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(71) Applicant and

(72) Inventor: KLEIN, William, M. [US/US]; 225 Marvin Avenue, Los Altos, California 94022 (US).

(74) Agents: MEYER, Sheldon, R. et al.; FLIESLER MEYER LLP, 650 California Street, Fourteenth Floor, San Francisco, California 94108 (US).

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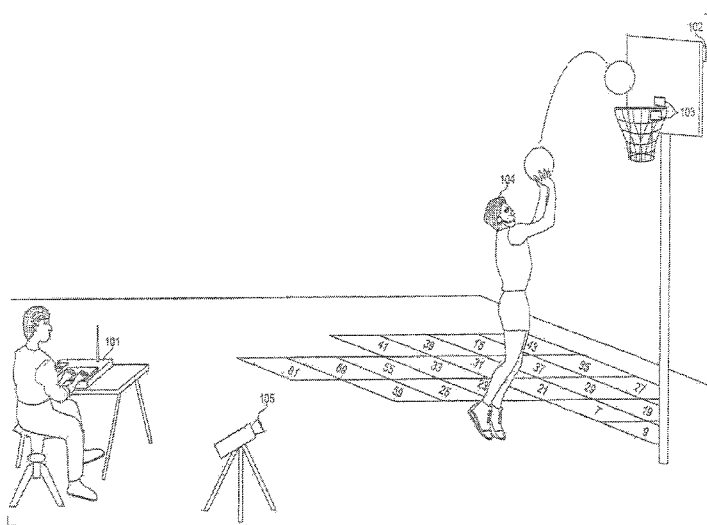
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(54) Title: PERFORMANCE MONITORING IN A SHOOTING SPORT USING SENSOR SYNCHRONIZATION



(57) Abstract: Embodiments provide mechanisms and methods for measuring shooting performance in multiplayer environments. These mechanisms and methods include advanced sensor technology that enables a portable console to determine player performance by monitoring actions of the player and activity at the basket using sensors associated with one or more players and a basket. The ability to determine player performance by monitoring actions of the player and activity at the basket makes it possible for coaches and players to measure levels of play, build teamwork among multiple players, improve and maintain skills, select players to meet game situations and team requirements, make decisions on player roles, and use playing environment space more efficiently.

PERFORMANCE MONITORING IN A SHOOTING SPORT USING SENSOR SYNCHRONIZATION

Claim of Priority

5 This Application claims priority to the following U.S. Provisional and Non-provisional patent applications:

U. S. Provisional Patent Application No. 60/758,714 entitled "Wireless Sensor Scoring with Automatic Sensor Synchronization," by William M. Klein, filed January 13, 2006 (Attorney Docket No. KLEIN-01000US2);

10 U.S. Patent Application No. 11/561,334 entitled "Wireless Sensor Scoring with Automatic Sensor Synchronization," by William M. Klein, filed November 17, 2006 (Attorney Docket No. KLEIN-01000US3);

U.S. Provisional Patent Application No. 60/819,868, entitled "Portable Wireless Sensor Scoring With Improved Shot Detection," by William M. Klein, filed July 11, 2006 (Attorney Docket
15 KLEIN-01002US0);

U.S. Patent Application No. 11/561,342, entitled "Performance Monitoring In A Shooting sport Using Sensor Synchronization," by William M. Klein, filed November 17, 2006, (Attorney Docket No. KLEIN-01002US1).

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Field of the Invention

The current invention relates generally to measuring shooting performance, and more particularly to a mechanism for real time wireless sensor scoring.

Background

30 There is an outstanding need in amateur and professional sports to identify players with the potential for development and to provide measurement and training tools to improve performance of existing players. No where is this more true than in the shooting sports, such as basketball, tennis, hockey, golf and others, in which the outcome of an entire game can be determined by the
35 performance of a single player taking a shot.

Currently, the selection, development, training and evaluation of players is almost completely dependent on the experience and observations of coaches and scouts and based upon observing actual play. These simple methods, however, lack any quantitative measure of shooting proficiency.

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Brief Description of the Drawings

FIGURE 1 is functional block diagram of an example playing environment in which techniques for measuring shooting performance in one embodiment of the present invention may be implemented.

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FIGURES 2A – 2J are block diagrams illustrating a high level overview of console apparatus for measuring shooting performance of one embodiment of the present invention.

FIGURES 3A – 3B are functional block diagrams of example playing environments having a plurality of superimposed cells indicating location for measuring shooting performance in one embodiment of the present invention.

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FIGURES 4A – 4C are block diagrams illustrating a high level overview of screens displayed by a console apparatus for measuring shooting performance of one embodiment of the present invention.

FIGURE 5 is functional diagram of an example encoding technique for qualifying shot types in the playing environment illustrated in FIGURE 1.

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FIGURE 6 is functional diagram of example historical performance measurements being tracked for a shooting session in the playing environment illustrated in FIGURE 1.

FIGURES 7A – 7B are operational flow diagrams illustrating a high level overview of techniques for measuring shooting performance of one embodiment of the present invention.

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FIGURES 8A – 8C are functional diagrams of example presentations for displaying performance measurements in the playing environment illustrated in FIGURE 1.

FIGURE 9 is a block diagram illustrating a high level overview of a screen displayed by a software embodiment for transferring information to and from a console apparatus of one embodiment of the present invention.

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FIGURES 10A – 10F are block diagrams illustrating a high-level overview of an example operation of a synchronization mechanism for synchronizing the console with the sensor(s) in an embodiment of the present invention

FIGURE 11 is a hardware block diagram of an example computer system, which may be used to embody one or more components of an embodiment of the present invention.

Detailed Description

Embodiments provide mechanisms and methods for measuring shooting performance in multiplayer environments. These mechanisms and methods include advanced sensor technology that enables a console to determine player performance by monitoring actions of the player and activity at the basket, which can comprise a hoop and a net, using sensors associated with one or more players and at a basket. The ability to determine player performance by monitoring actions of the player and activity at the basket makes it possible for coaches and players to measure levels of play, build teamwork among multiple players, improve and maintain skills, select players to meet game situations and team requirements, make decisions on player roles, and use playing environment space more efficiently.

In an embodiment, the invention provides a system for measuring shooting performance. One system embodiment includes a plurality of first sensors to detect shots taken and a plurality of second sensors to determine shots made. In a first embodiment, a sensor comprising an accelerometer is used to determine shots taken by sensing vibration. The accelerometer may be disposed at a basketball basket, for example, to detect vibration from the player (also referred to herein as a participant) taking a shot. One suitable accelerometer is the H48C by Hitachi Ltd. of Japan. In a second embodiment, a material that will be fixed onto the inside of the basketball net senses a ball passing through the basket. One such material suited to this application is Quantum Tunneling Composites (QTC) material, such as provided by Peratech Ltd., of North Yorkshire. As used herein, the term "sensor" is defined as any device for detecting an event that takes place in the shooting environment. The term sensor is intended to be broadly construed to include a single device, i.e., a detector, or a plurality of devices, i.e., an emitter and detector, and other configurations of devices. Alternative embodiments may include one or more of optical sensors, ultrasonic, e-fields, mechanical alternatives, strain gages and magnetic field sensors or combinations thereof.

A console is communicatively coupled with the first sensor and the second sensor to receive data and determine performance of a player based at least in part on the data received. In embodiments, the console can be a portable console realized using one or more of a cellular telephone, a personal data assistant (PDA), an MP3 compatible device, such as an iPod® by Apple Computer, Inc., or the like. The portable console may be coupled with the sensor(s) using one or more of Bluetooth™, wireless telephony, infrared (IR) sender/receivers and other communications mechanisms are contemplated. Embodiments as described herein may include a "portable" console; however, it should be noted that the console need not be portable, and a non-portable console can be substituted where desired.

Embodiments comprising sensor technology can provide one or more of the following benefits: (1) ease of retrofitting to an existing basketball system, (2) operable outdoors under various temperatures and environmental conditions, (3) low power consumption and battery powered, (4) low

interference with a ball in play, rim or backboard, (5) low cost, (6) sufficiently robust to reduce potential damage by contact with a ball or a player, and (7) reliable to better than 95% accuracy.

Optionally, a synchronization mechanism enables the console to “learn” which sensors are being associated with the console for play. The synchronization mechanism can enable the console to determine performance exclusively for players being monitored by the sensors associated with the console. Thus, sensors associated with multiple players may interact with one or more consoles in a common playing area free of interference. Multiple sensors that determine shots taken and shots made may be associated with a single console in order to facilitate team practice. Optionally, a third sensor disposed in a player’s shoe to monitor player activity. Player activity may include steps taken, calories burned, jumps made and the like.

In an embodiment, one or more location sensors are included that automatically detect the position of the player when shots are taken and record positional information along with information about the shot. This ability to obtain information to measure levels of play makes it possible to improve skills, select players to meet game situations and team requirements, and make decisions on player roles.

While the present invention is described herein with reference to example embodiments for measuring basketball players’ performance, the present invention is not so limited, and in fact, the real time measurement techniques provided by embodiments of the present invention are broadly applicable to a wide variety of shooting sports. As used herein, the term shooting sports is intended to be broadly construed to include any sport in which a player makes a shot, including without limitation basketball, tennis, hockey, water polo, polo, lacrosse, golf and other shooting sports. Thus, when describing embodiments exemplified by way of basketball, a basket refers to a target and/or gate. In other sports, such a target and/or gate is referred to using a descriptor such as goal for hockey, water polo, polo and lacrosse, hole for golf, or goal post for football, etc.

FIG. 1 is functional block diagram of an example playing environment in which techniques for measuring shooting performance in one embodiment of the present invention may be implemented. As shown in FIG. 1, a performance measuring system embodiment is being used in a basketball-playing environment. The system embodiment includes a first sensor 102 to detect number of shots taken, and a second sensor 103 to determine number of shots made. The first sensor includes a delay to avoid double counting the same shot when multiple triggering events occur. For example, in one embodiment, the first sensor includes a time delay, enabling the first sensor to avoid double counting the same shot from multiple vibrations of the rim or backboard. In an embodiment, sensor 102 is a vibration sensor to sense vibration when shots are made. In the embodiment depicted by FIG. 1, the first sensor 102 and second sensor 103 include a communication link to a portable console 101. The portable console 101 may be coupled with the sensor(s) using one or more of Bluetooth™, wireless telephony, radio frequency (RF), infrared (IR) sender/receivers and/or other communications mechanisms. The portable console 101 incorporates hardware, software or a combination thereof, to

measure, track and record shooting session performance results. In embodiments, the portable console 101 may be realized using one or more of a cellular telephone, a personal data assistant (PDA), an MP3 compatible device, such as an iPod® by Apple Computer, Inc., or the like. In one embodiment, the first sensor 102 is an accelerometer used to determine shots taken by sensing vibration. The accelerometer may be disposed at a backboard or in a player's tennis shoe, for example, to detect vibration from the player taking a shot. As mentioned above, one suitable accelerometer is the H48C by Hitachi Ltd. of Japan. In an embodiment, the second sensor 103 includes a material that will be fixed onto the inside of the basketball net and/or integrally formed with the basketball net, and senses a ball passing through the basket. One such material suited to this application is Quantum Tunneling Composites (QTC) material, such as provided by Peratech Ltd., of North Yorkshire. Switching devices are disclosed in detail by Lussey et al. in U.S. Pat. Publ. 2004/0252007, incorporated herein by reference. The publication describes a textile comprising a variably resistive element and textile-form members connective to external circuitry. The variable resistive element can act as a switching device responsive to deformation. One or more such switching devices can be employed to send a signal indicating a successful shot in response to mechanical deformation of the basketball net caused as the basketball passes through the basketball net. External circuitry can be fixedly connected to the backboard or other rigid structure, and wire electrically communicating a signal from the one or more such switching devices can be woven and/or threaded through the loops of the basketball net. In addition to a first sensor and one or more second sensors, optionally, a third sensor disposed in a player's shoe or article of clothing, may be used to monitor player activity, such as steps taken, calories burned, jumps made, etc. One such device for measuring performance of a wearer by way of footwear is the Nike+™ system available from Nike, Inc. The Nike+™ system employs a sensor placed inside a shoe that broadcasts wirelessly to a complementary receiver connected with an iPod®. The sensor measures and communicates a wearer's pace, performance, etc. Devices using similar technology can be employed as an optional third sensor, and can be configured to wirelessly communicate information to the portable console 101, whether the portable console 101 is an iPod®, or some other device.

