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(54) **METHOD AND APPARATUS FOR
MONITORING AND DETERMINING THE
POSITION OF A FOOTBALL**

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(57) **ABSTRACT**

The present invention is a method and apparatus for tracking the position of a game ball relative to a playing field during a game. It allows game officials to selectively record and store position information for the game ball in response to events during play and further allows game officials to reposition the ball accurately at the recorded and stored location.

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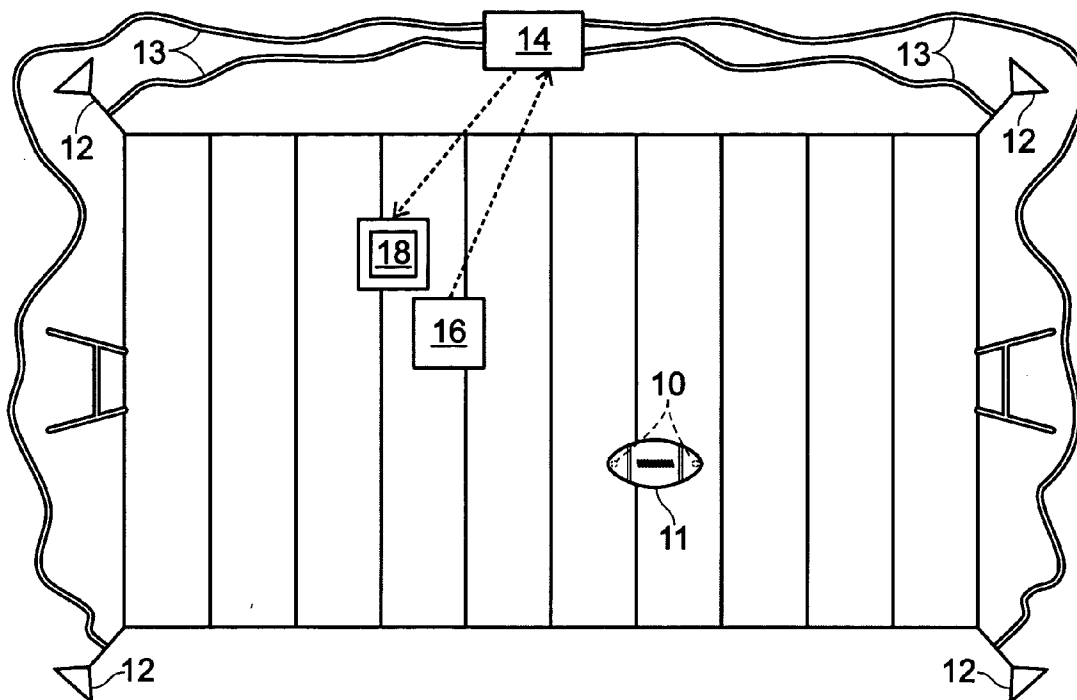


