further comprise an interface hardwired with a clock, for example if they are contained within a single unit.

In addition to communication instructions related to timekeeping, the command interface **24** may be configured to communicate with other data presentation interfaces, such as lights, video displays, buzzers, horns, a public address system, etc. In this way, the controller **12** may be used to control several aspects of game administration in addition to timekeeping.

The clock **14** is typically a countdown timer, and comprises any suitable timekeeping display unit. For example, it may be a large LCD screen, an LED or light-bulb array, etc. It may also be configured to display other information relating to game play, such as score, possession, down and yards-to-go information (e.g., in American football), sub-timers (such as the "shot-clock" in

basketball), player information, etc. As noted above, it may comprise circuitry or computer code configured to manage the timekeeping functionality, and receive start/stop/reset/etc. commands from the controller **12**, or it may constitute a "dumb" data presentation unit, with the timekeeping functionality performed by the controller, and displaying time as determined thereby.

The user interface **16** allows a timekeeper or other game official to manage the controller **12**, facilitating its automated control of the clock **14**. As will be described below, the equipment **18** is configured to transmit signals to the controller **12** to indicate that certain game-related events have taken place. Many of these events affect the clock, i.e., the clock should be started or stopped when they occur (for example, the in-bounding of a ball in a basketball game). Parameters relating to various events and their ramifications vis-à-vis the clock are stored in the controller **12**, either directly or via the user interface **16**. During play, the user indicates, via the user interface **16**, which event is about to occur, or has just occurred; the controller **12** then makes a determination regarding the clock (i.e., to start/stop/adjust it), based on the appropriate parameter and the input received. Non-limiting examples will be provided below for clarity.

As noted above, the equipment **18** is configured for detecting and communicating that certain game events have occurred. The equipment may include a ball, a goal (such as a rim in basketball, etc.), whistles, etc.

As illustrated in Fig. 2A, a ball **28** may be provided with an internal pressure sensor **30**, a wireless transceiver **32**, and a battery **47**. The ball **28** may be designed such that the excess weight of the pressure sensor **30** and transceiver **32** are offset by a similar reduction in weight thereof, so that it is still of regulation weight. In addition, a counterweight **34** may be provided so that the ball **28** performs normally, and does not "wobble" or present any other abnormal behavior during play.

The pressure sensor **30** is configured for detecting a sudden and substantial increase in internal pressure of the ball **28**, for example as a result of

coming in contact with or striking a foreign object (such as the floor or goal) after being thrown, or as a result of being caught or otherwise handled by a player. The pressure sensor **30** may be any suitable sensor known in the art. The pressure sensor **30** further comprises (or is constituted by) a transducer configured to communicate with the wireless transceiver **32**. The transducer **32** is configured to transmit information relating to the occurrence of a pressure change, as well as the magnitude thereof.

As illustrated in Fig. 2B, the pressure sensor **30** may be embodied by an indirect pressure sensor. For example, a piezoelectric grid **31** (illustrated schematically by a broken line), configured for detecting and/or measuring deformation of the ball, may be provided on the inner side of the ball membrane to measure changes in the shape of the ball, for example in response to striking an object, being caught, or being released, as described above. This is considered "indirect pressure sensing" since the change in pressure itself is not measured, but rather a condition which would indicate such a change in pressure is detected. The transducer **32** and battery **47** may be provided in any appropriate location(s).

As illustrated in Fig. 2C, the piezoelectric grid **31** may be held in position by an inflatable core **41** (shown in a deflated state) within the ball **28**. The grid **31** may be provided built into the core **41**, or may be disposed surrounding it. The core **41** may be connected to the valve **43** of the ball **28**, such that when the ball is inflated, the core inflates as well, and bears against the inner side of the ball's membrane when fully inflated. The core **41** comprises the transceiver **32**, a battery **47**, and any other necessary elements. Besides maintaining the positions of elements within the ball **28** at appropriate positions (e.g., at the center of the ball or at other positions so as not to affect the balance thereof during use), the core **41** serves to protect the elements from impacts which occur during use of the ball.