In an alternative embodiment, the second sensor includes a counter lever attached to a basketball rim or backboard to track shots made, or an opto-electronic sensor attached below the basketball rim or backboard. Proximity sensors can also be employed as well as other types of optical, electrical and mechanical sensors. In still more embodiments, the second sensor can take the form of tension activated sensors connected with or between the basketball hoop and the basketball net. Such tension activated sensor can comprise, for example, a rope pull switch ("RPS"). Rope pull switches are well known and commonly used as redundant safety switches. Such switches can be miniaturized to trigger on small applied tensile loads. For example, one or more loops of the basketball net can be connected to the rigid, or semi-rigid basketball hoop by way of the one or more tension activated switches. The second sensor can be employed to send a signal indicating a successful shot in response

to tension applied to one or more of the tension activated sensors caused as the basketball passes through the basketball net. In such embodiments, it may be desirable to form a basketball net using loops connected such that a hole of the basketball net through which a basketball travels has a minimum diameter smaller than a diameter of the basketball, thereby causing tension on one or more loops connected to a tension activated switch as the basketball is briefly suspended from the basketball net while the hole deforms to receive and allow the basketball to pass through the basketball net. While use of such switching signals can allow the second sensor to be functionally integrated with basketball nets having a classic aesthetic look (i.e. including loops forming a net), the second sensor can be an electrically communicative textile functionally integrated with a basketball net having a non-classic aesthetic look (i.e. not including an appearance of discrete loops). QTC textiles as described above can be employed in such applications. Alternatively, the basketball net can include a sleeve formed of a fabric sensor. The sleeve can resemble a net, or alternatively can have some other shape, such as that of a funnel. The sleeve can include one or more switches adapted to indicate that a basketball has passed through the sleeve. Such switches can respond to compressive or tensile stress, as desired. One such fabric sensor suited to this application is ElekTex™ available from Eleksen Group, plc of Bucks, United Kingdom. Another such fabric sensor suited to this application is Fibretronic Ltd., of North Yorkshire.

In still further embodiments, the second sensor includes one or more piezoceramic sensors connected with the basketball net, and/or connected between the basketball hoop and the basketball net. A piezoceramic sensor can be a sensor including one or more piezoelectric layers, for example one or more lead zirconate titanate (PZT) layers. Mechanical compression or tension on a poled piezoceramic sensor changes the dipole moment of the PZT layer, creating a voltage. Compression along the direction of polarization, or tension perpendicular to the direction of polarization, generates voltage of the same polarity as the poling voltage. Tension along the direction of polarization, or compression perpendicular to the direction of polarization, generates a voltage with polarity opposite that of the poling voltage. The piezoceramic sensor converts the mechanical energy of compression or tension into electrical energy. The piezoceramic sensor can be used with the basketball net and/or basketball hoop to sense the force of a basketball passing through the basketball hoop and basketball net, thereby detecting a successful shot. For example, one or more loops of the basketball net can be connected to the rigid or semi-rigid basketball hoop by way of one or more piezoceramic sensors. The second sensor can be employed to send a signal indicating a successful shot in response to tension applied to the one or more piezoceramic sensors caused as the basketball passes through the basketball net. As above, in such embodiments, it may be desirable to form a basketball net using loops connected such that a hole of the basketball net through which a basketball travels has a minimum diameter smaller than a diameter of the basketball, thereby causing tension on one or more loops connected to a tension activated switch as the basketball is briefly suspended from the basketball net while the hole deforms to receive and allow the basketball to pass through the basketball net.

Alternatively, the basketball net can include piezoceramic sensors connected between and/or within loops of the basketball net, for example. One of ordinary skill in the art will appreciate in light of these teachings that numerous different techniques for associating piezoceramic sensors with a basketball net and/or basketball hoop can be employed. The present invention is not intended to be limited to those specific embodiments described herein. One such piezoceramic sensor suited to this application is Disc Benders™ available from APC International, Ltd. of Mackeyville, Pennsylvania.

In an embodiment, portable console 101 optionally includes a synchronization mechanism that enables the portable console 101 to “learn” that sensors 102 and 103 are being associated with the portable console 101 for play. A sensor 103 will synchronize with a portable console 101 through a wireless interface by holding down a particular button on the sensor and the portable console simultaneously for 3 - 5 seconds as illustrated by FIGS. 10A – 10F. Other sensors for detecting shots taken by another player (not shown in FIG. 1) and shots made in another basket (not shown in FIG. 1) may also be associated with portable console 101 using the synchronization mechanism. The synchronization mechanism can enable the portable console 101 to determine performance exclusively for players associated with the portable console 101 and to block interference from sensors associated with players associated with consoles other than portable console 101 that may be use on the same or proximate playing area.

Embodiments can include one or more location sensors that automatically detect the position of the player and record positional information. In one such embodiment, a pressure sensitive grid comprising a plurality of cells indicating location is disposed over the playing field in order to detect the location of the player when making a shot. In another embodiment, an infrared sensor matrix is used to superimpose a plurality of location cells comprising a grid over the playing field. In a yet further embodiment, a camera coupled with a range detection device can be used to detect the location of the player with respect to cell locations in the playing environment. Examples of cells comprising a location grid is discussed in further detail below with reference to FIGS. 3A – 3B.

In one embodiment, a wireless headset 104 is worn by the player during play to communicatively couple the player to the portable console 101. Using voice recognition functionality in conjunction with the headset 104, the player can input voice commands, including type of shot to be taken, number of shots to be attempted, a time period for shooting and so forth without interrupting play. Further, in one play mode, the player can call out the types of shots using the headset 104 as the player takes the shot.

In one embodiment, a video camera 105 is operatively disposed to record shots the player takes. The video camera 105 can be constantly operating or can be triggered using a command from the wireless headset 104, a motion sensor (not shown) directed at the player, or by input of a command at the console 101 by a coach or another player.

In one embodiment, the vibration sensor and counter lever include wireless RF receiver communication links to the console 101. The console 101 (FIGS. 2A – 2J) includes input keys and a

display of key information for each shooting session. Various system embodiments may also include one or more of a timer, buzzer and warning device to signal the player. In one embodiment, a player or coach inputs the shooting session parameters and starts the program. When the player shoots from the specified court location, the console 101 records success or failure of each shot, along with the shot type and player location, for the desired period of time or number of shots. A warning voice projects elapsed time in one-minute increments as well as a countdown starting with 10 seconds of shooting time remaining or 10 shots left to take. The system's buzzer announces the completion of the session and the relevant performance data is displayed and saved if desired. All shot session data may be stored on a memory card and archived on a personal computer (PC) for historical analysis, review and comparison to other players. Alternatively, the console 101 can be directly linked to a computer.

FIG. 2A – 2J are block diagrams illustrating a high level overview of a console apparatus for measuring shooting performance of one embodiment of the present invention. The console embodiment illustrated in FIG. 2A includes a first display area 202 that provides prompting to the player or coach using text messages, graphics, icons or a combination thereof. Example prompts for a training session are discussed below with reference to FIG. 4A. A second display area 204 provides a view of the playing field to the player or coach. Display area 204 can be used to indicate the location from which the player takes shots. Display areas 202 and 204 may be implemented as different screens depicted on a single display in some embodiments. In one embodiment, a warning voice (not shown) projects elapsed time in one-minute increments. Additionally, one or more input keys 208, a reset key 210, start key 212 and select key 214 receive commands input manually from a player or a coach. A display 206 provides key information about each shooting session to the player or coach such as presenting a countdown starting with 10 seconds of shooting time remaining or 10 shots left to take. Display 206 may be embodied using LED, LCD or other type of display technology. Various console embodiments will also include a timer, buzzer and warning device (not shown). A memory card slot 220 is provided for receiving a memory card upon which performance data may be stored. The memory card may enable the console 101 to interface with a computer to populate a database with historical performance data, prepare charts and display graphs. Alternatively, the console 101 can be directly linked to a computer using a USB port or other communications interface. FIG. 2B illustrates another console embodiment, in which a computer style keyboard 216 provides a mechanism for a player or coach to enter information and respond to prompts. FIG. 2C illustrates a further console embodiment, in which the shooter or coach can configure display area 204 to display one or more cells superimposed on the playing field in order to select shot locations. Cells may be arranged according to any number of arrangements, including without limitation the arrangements illustrated by FIGS. 3A – 3B. One or more keys 208 include alphanumeric inputs to enable players or coaches to enter player names and so forth as well as numeric data. A display 206 provides the player or coach with information and control capabilities from the console. Shooting session indicators including a shots taken display 222, shots made display area 224, percentage made display 226 and location display 228

present shooting session statistics to the player or coach at the end of a shooting session or in real time. A display key 216 enables the shooter or coach to display the results of the last several shooting sessions on the console 101. Some embodiments include the capability to define a custom shooting routine or choose "random". For example, in one embodiment, a player or coach could define a three point shooting cycle by entering numbers of cells to shoot from, storing the locations in a memory and associating a code with the stored sequence. A download key 218 controls the exchange of shooting data, program updates and so forth between the console 101 and a memory card 220, or alternatively to another computing device via a network, USB or other type of communications link. Alternative embodiments implement the functionality of console 101 as software executing on a laptop or portable computer, personal data assistant (PDA), cell phone or other wireless device, wearable personal computer worn by the player or other devices.

FIG. 2D illustrates a console embodiment being used in a single player mode of operation. In the embodiment illustrated by FIG. 2D, display 206 toggles back and forth between display options, including the clock. Illuminated button indicators, for example, can indicate what data is currently being displayed by display 206. (e.g., in FIG. 2D, shots take and shots made are currently being displayed.) FIG. 2E illustrates another console embodiment, again being used in a single player mode, in which the display 206 provides a continuous clock display. FIGS. 2F – 2G illustrate console embodiments in a two player mode of operation. In the embodiment illustrated by FIG. 2F, display 206 toggles back and forth between display options, including the clock, while in the embodiment illustrated by FIG. 2G, the display 206 provides a continuous clock display. Similarly, FIGS. 2H – 2I illustrate console embodiments in a four player mode of operation. In the embodiment illustrated by FIG. 2H, display 206 toggles back and forth between display options, including the clock, while in the embodiment illustrated by FIG. 2I, the display 206 provides a continuous clock display. FIG. 2J illustrates another console apparatus for an embodiment marketed under the name SHOTMASTER™.

FIGS. 3A – 3B are functional block diagrams of example playing environments having a plurality of superimposed cells indicating location for measuring shooting performance in one embodiment of the present invention. As shown in FIG. 3A, in one example playing environment 300, a plurality of cells indicating location of a player are superimposed on the playing environment. Shooting locations in playing environment 300 are arranged according to a convention in which odd numbered shooting locations are disposed to one side of the playing area and even numbered shooting locations are on the opposite side of the playing area. Of course, in some embodiments, odd and even numbered cells may be on opposite sides from the ones illustrated in FIG. 3A. Such naming conventions of shooting locations are provided by embodiments of the present invention in order to facilitate easier player (or coach) identification of the player locations. Further, playing environment 300 includes cells having different sizes in areas considered to be of special interest to the player or relevance to scoring in the particular shooting sport under practice, such as the foul line or the 3 point line in basketball, for example. Another consideration for shooting location identification is

compliance with governing body, i.e., NBA, etc., rules or international governing body, i.e., Olympic Committee, rules. FIG. 3B illustrates another example playing environment 302, in which the plurality of cells indicating location of a player is arranged according to international rules. Each shooting location can vary in size and/or area and may be identified by a number, letter, color, combination thereof or other conventions that are contemplated.