Fig. 1

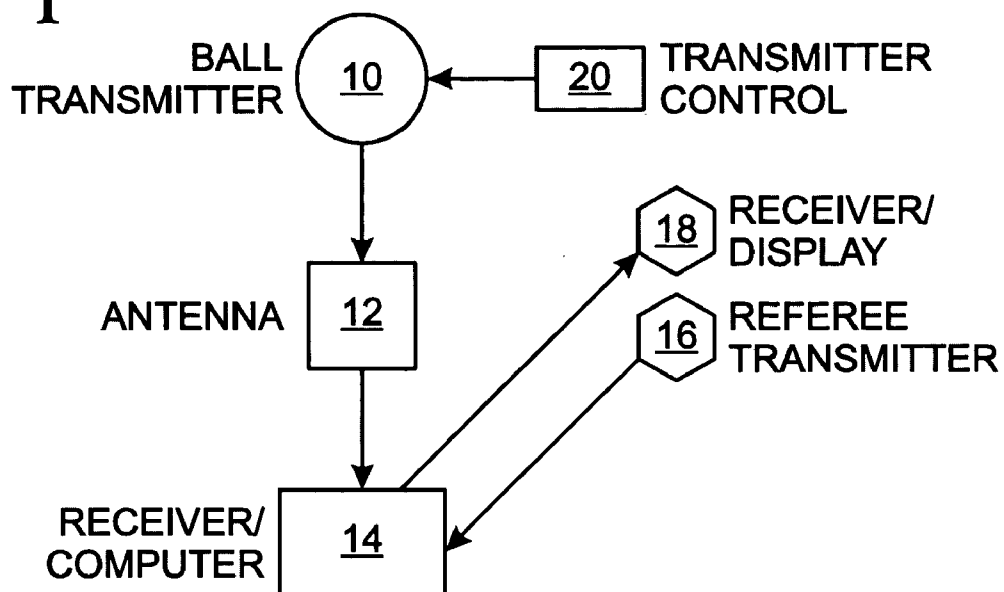


Fig. 2

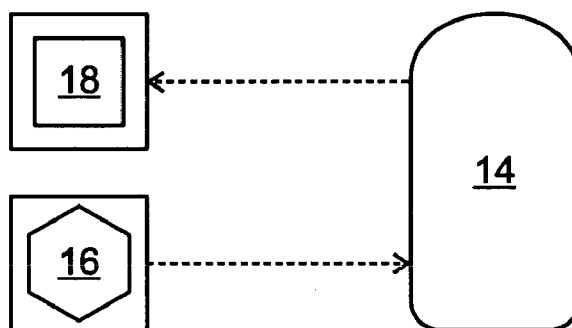


Fig. 3

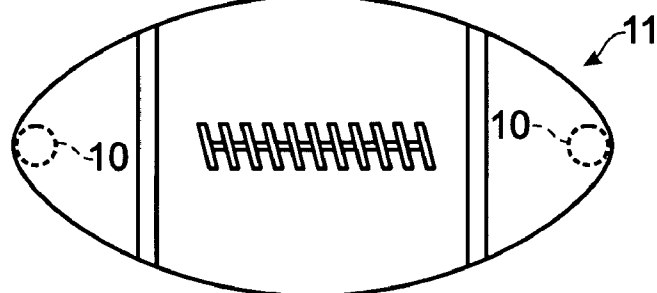