It will be appreciated that a similar core **41** may be provided with the example illustrated in Fig. 2A, i.e., containing therein as well the pressure sensor **30**, *mutatis mutandis*.

According to any example, the valve **43** of the ball **28** may be electrically connected to the battery **47** so as to allow charging thereof via the valve. In particular, electrical contacts (not illustrated) are provided on the valve to facilitate connection to a suitably designed charger for recharging the battery **47**. The battery **47** may be designed to have a capacity sufficient for use during an entire game.

The pressure sensor **30** may be calibrated to determine what type of game event precipitated the pressure change, for example based on the magnitude of the change. Alternatively or additionally, the input interface **22** and/or main processor **20** may be configured to make this determination based on information relating to the magnitude of the pressure change received thereby,

In addition or alternatively, a load cell **35** may be provided in the center of the ball, suspended with tension cables **37** running along three mutually perpendicular axes of the ball **28**. The load cell **35** is configured to detect slight changes in stress of each of the cables **37**, thus facilitating detection of slight changes in movement of the ball, for example due to a brushing against or low-speed impact with an object. The load cell **35** is further configured to communicate with the wireless transceiver **32**, either by a wireless connection or via a wire **39** provided for this purpose. It will be appreciated that one of the tension cables **37** may be configured for use as a communication wire between the load cell **35** and the wireless transceiver.

It will further be appreciated that one or both of the pressure sensor **30** and load cell **35** may be provided, or any other means for detecting contact or impact of the ball with another object.

The wireless transceiver **32** is configured to communicate with the input interface **22** of the controller **12**. It may either transmit the information furnished

to it by the pressure sensor, which is then interpreted by the main processor **20**, or be configured to analyze the information before sending. For example, it may be configured to send only data which meets or exceeds a predefined threshold, for example only sending a yes/no, or other simplified message.

As illustrated in Fig. 3, a goal **36** (in this case a basketball rim/net), comprising a backboard (not illustrated) and a rim **44** carrying a net **42**, may be provided with a sensor for detecting that a goal or score has been achieved. In addition, it comprises a transceiver **38** (wired or wireless) configured to communicate with the input interface **22** of the controller **12**.

For example, the sensor may be in the form of an expandable ring **40** located on the net **42**, at a position sufficiently below the rim **44** to ensure that play will not be affected. The ring **40**, in its relaxed position, may be slightly smaller than the ball, and expand when a goal is achieved. This is detected and transmitted to the controller **12** by the transceiver **38**.

Alternatively or in addition to the above, a set of three short range motion detectors **45a**, **45b**, **45c** may be provided at positions above, level with, and below the rim **44**, respectively. A goal may be registered as having occurred when all three detect motion in sequence, i.e., **45a** before **45b**, and **45b** before **45c**. The short range motion detector **45a** which is disposed above the rim may be mounted so as to detect a ball approaching the backboard.

The controller **12** may be configured so as to register a goal only when a proper sequence of detections have taken place. For example, a detection by short range motion detector **45a** must precede a detection by short range motion detector **45b** which must precede a detection by short range motion detector **45c** before a goal is registered. Alternatively, a dedicated controller (not indicated) associated with the three short range motion detectors **45a**, **45b**, **45c** may be provided to detect the detections and the sequence, and transmit a signal to the controller **12** that a goal has occurred.

It will be appreciated that any other appropriate means for detecting a goal may be provided.

As illustrated in Fig. 4, a whistle **46** may be provided with a sensor **48** to detect when air has been blown therein at a sufficient force to produce a sound. The sensor **48** is configured to communicate with a wireless transceiver **50**, which is configured to communicate with the input interface **22** of the controller **12**. Alternatively or in addition, the whistle may be configured to transmit a sound of a predetermined frequency which the input interface **22** is configured to detect.