Shooting location detection may be achieved using various techniques in embodiments of the present invention. For example, in one embodiment, a pressure sensitive grid comprising a plurality of cells indicating location is disposed over the playing field in order to detect the location of the player when making a shot. Such techniques are especially useful when cells vary in size and shape, such as the embodiments illustrated by FIGS. 3A – 3B. In another embodiment, an infrared sensor matrix is used to superimpose a plurality of location cells comprising a grid over the playing environment. In this embodiment, a device that includes an infrared sensor and an infrared light source produces pulses of infrared light and uses optics to focus reflections from the infrared light pulse from different portions of the playing environment to different detectors in a 2-D array detector. The detector produces indications of the distance to the closest object in an associated portion of the playing environment. A processor receives the indication of the infrared sensor to determine the player location. An exemplary infrared sensor for use in the present invention is available from Canesta, Inc. of San Jose, California. Details of such infrared sensors are described in the US patent 6,323,932 and published patent applications US 2002/0140633 A1, US 2002/0063775 A1, US 2003/0076484 A1 each of which are incorporated herein by reference. Such techniques are especially useful when cells are of uniform size and shape. In a further embodiment computer touch screen techniques can be used. In a yet further embodiment, a camera 105 coupled with a range detection device can be used to detect location of the player with respect to cell locations on the playing environment. Such techniques are especially useful when cell location may be determined using a range, such as the embodiments illustrated by FIGS. 3A – 3B. The player location determined by any one of these techniques may be stored along with other data about the shot.

FIGS. 4A – 4C are block diagrams illustrating a high level overview of screens displayed by a console 101 for measuring shooting performance of one embodiment of the present invention. As shown by FIG. 4A, one or more prompts may be displayed in display area 202 of console 101 to prompt a player or coach to input one or more parameters for the shooting session. In the embodiment illustrated by FIG. 4A, the player (or a coach) inputs a number of shooters, the appropriate court location, shot type, desired period of time and/or number of shots, and presses the start key 212 to initiate the program. In an alternative embodiment, the prompts shown in FIG. 4A may be provided to the player audibly via headset 104, and the player's responses received and analyzed using voice recognition processing to obtain responses from the player, thereby providing a "hands free" mode of operation.

An "Automatic synchronization" facility enables multi-player competition mode, in which multiple sets of sensors can be associated with a particular console to encourage team practice. FIG. 4B illustrates another example screen displayed by a console 101 in which a multi-sensor automatic synchronization mode is provided. As shown in FIG. 4B, in synchronize mode, the number of sensors to be associated with a particular console may be entered responsive to the prompts. As shown by
5 FIG. 4B, the console display prompts the user to activate a synchronization mechanism at each sensor to be associated with the console 101 successively. A sensor will synchronize with a console through a wireless interface by holding down a particular button on the sensor and the console simultaneously for 3 - 5 seconds as illustrated by FIGS. 10A - 10F. When the console 101 has identified each sensor
10 that is being assigned to it, the console displays a "synchronization complete" message. Automatic synchronization can enable multiple consoles to interact with sensors in a common playing area free of interference. FIG. 4C illustrates an example shooting session summary screen displayed in display area 202 or 204 of console 101 after a player completes a shooting session. As shown in FIG. 4C, shooting session summary statistics may be presented to the player or coach in a format emulating a
15 basketball (or other sport) scoreboard. Other embodiments will display the output using other formats appropriate to the shooting sport being practiced.

Encoding schemes may be used in some embodiments to simplify storage of shot types in databases or other storage mechanisms. For example, FIG. 5 is a functional diagram of an example encoding technique for qualifying shot types in the playing environment illustrated in FIG. 1. As
20 shown by FIG. 5, an encoding scheme can associate a number with a shot type. Such encoding techniques can enable analysis based upon statistics developed for different shot types and in certain cases simplify storage of historical shooting session information. While FIG. 5 illustrates one encoding scheme for basketball, other embodiments will employ other encoding techniques appropriate to the shooting sport being practiced.

FIG. 6 is functional diagram of example historical performance measurements being tracked for a shooting session in the playing environment illustrated in FIG. 1. The example table illustrated in FIG. 6 includes a list of parameters describing the results of a basketball shooting session in one embodiment. Various mechanisms for storing and tracking parameter data gathered from shooting sessions are made available in embodiments. For example, in one embodiment, a database is
30 used to store and organize parameter information, such as shown by FIG. 6. Other embodiments will employ other storage and organization techniques, and store different parameters, appropriate to the shooting sport being practiced.

FIGS. 7A - 7B are operational flow diagrams illustrating a high level overview of techniques for measuring shooting performance of one embodiment of the present invention. The
35 technique for measuring shooting performance shown in FIGS. 7A - 7B are operable with console 101 of FIGS. 2A - 2J. As shown in FIG. 7A, a user causes a console to synchronize with one or more sensors (block 701). Then, the player enters shooting session parameters at the console (block 702) as

described in further detail with reference to FIG. 7B. The player(s) may now perform the shooting session (block 703). As shown in FIG. 7B, a player enters the number of shooters (block 711). The player enters his shooter id number (or name) (block 712). The player selects the number of shots to take or a period of time to shoot (block 713). The player selects a shot location cell (block 714). As described above, some embodiments will automatically determine the location from which the shot is made. The player selects the type of shot (block 715). The player presses a start key to begin play (block 716). The player can then take the shots (block 717). Once the session is complete, the system automatically determines and displays results of the session, in the form of session statistics, to the player (block 718). Some embodiments include different operational characteristics, such as, for example automatically determining the shot location using one of the techniques described above instead of receiving it from the player (block 714) or receiving the type of shot via headset 104 to accommodate "hands-free" operation (block 715) and so forth.

FIGS. 8A – 8C are functional diagrams of example presentations for displaying performance measurements in the playing environment illustrated in FIG. 1. As shown in FIG. 8A, shooting session historical performance measurements may be presented to the player or coach in display area 202 or 204 of console 101. Other types of reports can be provided to assist the player or coach in evaluating the results of play. For example, Fig. 8B illustrates an example of a report organized by week. Table 1 illustrates other types of reports provided by various embodiments:

Report Type	Reports
Calendar	Weekly summary by day Monthly summary by week Yearly summary by month Cumulative by shooter
Location	All shot types By shot type Summary for 3 pointers
Shot type	All locations By location Summary for 3 pointers
Summaries	Top 10 shooting sessions by % made (by date) Top 10 shooting locations (location) Top 10 shot types (type) Top 10 shot types by location (type/loc.)

Table 1: Reports by Type

Some embodiments provide the capability to view the results of play in graph or other tabular formats. For example, FIG. 8C illustrates an example of a graph for providing results of play

in graphical format. Other embodiments will display other statistics appropriate to the shooting sport being practiced.

FIG 9 is a block diagram illustrating a high level overview of a screen displayed by a software embodiment for transferring information to and from a console apparatus of one embodiment of the present invention. As shown in FIG. 9, console 101 can include software that enables a variety of functions, including without limitation: 1) Connect/interface the console 101 with a PC via a USB port or other communications interface; 2) Display performance data in a variety of formats, such as illustrated by FIGS. 8A – 8C; 3) Download performance data to the PC; 4) Enable automatic generation of standardized performance data reports; 5) Provide for upload of firmware upgrades; 6) Allow performance data to be sent via email; 7) Transfer status information about operation of the console 101 and associated hardware and software back to manufacturer. Table 2 illustrates other types of menu options provided in an embodiment:

Pull down menus	Sub-menus
Enter shooter I.D.	
Select shot location	- All shot types - By shot type - Summary for 3 pointers
Select shot type	- All locations - By location - Summary for 3 pointers
Select calendar/dates	-Cumulative -Annual -Monthly -Weekly
Select report type	-Standard -Top 10 shooting sessions -Top 10 shot locations -Top 10 shot types by location

Table 2: Menu Options

Various embodiments will include other functions readily apparent to persons skilled in the art but not mentioned here for brevity.

In one embodiment, a path made by the ball during a shot is tracked by the console 101. The path information may be used to locate the ball as it goes through the hoop or may be used to track the path of the ball in order to analyze the shooter's technique. One technique for tracking the ball path during play involves adding a radio frequency identification ("RFID") chip to the ball. The RFID chip can signal a tracking unit integrated into or cooperatively coupled with the console 101, enabling the console 101 to track the path of the ball. In another technique, the video camera 105 and

image processing software may be used to track the path of the ball during the shot. An exemplary arc tracking analyzer for use in the present invention is available from Pillar Vision, Inc. of Menlo Park, CA (www.noahbasketball.com) and by Radar Golf, Inc. of Roseville, CA (www.radargolf.com).

FIGS. 10A – 10F are block diagrams illustrating a high-level overview of an example operation of a synchronization mechanism for synchronizing the console with the sensor(s) in an embodiment of the present invention. The console and each sensor will be synchronized with each other electronically. The purpose of the synchronization function is to uniquely identify a sensor with a console to allow one to one communication between the synchronized components. In one embodiment, a console 101 may communicate with up to four (4) unique sensors but a sensor should only communicate with one console at a time. A sensor will synchronize with a console through a wireless interface by holding down a particular button on the sensor and the console simultaneously for 3 - 5 seconds as illustrated by FIGS. 10A – 10F.

In other aspects, the invention encompasses in some embodiments, computer apparatus, computing systems and machine-readable media configured to carry out the foregoing methods. In addition to an embodiment consisting of specifically designed integrated circuits or other electronics, the present invention may be conveniently implemented using a conventional general purpose or a specialized digital computer or microprocessor programmed according to the teachings of the present disclosure, as will be apparent to those skilled in the computer art.

Appropriate software coding can readily be prepared by skilled programmers based on the teachings of the present disclosure, as will be apparent to those skilled in the software art. The invention may also be implemented by the preparation of application specific integrated circuits or by interconnecting an appropriate network of conventional component circuits, as will be readily apparent to those skilled in the art.

The present invention includes a computer program product which is a storage medium (media) having instructions stored thereon/in which can be used to program a computer to perform any of the processes of the present invention. The storage medium can include, but is not limited to, any type of rotating media including floppy disks, optical discs, DVD, CD-ROMs, microdrive, and magneto-optical disks, and magnetic or optical cards, nanosystems (including molecular memory ICs), or any type of media or device suitable for storing instructions and/or data.

Stored on any one of the computer readable medium (media), the present invention includes software for controlling both the hardware of the general purpose/specialized computer or microprocessor, and for enabling the computer or microprocessor to interact with a human user or other mechanism utilizing the results of the present invention. Such software may include, but is not limited to, device drivers, operating systems, and user applications.

FIG. 11 illustrates an exemplary processing system 1100, which can comprise the console 101 of FIGS. 2A - 2J. Turning now to FIG. 11, an exemplary computing system is illustrated that may comprise the console 101 of FIGS. 2A - 2J. While other alternatives might be utilized, it will be

presumed for clarity sake that components of the systems of FIGS. 2A - 2J are implemented in hardware, software or some combination thereof in at least one embodiment.

Computing system 1100 comprises components coupled via one or more communication channels (e.g., bus 1101) including one or more general or special purpose processors 1102, such as a
5 Pentium®, Centrino®, Power PC®, digital signal processor ("DSP"), and so on. System 1100 components also include one or more input devices 1103 (such as a mouse, keyboard, microphone, pen, and so on), and one or more output devices 1104, such as a suitable display, speakers, actuators, and so on, in accordance with a particular application. (It will be appreciated that input or output devices can also similarly include more specialized devices or hardware/software device
10 enhancements suitable for use by the mentally or physically challenged.)

System 1100 also includes a computer readable storage media reader 1105 coupled to a computer readable storage medium 1106, such as a storage/memory device or hard or removable storage/memory media; such devices or media are further indicated separately as storage 1108 and
15 memory 1109, which may include hard disk variants, floppy/compact disk variants, digital versatile disk ("DVD") variants, smart cards, read only memory, random access memory, cache memory, and so on, in accordance with the requirements of a particular application. One or more suitable communication interfaces 1107 may also be included, such as a modem, DSL, infrared, RF or other suitable transceiver, and so on for providing inter-device communication directly or via one or more suitable private or public networks or other components that may include but are not limited to those
20 already discussed.