Fig. 4

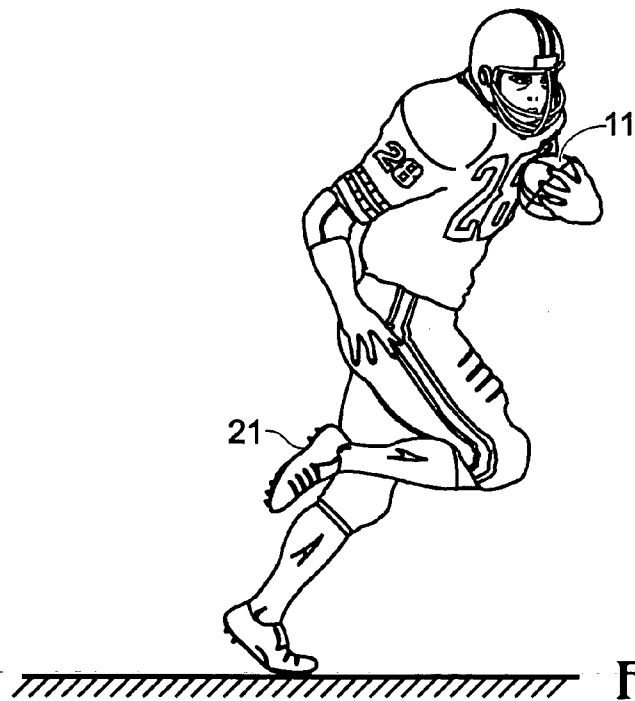
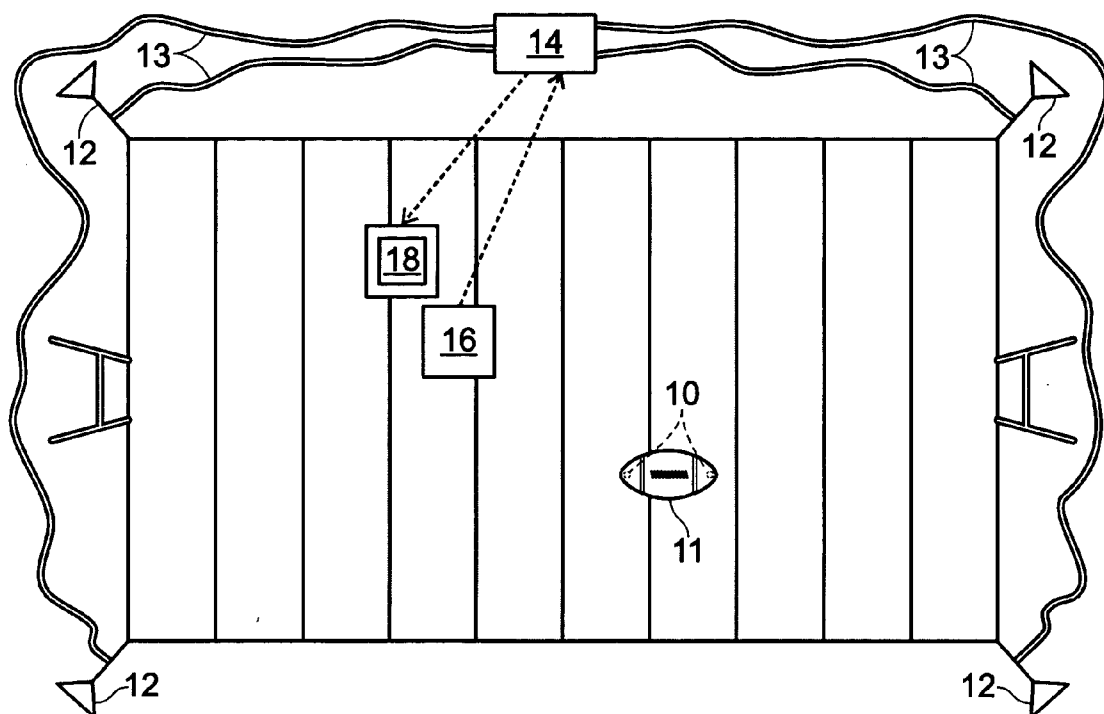
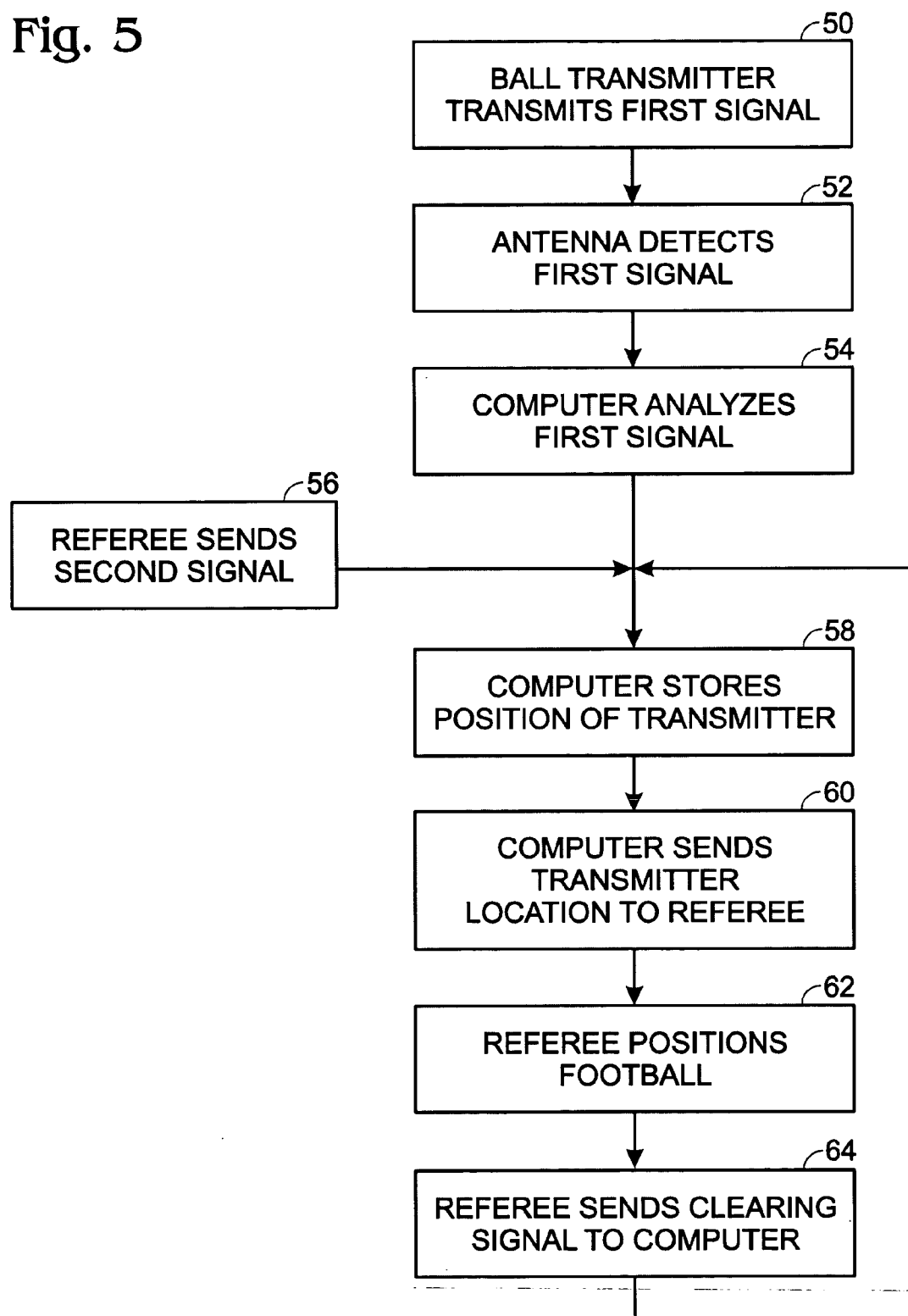