The auxiliary sensors **17** may include sensors built into the court or playing field. For example, sensors, such as photoelectric sensors, may be located around the court or playing field so as to determine when an out-of-bounds condition occurs. In addition, the court or playing field may be provided with means for detecting the presence, location, and/or force exerted by objects thereof. This may be accomplished, as illustrated in Fig. 5, by providing an array of court sensors **52** above or just below the surface of the court or playing field. Detections of the court sensors **52** may be used to detect and differentiate between an impact detected by the ball **28** which occurs from a floor impact from those occurring from impact with a player, as well as inform the controller as to the location of the floor impact.

Prior to use, parameters are stored in the controller **12**, along with the implications of each. For example, start of play of a basketball game may be determined by when the ball is legally tapped by a jumper on the jump ball. Thus, the parameter would be to detect such a tap and then start the clock. During use, immediately prior to the jump ball, the timekeeper indicates, via the user interface **16**, that a jump ball is about to occur, initiating operation as per the appropriate parameter. The controller **12** receives this information, and begins the clock when the tap is detected. Similar methods are employed to start the clock when the ball has been in-bounded, or to stop the clock when a goal has

been achieved. In addition, the controller **12** may be configured to stop the clock when it has been determined that a referee or other game official has blown his whistle **46**.

The system **10** can thus be considered "semi-automated", since while the starting/stopping of the clock is automated, it only occurs when the timekeeper indicates that it should take place.

The controller **12** may further be configured to adjust the time on the clock. For example, if a game event has occurred before the timekeeper has indicated that it would occur, he may review the inputs received by the controller **12**, and indicate *post facto* the type of event that occurred. The controller **12** then adjusts the clock accordingly. For example, if a ball is in-bounded before the timekeeper indicates that it is about to be in-bounded, he may indicate which signal received from the ball is associated with the appropriate event for restarting the clock.

According to a modification, the system is integrated with a video system for facilitating adjusting the time. The system synchronizes video information about the game, such as a recorded video thereof, with the signals received from the equipment. For this purpose, it may communicate with the controller **12**, for example a storage system thereof, in order to retrieve information relating to game information, including game events. In the above example, the user may review the video of the game, specifically the portion thereof when the ball was in-bounded. While viewing the video, indications may be displayed on-screen corresponding to the signals received from the equipment **18** (see Fig. 6). The indications may be displayed in real-time, and selectively enabled/disabled and moved around the screen so as not to interfere with viewing a relevant portion of play. This facilitates identifying the events which correspond to each signal.

In addition, the main processor **20** may be configured for interfacing with the video system so as to allow reviewing the game or a portion thereof in synchronization with signals received by the input interface **22**, thus allowing a

game official to visually review a recording of the game or a portion thereof with information regarding game events displayed or otherwise indicated at the appropriate chronological position.

As illustrated in Fig. 7, a data presentation **54** unit may be provided. The data presentation unit **54** may be configured to present game information **56** along with corresponding time information **58** which is determined by the controller **12**.

Those skilled in the art to which this invention pertains will readily appreciate that numerous changes, variations and modifications can be made without departing from the scope of the invention *mutatis mutandis*.

CLAIMS:

1. A system comprising:

- one or more sensors, each configured to sense a predefined signal associated with one or more game events during a sports game;
- a clock configured to display time during said game; and
- a controller configured to:
  - receive information from said sensors regarding a sensed signal;
  - determine, at least based on said information, that a game event has occurred; and
  - interface with said clock and control the running thereof, at least in response to the determination of a game event;

wherein said system is configured for facilitating timekeeping during said sports game.

2. A system according to Claim 1, wherein one or more of said sensors is:

- integrated with equipment configured for use in playing said game; and
- configured for detecting a game event associated with the equipment.

3. A system according to Claim 2, wherein said sports game is basketball.

4. A system according to Claim 3, wherein said equipment comprises a goal, a game event associated with said goal being achieving a score.

5. A system according to Claim 4, wherein said goal comprises a backboard, a rim, a net, and at least two of said sensors constituting goal sensors.

6. A system according to Claim 5, wherein said controller is configured to determine that a score has occurred when said at least two sensors sense a signal in a predetermined sequence.