Working memory 1110 further includes operating system ("OS") 1111 elements and other programs 1112, such as one or more of application programs, mobile code, data, and so on for implementing system 1100 components that might be stored or loaded therein during use. The particular OS or OSs may vary in accordance with a particular device, features or other aspects in
25 accordance with a particular application (e.g. Windows, WindowsCE, Mac, Linux, Unix or Palm OS variants, a cell phone OS, a proprietary OS, Symbian, and so on). Various programming languages or other tools can also be utilized, such as those compatible with C variants (e.g., C++, C#), the Java 2 Platform, Enterprise Edition ("J2EE") or other programming languages in accordance with the requirements of a particular application. Other programs 1112 may further, for example, include one
30 or more of activity systems, education managers, education integrators, or interface, security, other synchronization, other browser or groupware code, and so on, including but not limited to those discussed elsewhere herein.

When implemented in software (e.g. as an application program, object, agent, downloadable, servlet, and so on in whole or part), a learning integration system or other component
35 may be communicated transitionally or more persistently from local or remote storage to memory (SRAM, cache memory, etc.) for execution, or another suitable mechanism can be utilized, and components may be implemented in compiled or interpretive form. Input, intermediate or resulting

data or functional elements may further reside more transitionally or more persistently in a storage media, cache or other volatile or non-volatile memory, (e.g., storage device 1108 or memory 1109) in accordance with a particular application.

5 Other features, aspects and objects of the invention can be obtained from a review of the figures and the claims. It is to be understood that other embodiments of the invention can be developed and fall within the spirit and scope of the invention and claims. The foregoing description of preferred embodiments of the present invention has been provided for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise forms disclosed. Many modifications and variations will be apparent to the practitioner skilled in the art.

10 The embodiments were chosen and described in order to best explain the principles of the invention and its practical application, thereby enabling others skilled in the art to understand the invention for various embodiments and with various modifications that are suited to the particular use contemplated. It is intended that the scope of the invention be defined by the following claims and their equivalence.

In the Claims:

1. A shooting sport measurement system, comprising:
a first sensor to detect an attempted shot taken by one or more participants;
a second sensor to detect a successful shot by one or more participants; and
5 a console communicatively coupled with the first sensor and the second sensor to determine performance of the one or more participants based at least in part on the attempted shot and the successful shot; and
wherein the first sensor includes a sensor adapted to detect vibration and the second sensor includes a sensor adapted to detect an object passing a target.
10
2. The system of claim 1, wherein the console is a portable console.
3. The system of claim 2, wherein the portable console includes at least one of a cellular telephone, a personal data assistant (PDA), and an MP3 compatible device.
15
4. The system of claim 1, further comprising,
a third sensor to determine an effort;
wherein the third sensor is removably connected with the one or more participants.
- 20 5. The system of claim 4, further comprising the third sensor disposed in a shoe of the one or more participants.
6. The system of claim 1, wherein the first sensor comprises an accelerometer connected with a rigid or semi-rigid structure near the target to determine the attempted shot based on vibration of the
25 rigid or semi-rigid structure.
7. The system of claim 1, wherein:
the target is a basketball hoop having a basketball net extending therefrom; and
the second sensor is a textile form sensor associated with the basketball net.
30
8. The system of claim 1, wherein:
the target is a basketball hoop having a basketball net extending therefrom; and
the second sensor is a piezoceramic sensor associated with one or both of the basketball net
and a basketball hoop.
35
9. The system of claim 1, wherein:
the target is a basketball hoop having a basketball net extending therefrom; and

the second sensor is a rope pull switch associated with one or both of the basketball net and a basketball hoop.

10. The system of claim 1, wherein:

the target is a basketball net; and

the second sensor includes a material fixed onto the inside of the basketball net to sense a ball passing through the basketball net.

11. The system of claim 1, further comprising a detection mechanism that detects a position of the one or more participants.

12. The system of claim 11, wherein the detection mechanism is one or both of an infrared sensor that detects a position of the one or more participants using a 2-D grid and a camera having a ranging device.

13. The system of claim 11, wherein the detection mechanism is a pressure sensor grid disposed on at least a portion of a playing field.

14. The system of claim 13, further comprising:

a plurality of cells superimposed onto at least a portion of a playing field, wherein the plurality of cells indicates a player's position when a shot is taken.

15. The system of claim 13, wherein each of the plurality of cells are sized according to scoring relevance.

16. The system of claim 13, wherein each of the plurality of cells is associated with an alphanumeric naming convention facilitating ease of use.

17. The system of claim 1, further comprising:

a video device for capturing a video record of the attempted shot;

wherein the video device is activated by detection of the attempted shot.

18. The system of claim 1, further comprising:

a wireless headset for capturing an audio command from the one or more participant for

controlling a recording of information.

19 The system of claim 11, wherein the detection mechanism includes visual player location indicia that are adapted to be viewed by a console operator such that the console operator can manually enter the indicia into the console.

5 20. A computer based method for measuring shooting sports performance, the method comprising the computer implemented steps of:

determining whether a shot is attempted;

determining whether an attempted shot is successful;

determining a location of a participant taking the attempted shot;

10 receiving information about the participant; and

determining performance of the participant based on the determining steps.

21. A shooting sports measurement system, comprising:

a sensor to determine an attempted shot,

15 a sensor to determine a successful shot,

a detection mechanism that detects a position of a player when the attempted shot is determined;

a console, the console communicatively coupled with the sensors and the detection mechanism to receive data and determine performance of the player; and

20 wherein the sensor to determine an attempted shot includes at least one sensor disposed to sense vibration and the sensor to determine a successful shot includes at least one sensor to sense a ball passing through a target, thereby enabling the console to determine player performance by monitoring at least one of actions of the player and activity at the target.

25 22. The system of claim 21, wherein the detection mechanism includes visual player location indicia that is adapted to be viewed by a console operator, such that console operator can manually enter a location into the portable console.

23. The system of claim 21, wherein the detection mechanism automatically detects a position of a
30 player when the sensor determines an attempted shot is taken by the player.

24. The system of claim 21, wherein the detection mechanism automatically detects a position of a player when the sensor determines a successful shot is taken by the player.

35 25. The system of claim 21, wherein the portable console includes at least one of a cellular telephone, a personal data assistant (PDA), and an MP3 compatible device.

26. A shooting sports measurement system, comprising:

a plurality of first sensors to detect shots taken by a plurality of players,

a plurality of second sensors to determine shots made by the plurality of players,

a console, the console communicatively coupled with the plurality of first sensors and the

plurality of second sensors to receive data and determine performance of at least one player based at least in part on the data received; and

a synchronization mechanism to enable the console to learn which of the plurality of first sensors and the plurality of second sensors are associated with the console, thereby enabling the console to determine performance exclusively for players being monitored by the sensors associated with the console.

27. The system of claim 26, further comprising a detection mechanism that detects a position of a player when the player takes a shot, the console determining performance of at least one player based at least in part on information received from the detection mechanism that detects a position of a player.

28. The system of claim 26, wherein the first sensor comprises a vibration sensor adapted to be attached to the basketball rim or backboard to detect a shot taken.

29. The system of claim 26, wherein the second sensor comprises at least one of an optoelectronic sensor or a counter lever, adapted to be attached to the basketball rim or backboard to determine number of shots made at a specified location.

30. The system of claim 26, wherein the console acts as an input and output device for each shooting session.

31. The system of claim 26, wherein the console includes a time display, wherein the time display is selectively enabled to be at least one of continuously displayed and displayed alternating with display of play information.

32. The system of claim 27, wherein the detection mechanism that detects position of a player making shots comprises:

an infrared sensor that automatically detect a player's position using a 2-D grid.

33. The system of claim 27, wherein the detection mechanism that detects position of a player making shots comprises:

a pressure sensor grid disposed at least a portion of a playing field.

34. The system of claim 27, wherein the detection mechanism that detects position of a player making shots comprises:

a camera with a ranging device.

35. The system of claim 27, further comprising:

a plurality of cells superimposed onto at least a portion of a playing field, wherein the plurality of cells indicates a player's position when a shot is taken.

36. The system of claim 35, wherein the plurality of cells superimposed onto at least a portion of a playing field further comprises:

a plurality of cells of varying sizes according to relevance to scoring in the shooting sport under practice superimposed onto at least a portion of a playing field.

37. The system of claim 35, wherein the plurality of cells superimposed onto at least a portion of a playing field further comprises:

a plurality of cells associated with an alphanumeric naming convention facilitating ease of use superimposed onto at least a portion of a playing field.

38. The system of claim 35, wherein the plurality of cells superimposed onto at least a portion of a playing field further comprises:

a plurality of cells arranged according to a playing rule superimposed onto at least a portion of a playing field.

39. The system of claim 35, wherein the plurality of cells superimposed onto at least a portion of a playing field further comprises:

a plurality of cells arranged according to an international playing rule superimposed onto at least a portion of a playing field.

40. The system of claim 26, further comprising:

a video device for capturing a video record of a player taking a shot, wherein the video device is triggered when a shot is taken.

41. The system of claim 26, further comprising:

a wireless headset for capturing a audio commands from a player taking a shot, wherein the audio commands control recording of information about the shot.

42. The system of claim 27, wherein the detection mechanism includes visual player location indicia that are adapted to be viewed by a console operator such that the console operator can manually enter the indicia into the console.

5 43. A computer based method for measuring shooting sports performance, the method comprising the computer implemented steps of:

determining whether a shot is made;

synchronizing the shot with one of a plurality of players;

determining a location of the player taking the shot when the shot is taken;

10 receiving information about the player; and

determining performance of the player based on the determining steps.

44. A shooting sports measurement system, comprising:

a sensor to determine shots made,

15 a detection mechanism that detects a position of a player when the player takes a shot;

a console, the console communicatively coupled with the sensor and the detection mechanism to receive data and determine performance of a player; and

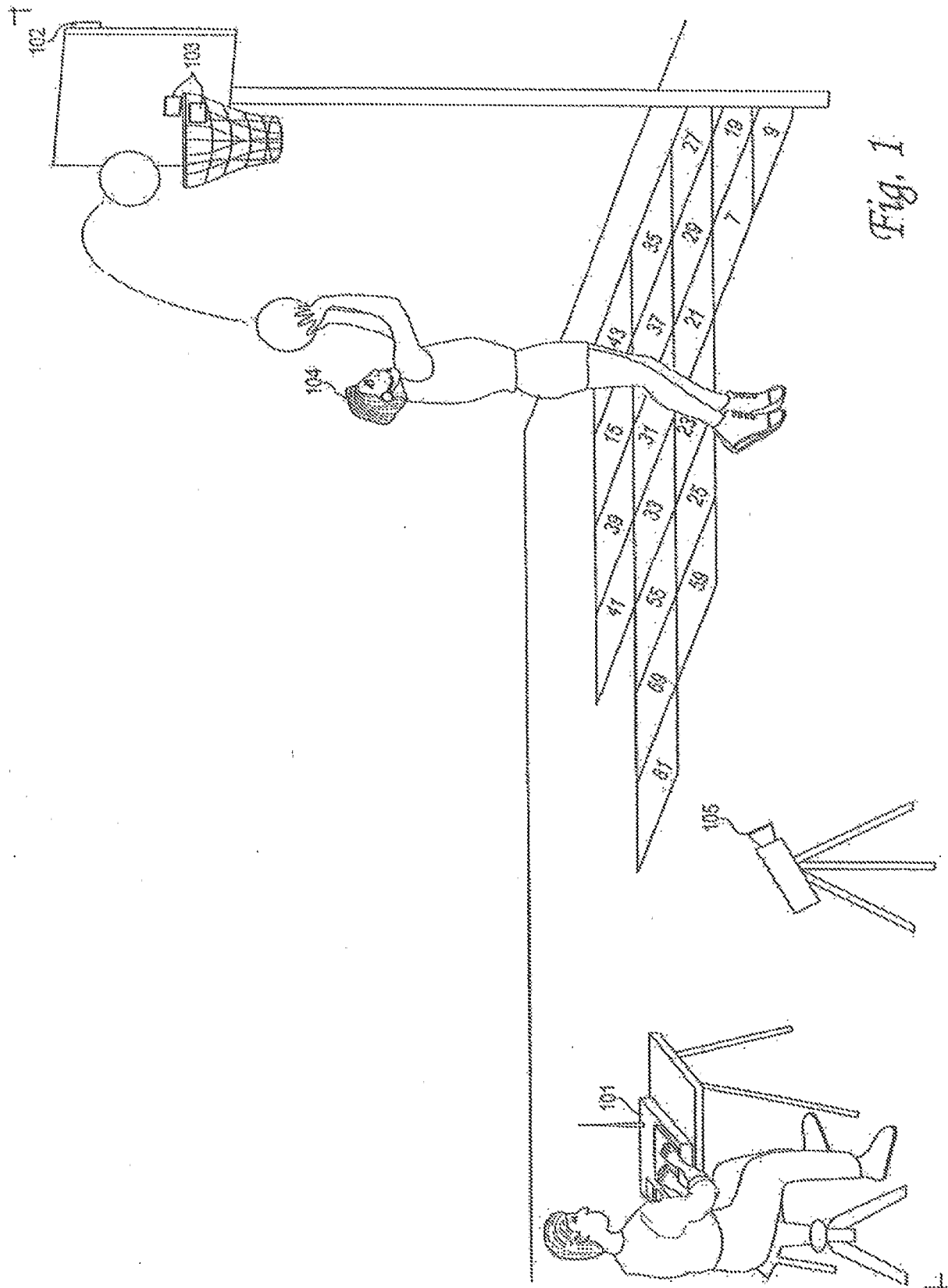
a synchronization mechanism to associate the sensors with the console, thereby enabling the console to determine performance exclusively for players being monitored by the sensors.