Fig. 6

Fig. 5



METHOD AND APPARATUS FOR MONITORING AND DETERMINING THE POSITION OF A FOOTBALL

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a method and apparatus for tracking the position of a ball, such as a football, relative to a playing field during a game, for selectively recording the position of the ball at times during the game and thereafter providing location information about the game ball to a game official.

[0003] 2. Related Art

[0004] Football is a game in which play frequently is temporarily stopped by game officials and the ball used for the game may be repositioned prior to the resumption of play. A ball is placed in an initial position, which is the same at the beginning of every game. Thereafter, the ball is kicked downfield to the opposing team which tries to return the football to the end of the field from which it was kicked. Once the receiving team gets the football, the player with the ball may run until such time as he is tackled by the kicking team, the player runs out of bounds, or some other event occurs that is witnessed by a game official and for which game rules require the official to stop the live action. Once the play is stopped, the game official must position the football based upon where he last saw the ball at the moment the live action was stopped.

[0005] One problem is inherent, however, in traditional methods of positioning the ball in the game of football, and in many other sports: often the game official's view of the ball is obscured. For example, if the player carrying the football is tackled by several other players, the game official often does not see the position of the ball because it is hidden beneath the tackling players. Similarly, it is sometimes difficult to discern when a player has stepped out of bounds and where the ball was located when the player went out of bounds. While the game official may have a general idea of where the ball should be positioned, relying on the discretion of the official remains an inaccurate method of locating the ball. The importance of properly positioning the ball and, thus, the official's judgment, becomes greater as the ball's position nears the goal line. Millions of dollars in employment compensation, advertising fees and promotional costs may be at stake in professional athletic contests. A mistake of only a couple of inches in positioning the ball could affect the outcome of the game and thus affect the amount of money earned or lost by parties with an interest in the game. As such, it is the object of the invention to remove the need for game official discretion by creating a method and apparatus for the tracking, recording and relaying of the location of a game ball relative to the playing surface at any given moment during a game.

[0006] Methods have previously been disclosed for locating a ball or other similar object during game play. Several such methods, however, allow only for locating of ball relative to its previous placement. See for example, U.S. Pat. Nos. 4,675,816; 5,346,210; 6,141,060; and Pub. No. 2002/0089674. Further, these methods of locating objects still require a game official to exercise discretion in "spotting" or positioning the ball relative to the field. Since such methods

do not allow for the live tracking of the ball and continue to require the discretion of the gaming official in positioning the football or other object after a break in live action, the accuracy of the placement or "spotting" of the ball is not improved.

[0007] Other methods, such as the ones disclosed in U.S. Pat. Nos. 5,150,895, 5,564,698, and PCT Publication No. WO 89/00066, use a variety of methods to track a ball or similar object in motion during game play. These inventions lack the ability to record and relay to game officials the location of the ball or similar object at any given moment during the game.

[0008] What is needed is a method and apparatus that permits the ball's position to be stored and recorded and then communicated to a game official, thereby removing the need for game officials to exercise discretion in "spotting" or placing the ball at the end of a given play. Removing the officials' discretion is desirable as it allows for an accurate placement of the ball should the officials' lines of sight be obstructed in the normal course of the game.

SUMMARY OF THE INVENTION

[0009] Accordingly, it is the object of the present invention to provide a method and apparatus for the live tracking of a ball and players relative to a playing field which avoids the disadvantages of the prior art.

[0010] In addition, it is an object and advantage of the present invention to provide a method and apparatus for recording and relaying to the game official the location of the ball and players at any given moment during a game.

[0011] Therefore, it is a further object of the invention to reduce the need for game official discretion by presenting a method and apparatus for tracking, recording and relaying the location of a ball relative to the playing field at any given moment during a game.

[0012] Other objects and advantages of the present invention will in part be obvious and in part appear hereinafter.

[0013] As set forth hereinafter, the present invention comprises positioning transmitting devices into a game ball, such as a football. Alternately, the transmitters can be positioned in the padding, clothing, or shoes or otherwise attached to the players instead of locating them within the football, allowing each player to be tracked independently in place of or in addition to tracking the game ball.