7. A system according to Claim 6, the goal comprising:

- a first goal sensor configured to sense a signal associated with the game ball approaching the backboard;

- a second goal sensor configured to sense a signal associated with the game ball passing through the rim; and
- a third goal sensor configured to sense a signal associated with the game ball passing through the net;

said controller being configured to determine that a score has occurred when:

- said first goal sensor senses the signal before the second goal sensor senses the signal; and
- said second goal sensor senses the signal before the third goal sensor senses the signal.

8. A system according to any one of Claims 3 through 7, wherein said equipment comprises a ball.

9. A system according to Claim 8, wherein said ball comprises one of said sensors constituting a ball sensor, said ball sensor being configured to sense contact with a foreign object.

10. A system according to Claim 9, said ball sensor comprising a pressure sensor configured to sense a change in internal pressure of the ball.

11. A system according to Claim 9, said ball sensor comprising a piezoelectric grid configured to detect changes in the shape of the ball.

12. A system according to any one of Claims 9 through 11, wherein said controller is configured to determine the type of game event associated with the signal sensed by the ball sensor at least partially based on the magnitude thereof.

13. A system according to any one of Claims 9 through 12, wherein said ball further comprises a wireless transceiver to pass information from said ball sensor to said controller.

14. A system according to any one of Claims 3 through 13, wherein said equipment comprises a whistle.

15. A system according to Claim 14, wherein said whistle comprises one of said sensors constituting a whistle sensor, said whistle sensor being configured to sense a blowing of the whistle.

16. A system according to any one of Claims 3 through 15, wherein said equipment comprises a court surface.

17. A system according to Claim 16, wherein said court surface comprises one or more of said sensors constituting court sensors, said court sensors being configured to sense impact thereon of one or more of a ball and a player.

18. A system according to Claim 15, wherein said court sensor is configured to sense the location thereon of said one or more of a ball and a player.

19. A system according to any one of the preceding claims, further comprising a video system in communication with said controller, said video system being configured to synchronize video information of the sports game with game events determined by the controller.

20. A system according to Claim 19, wherein said video information comprises a recorded video of at least a portion of the game.