20 45. The system of claim 44, wherein the detection mechanism includes visual player location indicia that is adapted to be viewed by a console operation, such that console operator can manually enter the location into the console.

25 46. The system of claim 44, wherein the detection mechanism automatically detects a position of a player when the player take a shot.

47. The system of claim 44, wherein the detection mechanism automatically detects a position of a player when the player takes a shot.

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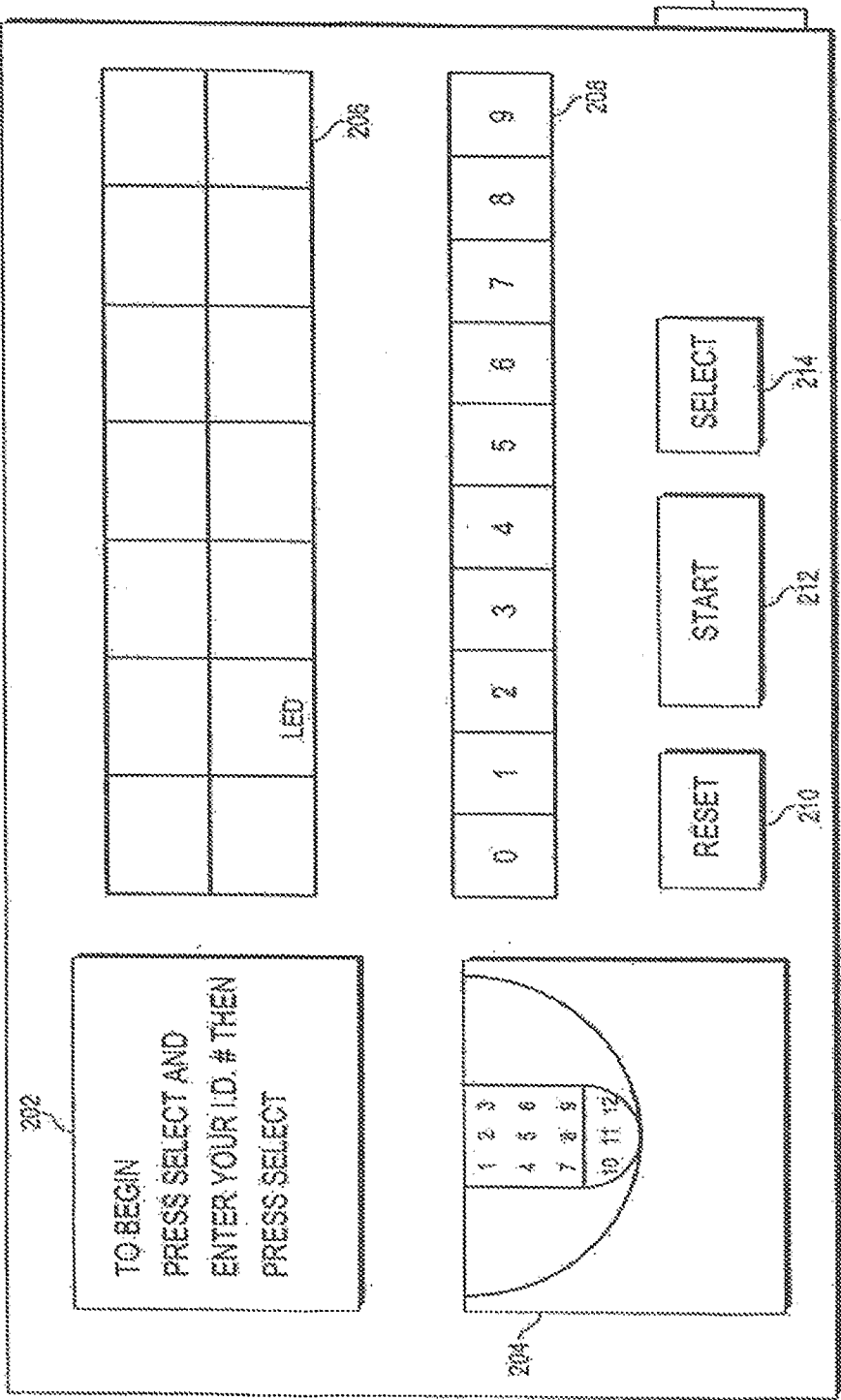


Fig. 2A

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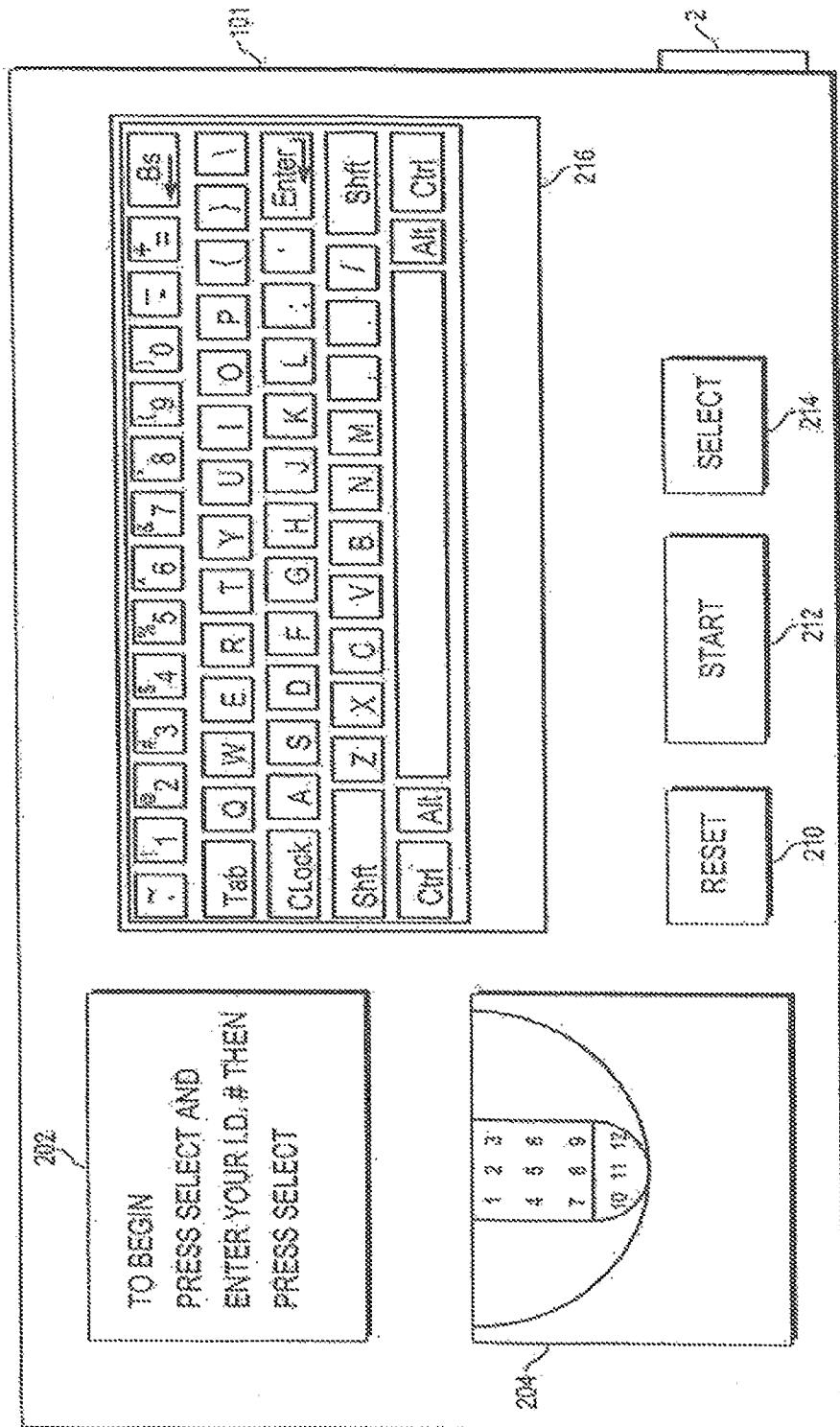


Fig. 2B

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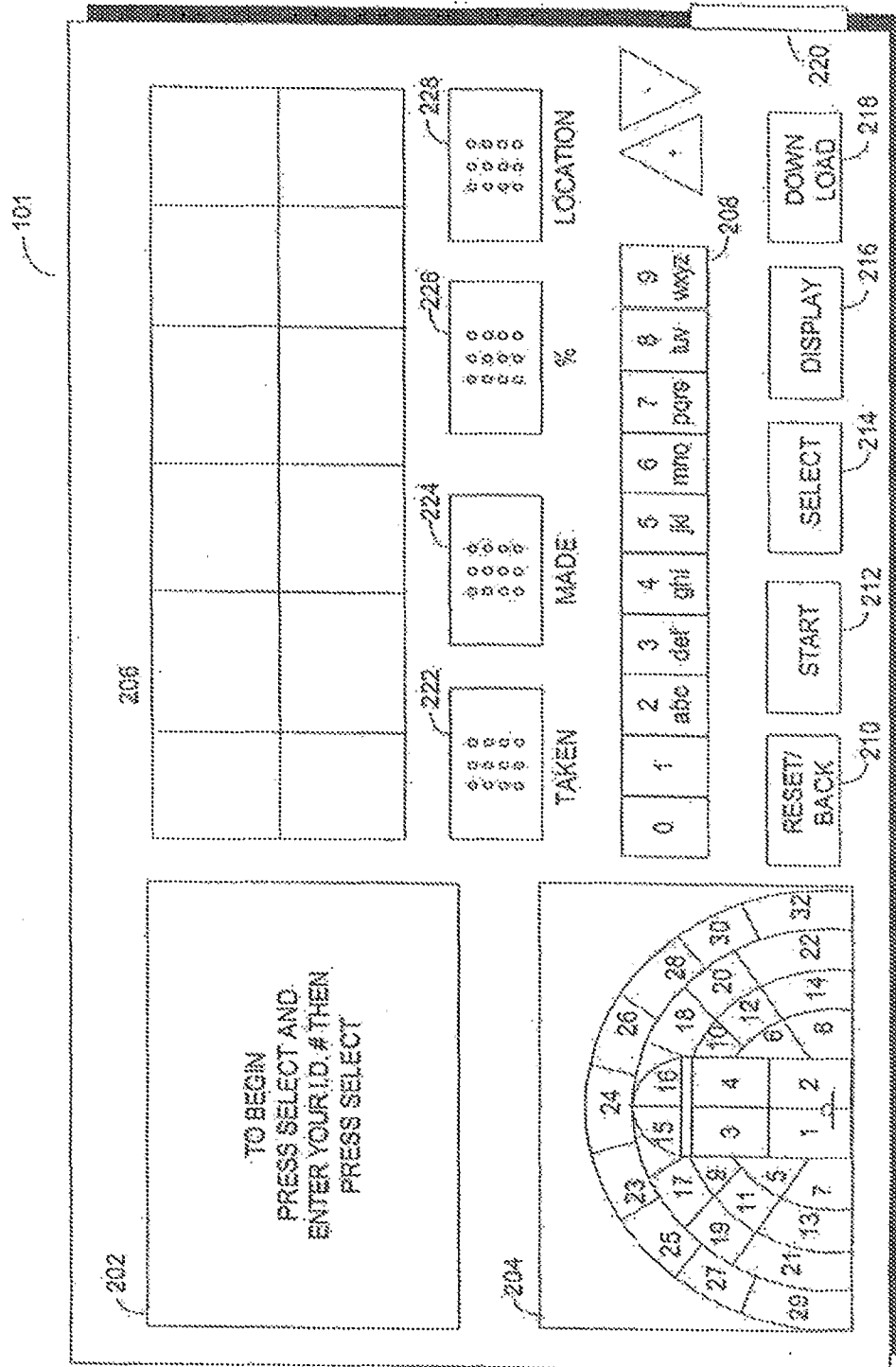