[0014] The signals from the transmitter are detected by an antenna, which is either positioned below the playing surface or erected above ground and is attached to a receiver and microcomputer. The receiver and microcomputer use the signals detected by the antenna to compute the location of the transmitter. At any time during a game, in response to an event that requires the end of play, a game official may transmit a signal from a second transmitter, which signal is detected by the antenna and received by the receiver and microcomputer. The official's signal directs the microcomputer to store the position information associated with the ball at the moment the official sends the signal.

[0015] According to the present invention, the stored location is then communicated to the official to allow the official to properly position the ball for resumption of play. Preferably, the location information is transmitted to the

official by a third transmitter connected to the microcomputer and is received by the official using a receiver connected to a portable display that depicts the location of the ball relative to the playing field. In addition or in the alternative to communicating the signal to a game official, the location can be communicated to broadcasters or spectators. As disclosed herein, the present invention encompasses alternate means of communicating the location information to the official.

[0016] Such tracking and recording will prove useful when, as often occurs, an event that temporarily ends live action can be seen by an official but the location of the ball at that moment cannot be accurately determined. Until now, such an event required the official to guess or estimate the actual location of the ball.

BRIEF DESCRIPTION OF DRAWING

[0017] The present invention will be more fully understood and appreciated by reading the following Detailed Description in conjunction with the accompanying drawings, in which:

[0018] FIG. 1 is a schematic representation of the apparatus of the preferred embodiment.

[0019] FIG. 2 is a schematic representation of the game official's remote and microcomputer.

[0020] FIG. 3 is a side direction view of a football configured for one embodiment.

[0021] FIG. 4 is a schematic representation of the relative positions of components according to one embodiment of the invention.

[0022] FIG. 5 is a flow chart showing the method of the present invention.

[0023] FIG. 6 is a side view of an alternate embodiment of the apparatus.

DETAILED DESCRIPTION OF THE INVENTION

[0024] Referring now to the drawings, in which like reference numerals refer to like parts throughout, there is seen in FIG. 1, a ball transmitter 10, an antenna 12, a receiver/computer 14, a referee transmitter 16 and means for communicating ball position information from the receiver/computer 14 to a game official. Means for communicating ball position information may comprise, for example, a receiver/display 18. During a game, the ball transmitter 10 sends a signal that is detected by the antenna 12 and processed by the receiver/computer 14 to determine the location of the ball transmitter 10. At any time during a game, a game official can activate the referee transmitter 16 to direct the receiver/computer 14 to store the ball's position information, which information is then conveyed to the official, for example by being displayed on the receiver/display 18, to allow proper placement of the game ball.

[0025] The ball transmitter 10 consists of a small, lightweight radio frequency transmitter positioned inside a game ball as shown in FIG. 3, without substantially affecting the weight or other playing characteristics of the ball. The preferred embodiment includes two ball transmitters placed within opposing ends of the game ball as shown in FIG. 3.

[0026] The ball transmitter 10 can be any transmitter that is small enough to be securely positioned within a game ball and has sufficient range to transmit a signal that is detectable by the antenna 12. Preferably, the ball transmitter 10 is powered by a lightweight, long-lasting power source, such as a lithium battery is sufficient to last the useful life of the ball. To conserve power, the ball transmitter 10 can preferably be selectively turned on and off using a transmitter control 20, such as a magnet or a coded remote control, as is known to those skilled in the art.

[0027] Preferably, the ball transmitter 10 is inserted in the game ball when it is manufactured. In a football, preferably two ball transmitters 10 are used, which are round or conical so that they can be securely fastened to the interior of the football as seen in FIG. 3. Two ball transmitters 10, positioned in the opposing ends of the football 11, are preferred to avoid changing the balance of the football 11 and affecting its playing characteristics. Alternatively, one can install a single transmitter 10 in one end of the ball and secure a counterbalance of similar weight in the opposing end. Other shapes of transmitters and methods of insertion are of course available and would vary from ball to ball, depending on the size and shape of the ball used for the sport.

[0028] The antenna 12 comprises an above ground array as shown in FIG. 4 capable of receiving the signal transmitted by the ball transmitter 10. According to the preferred embodiment, the antenna 12 comprises an array of four antenna segments, located at the corners of the playing field. Alternately, the antenna 12 can be a subsurface metallic grid or an array of parallel subsurface antenna segments capable of receiving the signal transmitted by the ball transmitter 10. In one embodiment the antenna 12 consists of parallel antenna segments spaced approximately 10 yards apart and parallel to the yard lines of a football field. The antenna 12 must be constructed of weather-resistant and non-corrosive materials to ensure reliability and durability.