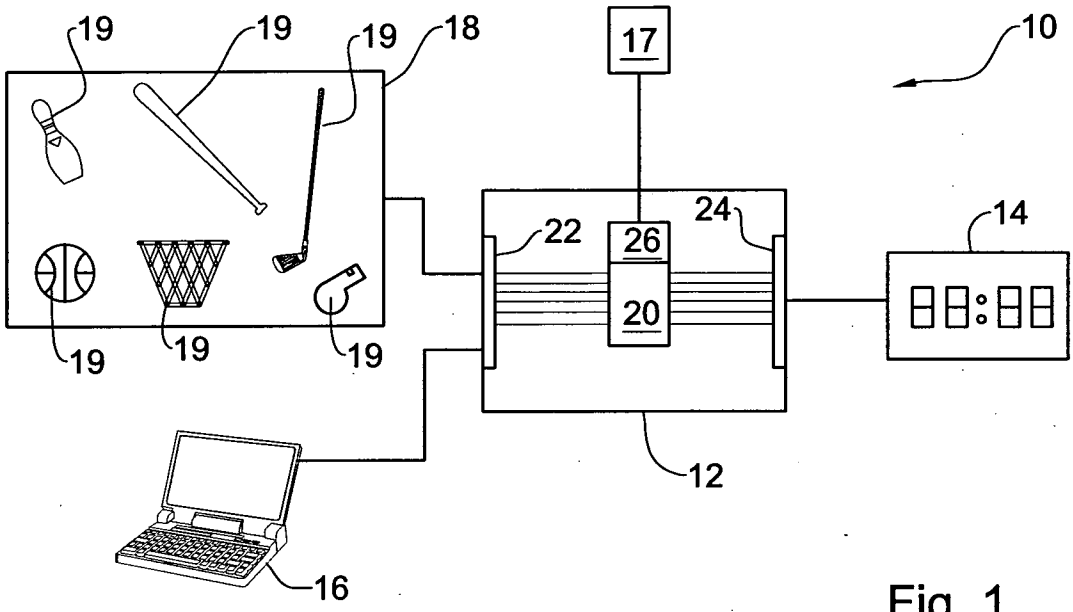

Fig. 1

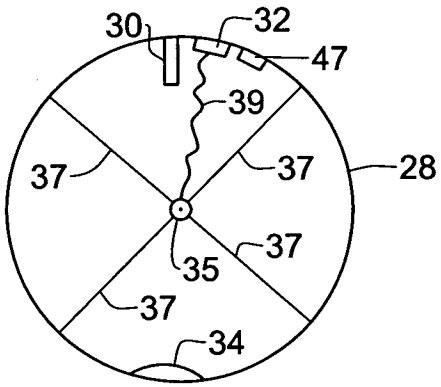

Fig. 2A

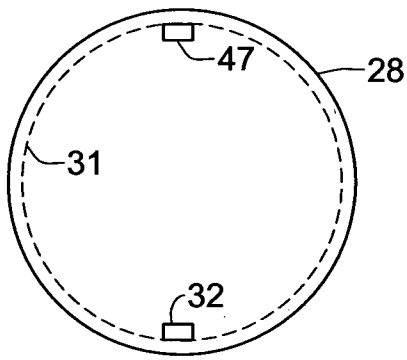

Fig. 2B

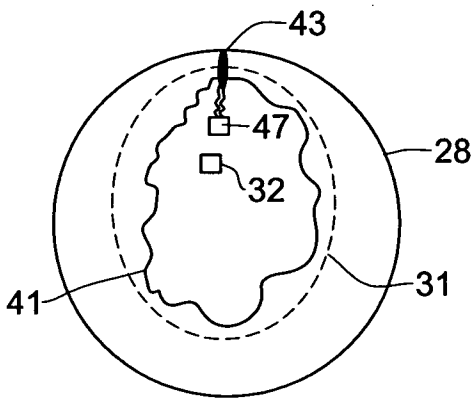

Fig. 2C

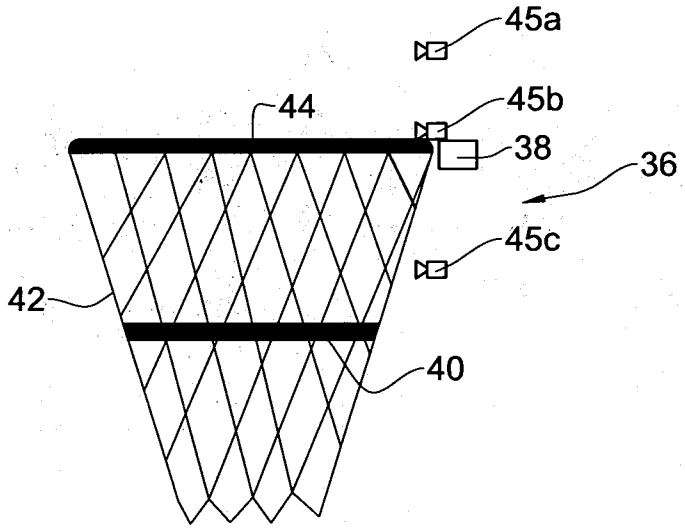