Fig. 2C

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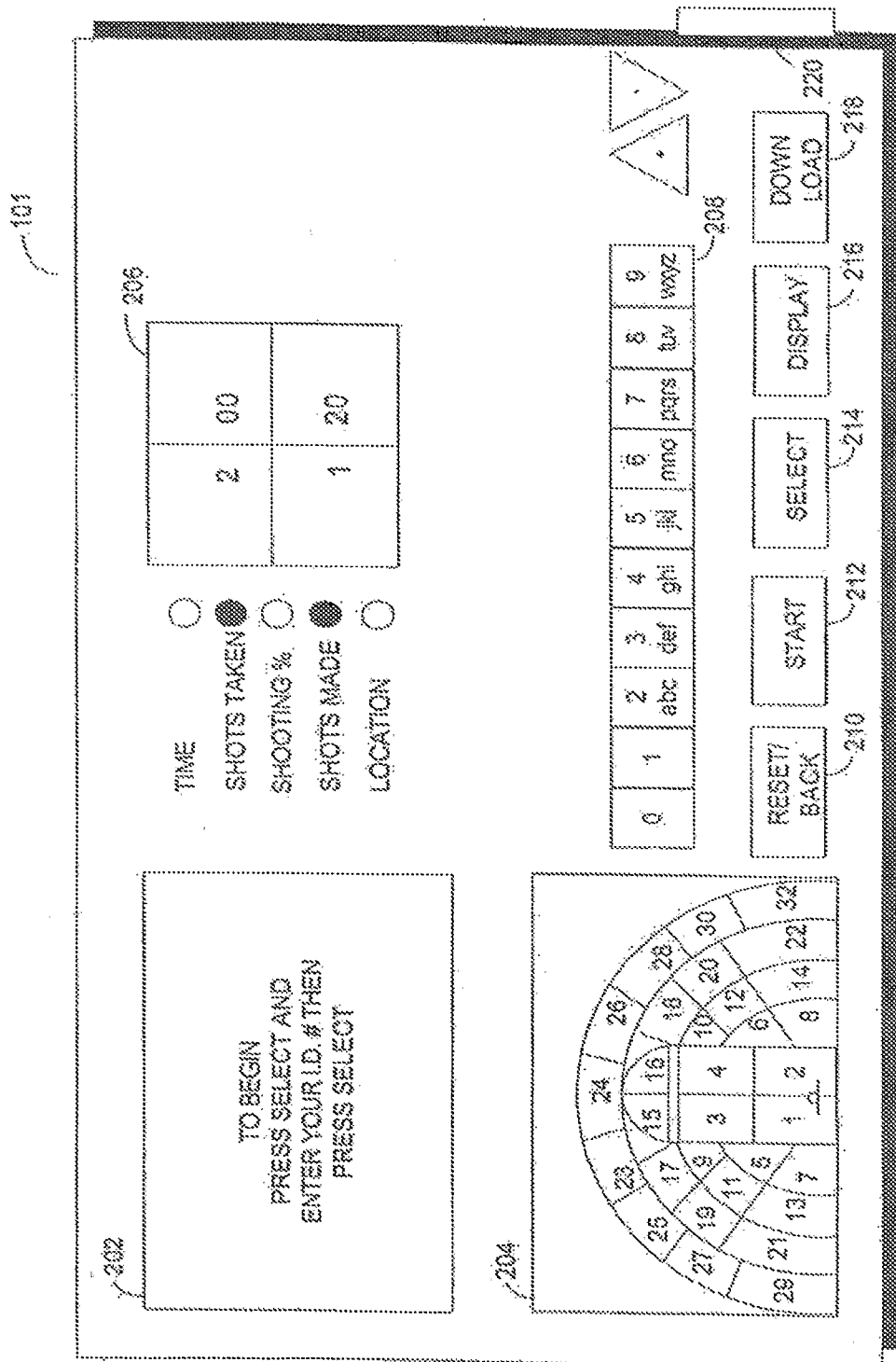


Fig. 2D

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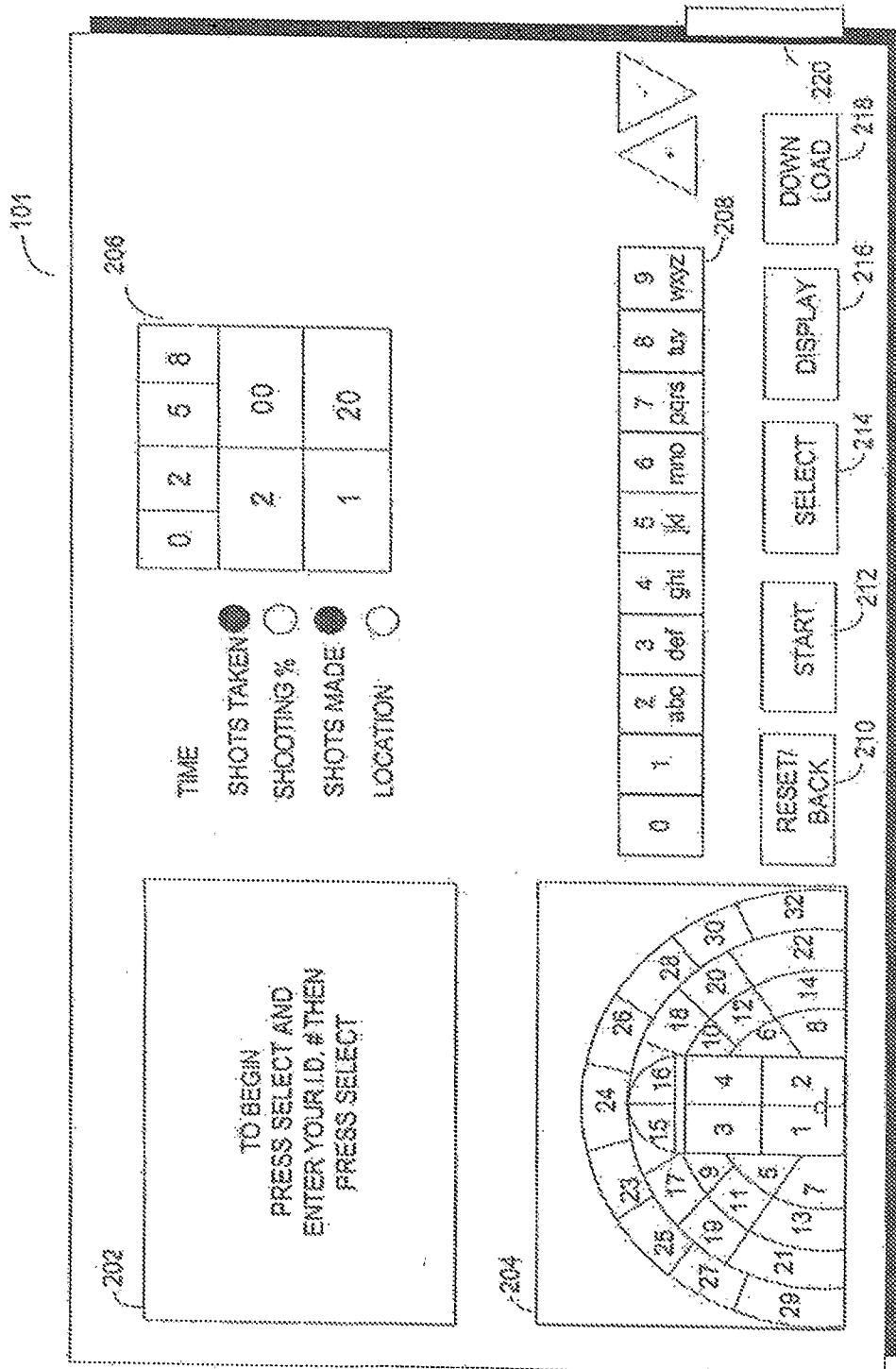