[0029] Each segment of the antenna 12 is connected to a receiver/computer 14, as shown in FIGS. 1 and 4. The receiver is capable of receiving signals in the frequency range used by the ball transmitter 10. The receiver/computer 14 is programmed to analyze the received signals so that it can determine the location of the ball transmitter 10. As is known by those skilled in the art, the location of a single transmitter can be triangulated using two or more antennas for receiving the transmitter's signal. For example, location information for the ball transmitter 10 relative to the antenna 12 can be determined by analyzing the signals received by any two segments of the antenna array. While the antenna 12 of the preferred embodiment comprises four antenna segments, those skilled in the art will recognize that triangulation information can be obtained using only two antenna segments. Two antenna elements, for example, located at diagonally opposed corners of a playing field will produce sufficient location information to locate the ball transmitter 10 at any location on the field. Additional antenna segments, however, provided redundancy and a higher level of precision in locating the ball transmitter 10.

[0030] Where the antenna 12 consists of antenna segments that are parallel to the field surface (as would be the case in a subsurface array), triangulation from two parallel antenna segments will produce useful location information only in a plane that is perpendicular to the axes of the parallel antenna

segments. That is, if the antenna **12** consists of horizontal antenna segments parallel to a football field's goal lines, triangulation can only determine the location of the ball transmitter **10** relative to the goal lines; it cannot determine the location of the ball relative to the field's sidelines. An antenna **12** comprising a below-ground array of segments parallel to the goal lines will suffice to provide ball location information only relative to the goal lines. If, however, the array includes one or more separate underground segments parallel to the field's sidelines, it will be possible to also triangulate the location of the ball transmitter **10** relative to the sidelines.

[0031] The receiver/computer **14** is provided with a storage memory that allows ball position information to be stored. In addition, when used for sports such as football, in which the teams switch sides of the field during the game, the receiver/computer **14** can be programmed to convert ball position information to provide correct ball position information after the teams switch ends of the field. Preferably, the receiver/computer **14** has storage memory capable of recording and storing continuous ball position information for an entire game. At a minimum, the storage memory must be capable of storing position information for at least one ball location in response to a remote command from a game official.

[0032] According to the present invention, game officials use a referee transmitter **16** to transmit a distinct signal to be detected by the antenna **12** and processed by the receiver/computer **14**. Alternatively, the distinct signal can be detected by a second antenna (not shown) and processed by the receiver/computer **14**. The referee transmitter **16** can be activated by a pushbutton or similar switch. In the preferred embodiment, the referee transmitter **16** is sufficiently small as to not encumber the official and may be mounted on a wrist. The receiver/computer **14** is programmable to store the current ball position information in response to a signal from the referee transmitter **16**. Thus, when a game official observes an event that requires play to be temporarily stopped, the official activates the referee transmitter **16**, causing the receiver/computer **14** to store the current ball location. The signal of the referee transmitter **16** must be distinct from that of the ball transmitter **10** so that the referee transmitter **16** does not affect the process of determining the location of the ball transmitter **10**. This is achieved if the referee transmitter **16** transmits on a different frequency than the ball transmitter **10**. The referee transmitter **16** may be capable of sending a clearing signal that directs the receiver/computer **14** to clear its storage memory location and prepare to receive a new storage signal from the referee transmitter **16**. In this case, the receiver/computer **14** should be programmed to receive the clearing signal. The clearing signal can be a signal transmitted on a unique frequency or any unique combination of signals that the receiver/computer **14** has been programmed to recognize as a command to clear its memory storage. Alternatively, the receiver/computer **14** can be programmed to automatically clear its storage memory before storing the ball location in response to a signal from referee transmitter **16**.

[0033] The present invention also includes means for communicating to the game official the ball location information stored by the receiver/computer **14**. Preferably, the ball location information is transmitted over radio frequency from the receiver/computer **14** to a receiver/display **18**

operated by the game official. Alternatively, the ball location information can be displayed visually at the receiver/computer **14** and communicated verbally or by hand signals to the game official on the field. In the preferred embodiment, the receiver/display **18** includes a microprocessor that can process the ball location information and display it visually on a display screen. In one embodiment, the display screen presents the ball location information in numerical format, such as the yard-line at which the game official should position the ball. In another embodiment, the display screen presents the game official with directional signals such as arrows, such that when the official moves in the direction indicated by the signals, he arrives at the proper ball location. Alternatively, the receiver/display **18** can provide an audible signal that changes with the referee's distance from the proper ball location; when the referee arrives at the position where the ball should be located the receiver/display **18** provides another audible signal to indicate that the referee is at the proper position. In yet another embodiment, the receiver/display **18** includes a display screen that is large enough to graphically display the continuous motion of the ball relative to the field. Such a display can be used to follow the path of the ball during play and can show whether the ball's movement during play has violated the rules. For example, whether the ball has been carried out of bounds or if the ball has been advanced using a forward pass forward of the line of scrimmage.