Fig. 3

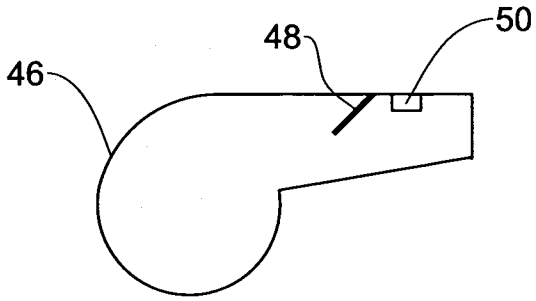

Fig. 4

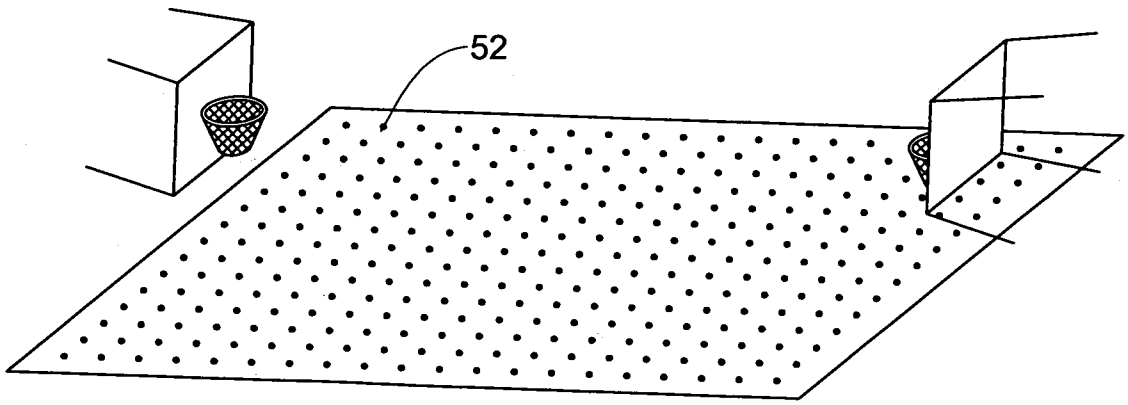

Fig. 5

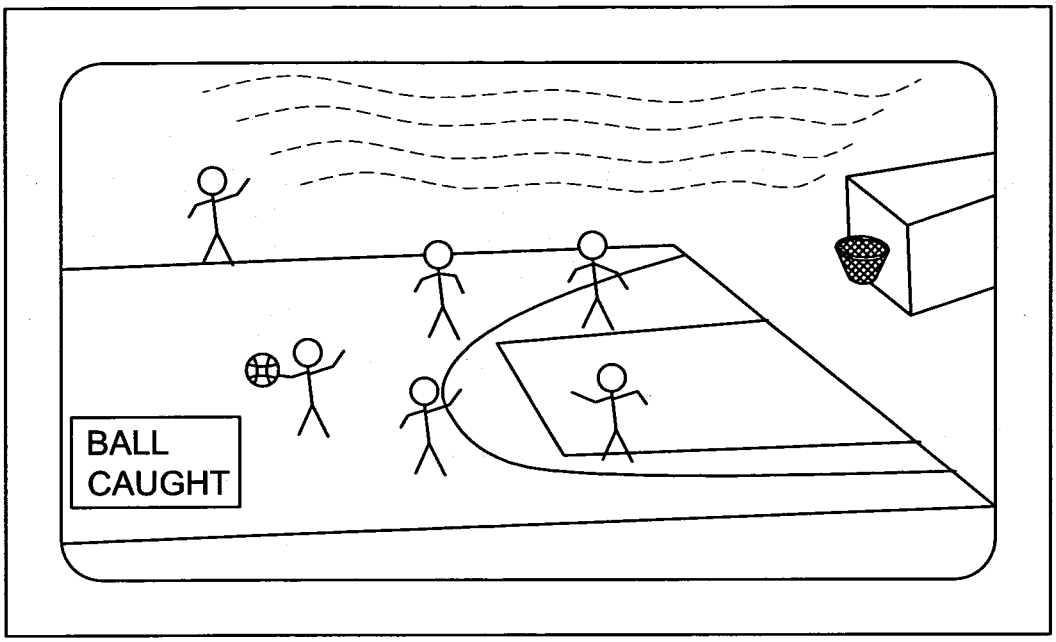

Fig. 6

EVENT	GAME CLOCK	SHOT CLOCK
BALL RELEASE	5:09.7	0:13.4
GOAL	5:07.8	0:11.5

54

56 58

Fig. 7