Fig. 2E

7/25

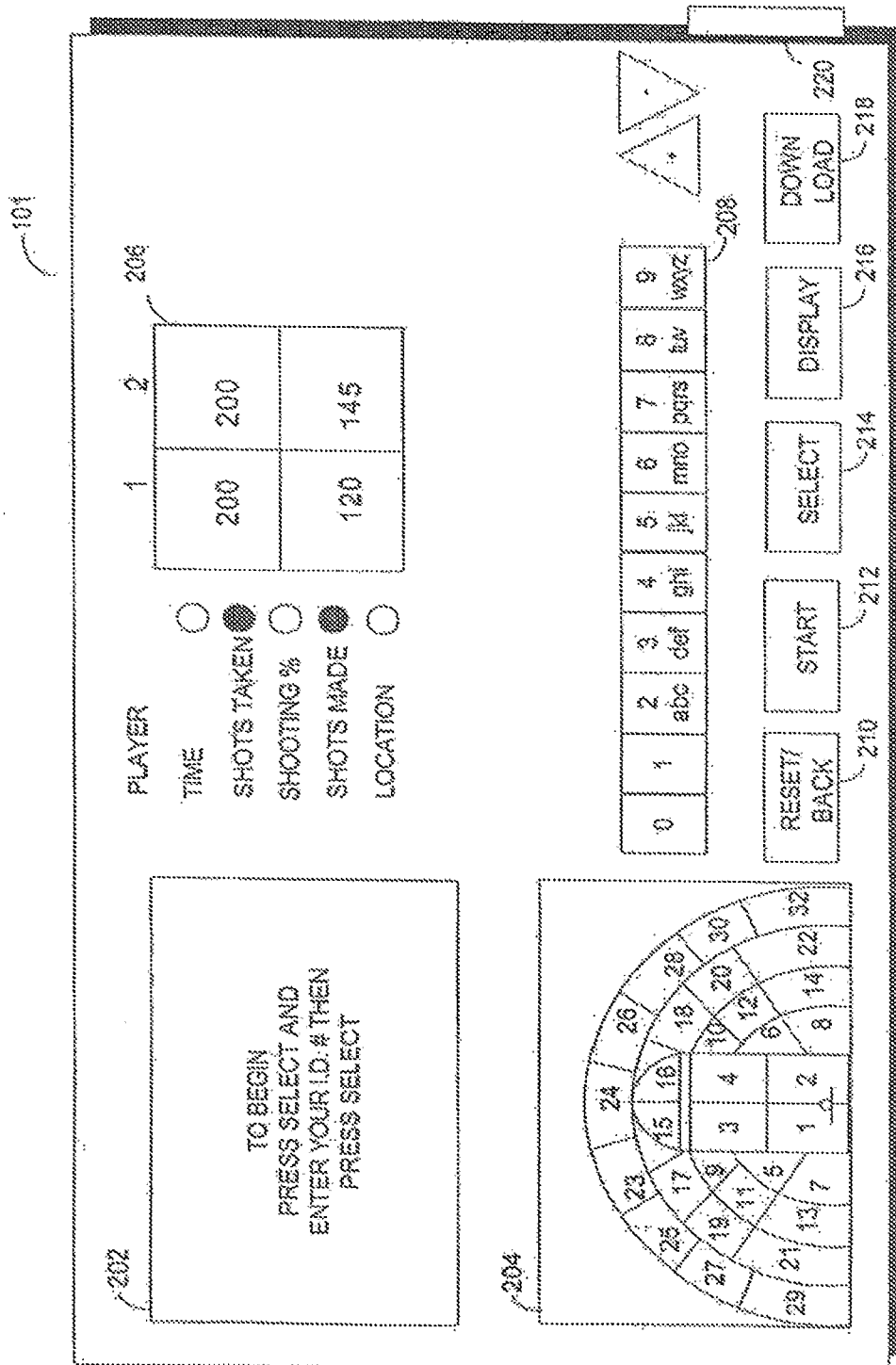


Fig. 2F

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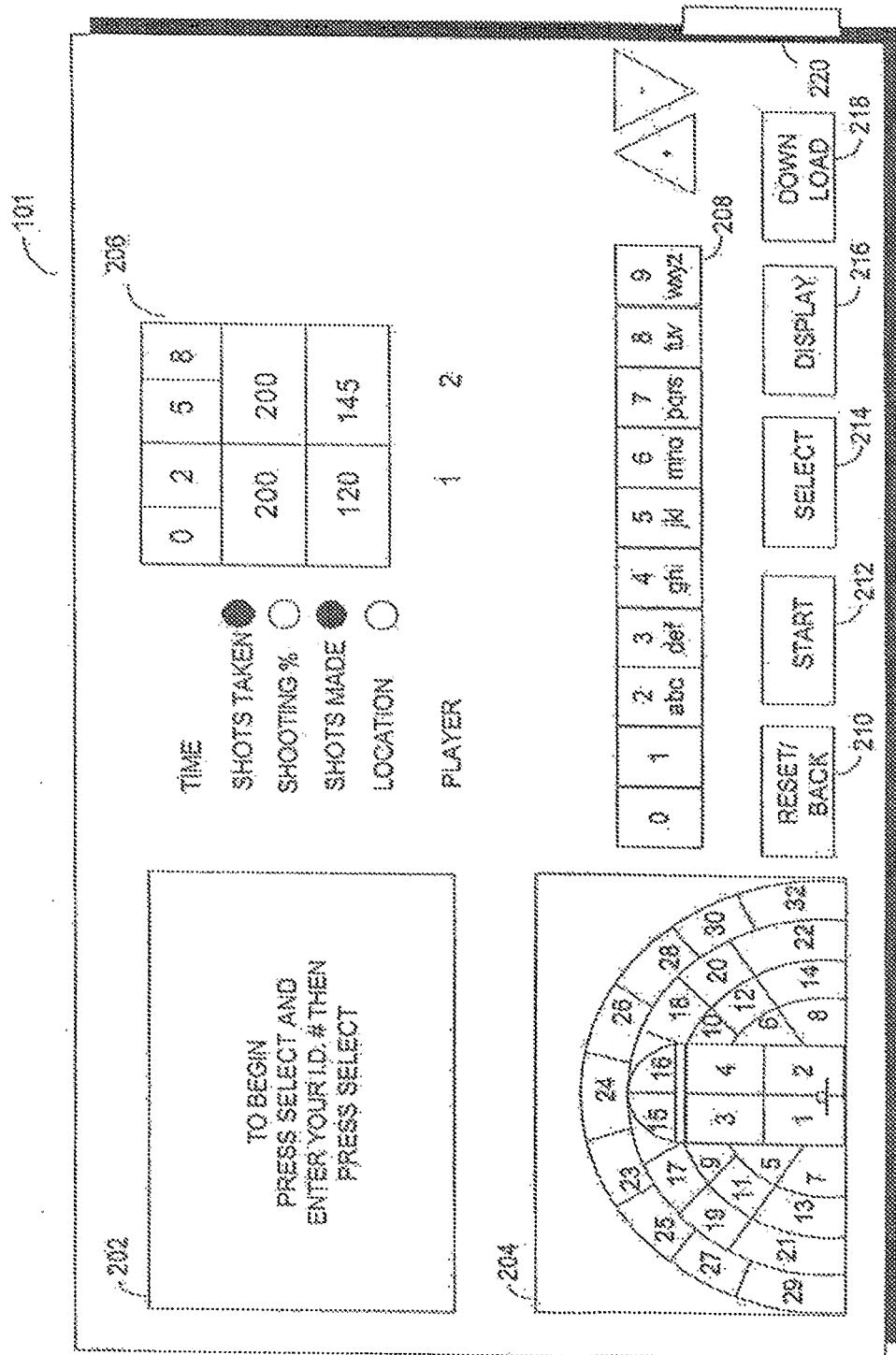


Fig. 25

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TO BEGIN
PRESS SELECT AND
ENTER YOUR ID.# THEN
PRESS SELECT

PLAYER

TIME ☐

SHOTS TAKEN ☒

SHOOTING % ☐

SHOTS MADE ☒

LOCATION ☐

1	2	3	4
200	200	200	200
120	145	155	180

0	1	2	3	4	5	6	7	8	9
		abc	def	ghi	jkl	mno	pqrs	tuv	wxyz

RESET/
BACK

START

SELECT

DISPLAY

DOWN
LOAD

TO BEGIN
PRESS SELECT AND
ENTER YOUR ID.# THEN
PRESS SELECT

0	1	2	3	4	5	6	7	8	9
		abc	def	ghi	jkl	mno	pqrs	tuv	wxyz

RESET/
BACK

START

SELECT

DISPLAY

DOWN
LOAD

Fig. 2H

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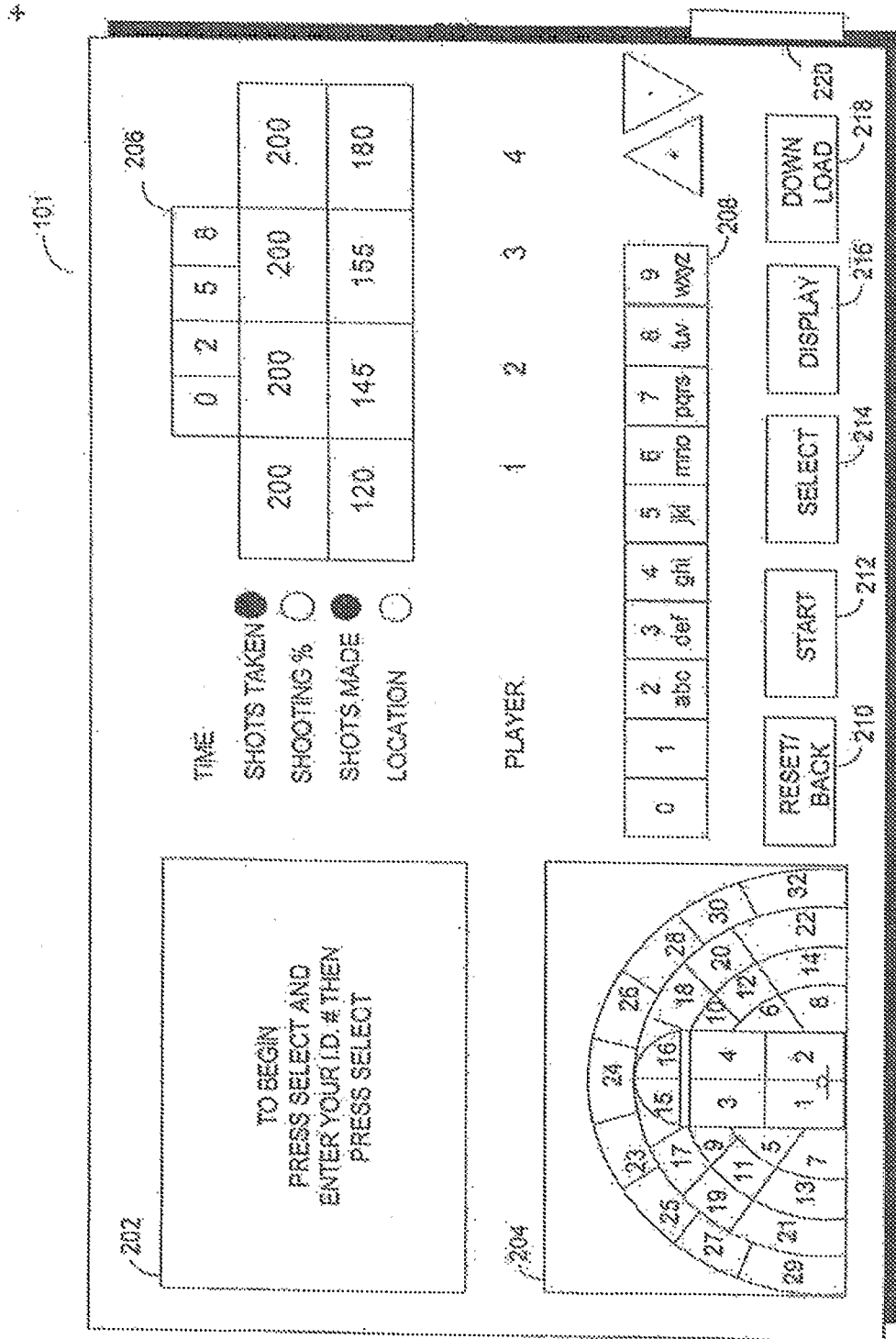
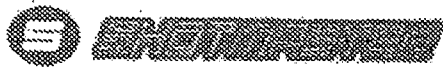
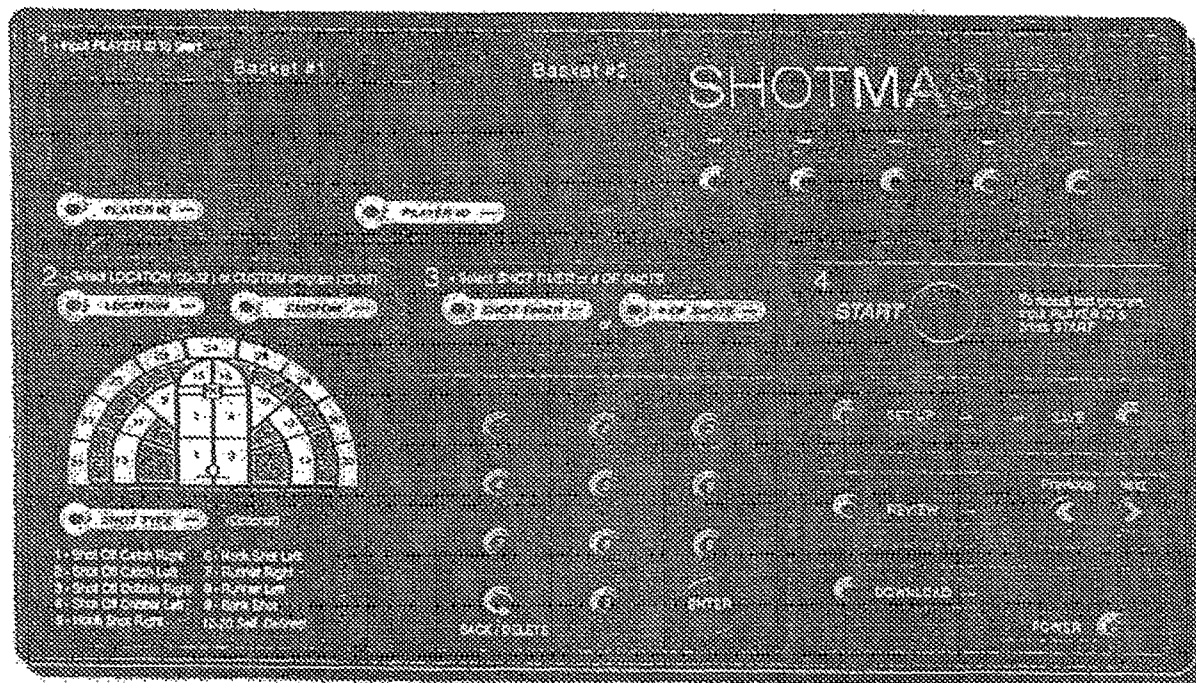