[0034] In one embodiment of the present invention, the receiver/computer **14** can be programmed to determine when the ball transmitter **10** crosses a linear boundary of the playing field, for example the left or right sideline or one of the goal lines. According to this embodiment, the receiver/computer **14** is also programmed to transmit a signal to receiver/display **18** to alert a game official that the ball transmitter **10** has crossed a linear boundary so that the official can take appropriate action.

[0035] As disclosed above, the receiver/computer **14** can be constructed to have storage memory capable of storing continuous ball location information for the entire game. According to an alternate embodiment, each of the receiver/display **18** and receiver/computer **14** include clocks that are synchronized to each other. The ball location information stored in the storage memory of the receiver/computer **14** can be associated with clock information as the data is stored in the storage memory. According to this embodiment, when directed by the game official the receiver/display **18** stores the time for which the official wishes to record ball location data. When positioning the ball, the receiver/display **18** communicates with the receiver/computer to retrieve ball location information for the time stored in the receiver/display **18**. The receiver/display **18** presents the ball location information visually to the game official as described above.

[0036] Preferably, the referee transmitter **16** and receiver/display **18** are combined in a single unit that allows game officials to both signal the receiver/computer **14** to store ball location information and to display ball location information. In an alternate embodiment, however, the devices may be separate. This may be necessary, for example, if a plurality of game officials have referee transmitters **4** while only one game official has a receiver/display **18**.

[0037] In an alternate embodiment, a player transmitter **21** is placed in the padding, clothing, or shoes of a player or is

otherwise attached to the player, for example in the cleat's of a player's shoes as shown in **FIG. 6**. In this embodiment, the location of the ball is determined from the location of the player transmitter **21** of the player that is carrying the ball. According to this embodiment, a plurality of player transmitters **21** is provided for positioning in each player's uniform. Each player transmitter **21** transmits a distinct signal, differentiated from other transmitters by frequency, modulation, or other methods known in the art. According to this embodiment, the antenna **12** detects the plurality of signals from the plurality of player transmitters **21** and conveys the signals to the receiver/computer **14** which analyzes the signals to determine the position information of each player transmitter **21**. The receiver/computer **14** stores each location in response to a signal from referee transmitter **16**. According to this embodiment, the invention further comprises means for the referee to select a single player transmitter **21** position information from the plurality of position information stored by the receiver/computer **14**. The referee would select the player transmitter **21** position information associated with the player that the referee observed carrying the ball at the time the referee sent the signal directing that ball location information be stored and recorded. As in the preferred embodiment, the invention comprises means for communicating to the game official the ball location information stored by the receiver/computer.

[0038] While the present invention has been described for use by game officials to improve the accuracy of ball placement during play of a football game, those skilled in the art will recognize that the present invention can also be used by a broadcaster or spectator to enable the broadcaster or spectator to determine if a game official has properly positioned a football during play of a football game. When used in this fashion, referee transmitter **16** and the receiver/display **18** would be employed by the broadcaster or spectator rather than (or in addition to) the game official.

[0039] The method of monitoring and determining the position of a football according to this invention comprises steps **50-62** as depicted in flow chart form in **FIG. 5**. First, the ball transmitter **10** sends a first signal to be detected by the antenna **12**. Once detected by the antenna **12**, the first signal is processed by the receiver/computer to determine the location of the ball transmitter **10**. When a game official sees an event that requires the official to temporarily suspend play, such as a knee touching the ground or a player running out of bounds, the game official activates the referee transmitter **16**. When the referee transmitter **16** is activated, it sends a second signal, which is for the receiver/computer **14**. In response to the second signal, the receiver/computer **14** stores the location information of the ball at that time. During the temporary suspension of play, the receiver/computer **14** communicates the stored ball location information to the receiver/display **18**, where it is displayed for the game official to view. The official uses the ball location information from the receiver/display **18** to accurately position the ball so it is ready for resumption of play. The game official then activates the referee transmitter **16** to send a clearing signal to the receiver/computer **14**.

[0040] While there has been illustrated and described what is at present considered to be the preferred embodiment of the invention, it should be appreciated that numerous changes and modifications are likely to occur to those skilled in the art. It is intended in the appended claims to cover all

those changes and modifications that fall within the spirit and scope of the present invention.

What is claimed is:

1. A method for determining the position of a game ball during an athletic competition on a playing field having defined boundaries, comprising the steps of:

transmitting a first signal from the game ball; and

receiving and analyzing said first signal, to determine the position of the game ball.

2. The method of claim 1 further comprising the step of: communicating the game ball's position to a game official.

3. The method of claim 2 further comprising the step of: displaying the game ball's position on a visual display.

4. The method of claim 2 further comprising the steps of: selectively transmitting a second signal;

receiving said second signal;

recording the game ball's position in response to said second signal; and

transmitting a third signal to communicate the game ball's position to a game official.

5. The method of claim 4 further comprising the step of: displaying the game ball's position on a visual display.

6. The method of claim 4 further comprising the steps of: comparing the game ball's position, as determined by said first signal, to the position recorded in response to said second signal; and

providing the game official directions to move the game ball to a location described by the position recorded in response to said second signal.

7. The method of claim 6 wherein providing directions to said game official uses audible signals.

8. The method of claim 6 wherein providing directions to said game official uses visual signals.

9. The method of claim 1 further comprising the steps of: determining if the game ball has crossed a boundary of the playing field; and

communicating an out of boundary alert to a game official.

10. The method of claim 9 wherein communicating an out of boundary alert to said game official uses audible signals.

11. The method of claim 9 wherein communicating an out of boundary alert to said game official uses visual signals.

12. A method of determining the position of a game ball during an athletic competition on a playing field comprising the steps of:

transmitting a signal from the game ball;

receiving and analyzing said signal, using a microprocessor, to determine the position of said game ball; and

communicating the game ball's position to a game official.

13. A method of determining the position of a game ball during an athletic competition on a playing field comprising the steps of:

transmitting a signal from the game ball;
 receiving and analyzing said signal, using a microprocessor, to determine the position of said game ball;
 continuously recording the game ball's position;
 attaching and storing a time stamp to the recorded position of said game ball; and
 providing the game ball's position for a selected time in response to a query.

14. The method of claim 13 further comprising the step of:
 graphically displaying the game ball's position at a remote terminal.

15. The method of claim 14 wherein the game ball's position is graphically displayed at a remote terminal located with a game official.

16. A method of determining the position of a game ball during an athletic competition on a playing field comprising the steps of:

transmitting a first signal from a player carrying the game ball;

receiving and analyzing said first signal, to determine the position information of the game ball; and

communicating the game ball's position to a game official.

17. A system for determining the position of a game ball during an athletic competition on a playing surface having defined boundaries, comprising:

a first transmitter positioned in the game ball, for transmitting a first signal;

a first antenna for detecting said first signal;

a first receiver for receiving said first signal;

a microprocessor for determining the position of the game ball in response to said first signal; and

means for recording said position.

18. The system of claim 17 further comprising means for communicating the game ball's position to a game official.

19. The system of claim 18 wherein said means for communicating the game ball's position comprises:

a second transmitter for transmitting a second signal, said second signal containing the game ball's position; and

display means for graphically displaying the game ball's position contained in said second signal.

20. The system of claim 17 further comprising control means for selectively directing said microprocessor to record the game ball's position for a specific point in time.

21. The system of claim 20 wherein said control means comprises a transmitter that is selectively operable to send a control signal to said microprocessor and wherein said microprocessor is programmed to record the game ball's position at the time said transmitter sends said control signal.

22. The system of claim 17 further comprising:

said microprocessor comprising a first clock for associating first time information with said position;

a second transmitter for transmitting a second signal that contains said position;

a display/receiver comprising a second clock for providing second time information;

means for synchronizing said second clock with said first clock;

means for selectively recording said second time information;

means for communicating a third signal to said microprocessor, said third signal containing said second time information; and

wherein said second transmitter transmits said second signal in response to said third signal.

23. Apparatus for determining the position of a game ball on a playing surface during an athletic competition, comprising:

a first transmitter located in the uniform of a player carrying the game ball, for transmitting a first signal;

a first antenna for detecting said first signal;

a first receiver for receiving said first signal; and

a microprocessor for determining the position of the game ball in response to said first signal.

24. A football for use with a system for determining the position of a game ball on a playing surface during an athletic competition, said football including a transmitter mounted therein for sending a signal for being triangulated by a computer that stores and records position information for said football.

25. A display/receiver for use with a system for determining the position of a game ball on a playing surface during an athletic competition, said display/receiver comprising:

a receiver for receiving a signal, said signal modulated to convey the game ball's location;

a microprocessor for interpreting the game ball's location modulated in said signal; and

means for communicating the game ball's location to a game official.

26. The display/receiver of claim 25 wherein said means for communicating the game ball's location communicates said location visually.

27. The display/receiver of claim 25 wherein said means for communicating the game ball's location communicates said location audibly.

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