Fig. 21

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Controller

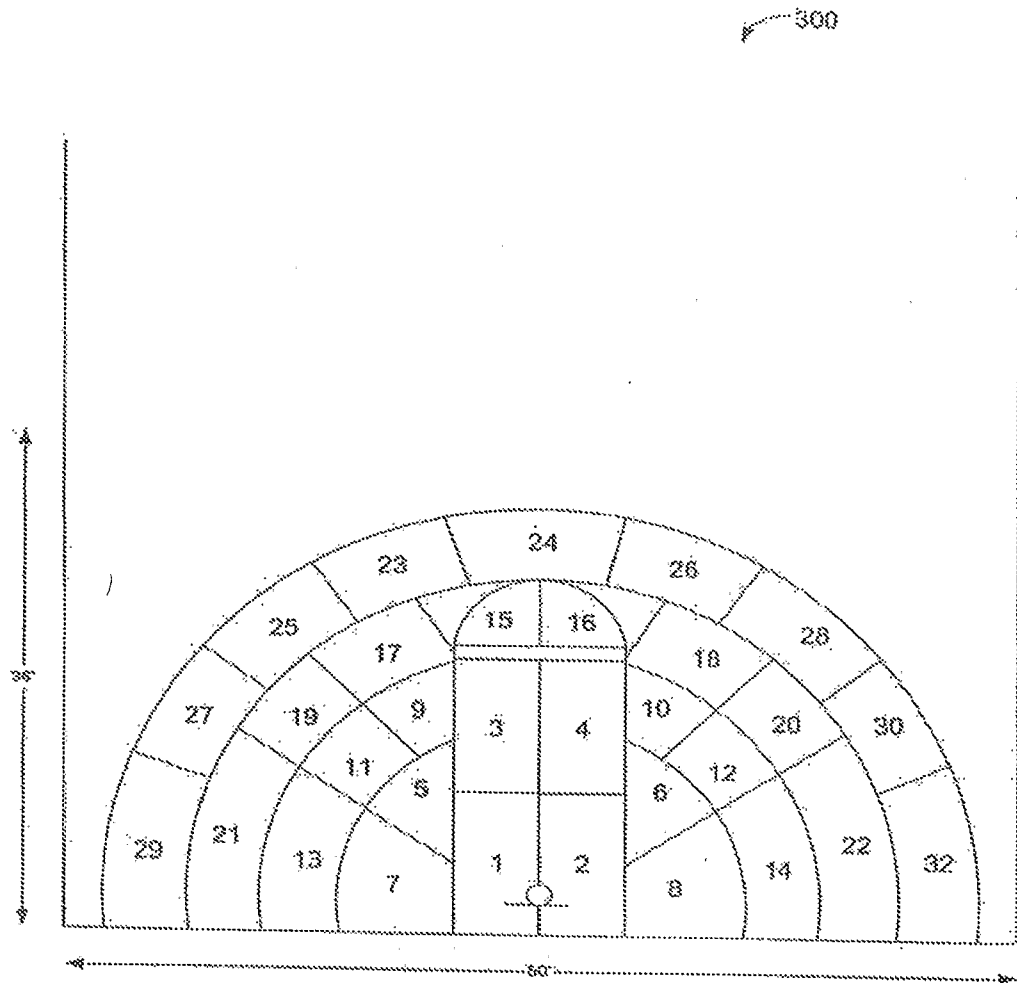


Zoe Design Associates, Inc. 2007-01-01 & 2007-01-01



Fig. 2J

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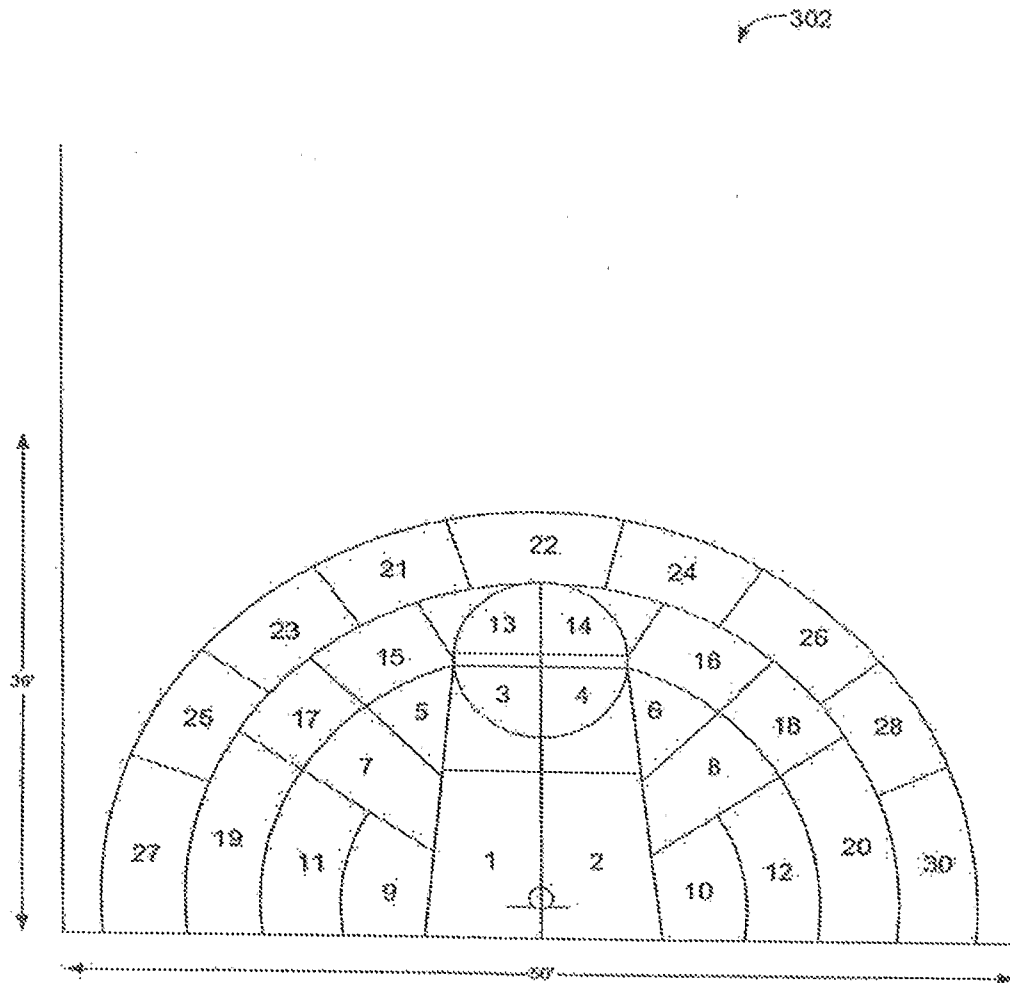


Fig. 3B

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- ENTER NUMBER OF SHOOTERS
- ENTER SHOOTER ID# OR NAME
- ENTER # OF MINUTES OR NUMBER OF SHOTS TO TAKE
- ENTER SHOT LOCATION (CELL, 3PT. CYCLE, OR PROGRAM)
- ENTER SHOT TYPE
- PRESS START

Fig. 4A

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- ENTER NUMBER OF SENSOR PAIRS
- DEPRESS SYNCH BUTTON ON SENSOR # 1
- DEPRESS SYNCH BUTTON ON SENSOR # 2
-
-
-
- DEPRESS SYNCH BUTTON ON SENSOR # n
- SYNCHRONIZATION COMPLETE

Fig. 4B

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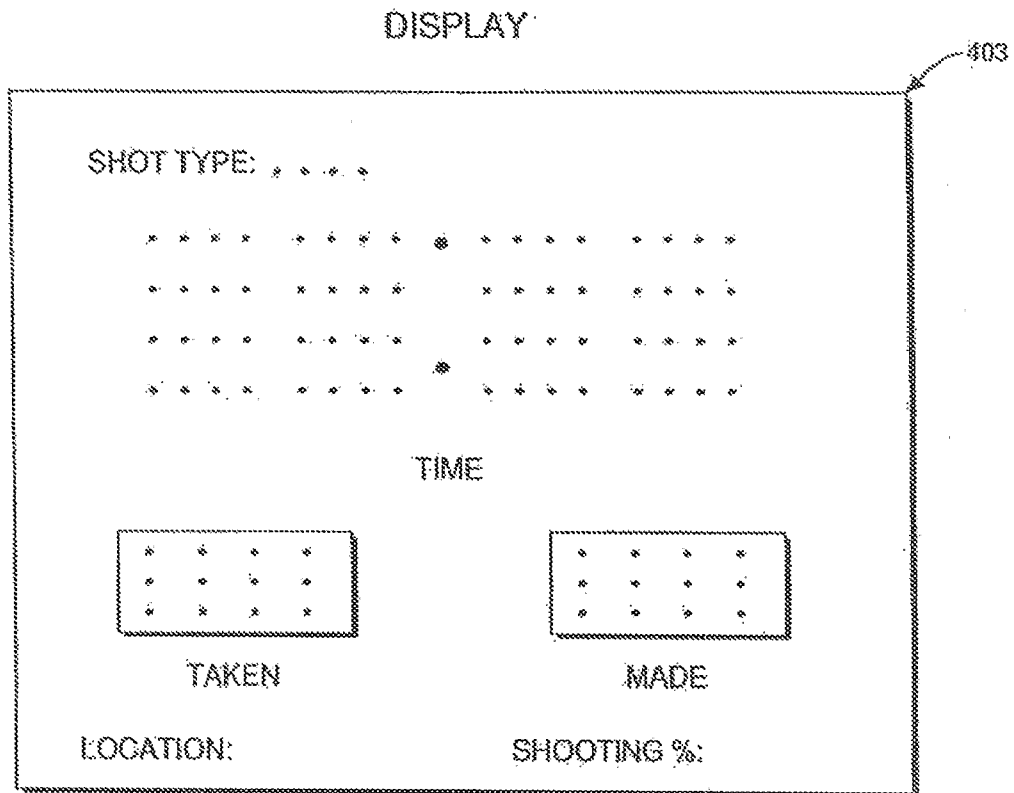


Fig. 4C

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SHOT TYPES

1. JUMP SHOT OFF CATCH RIGHT
2. JUMP SHOT OFF CATCH LEFT
3. SHOT OFF DRIBBLE RIGHT
4. SHOT OFF DRIBBLE LEFT
5. HOOK SHOT RIGHT
6. HOOK SHOT LEFT
7. RUNNER RIGHT
8. RUNNER LEFT
9. BANK SHOT
- 10 - 50. SELF DEFINED

Fig. 5

INPUT DATA AND MEASUREMENTS

TYPICAL HISTORICAL DATA

SHOOTER: ID. PERFORMANCE DATA
SHOOTING TIME: MINUTES AND SECONDS
SHOT LOCATION: AS SPECIFIED
DATE AND TIME OF WORKOUT - CYCLE NUMBER
OPTION: ENTER # OF SHOTS TO BE TAKEN

TYPICAL MEASURED DATA:

- LOCATION
- NO. SHOTS TAKEN
- NO. SHOTS MADE
- ELAPSED TIME
- PERSONAL RECORD
- % MADE

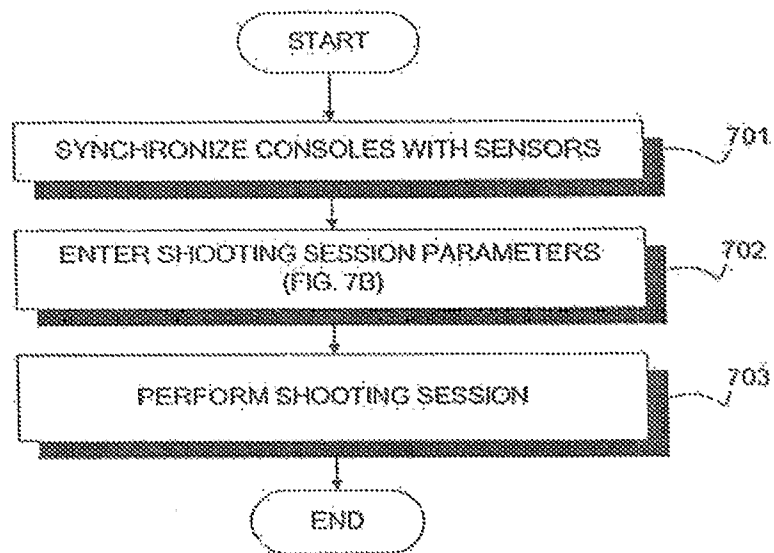
TYPICAL RESULTS (PER CYCLE, CUMMULATIVE, BY DATES):

- SHOOTING % BY LOCATION
- HISTORICAL SHOOTING STATISTICS
- SHOTS TAKEN
- SHOTS MADE

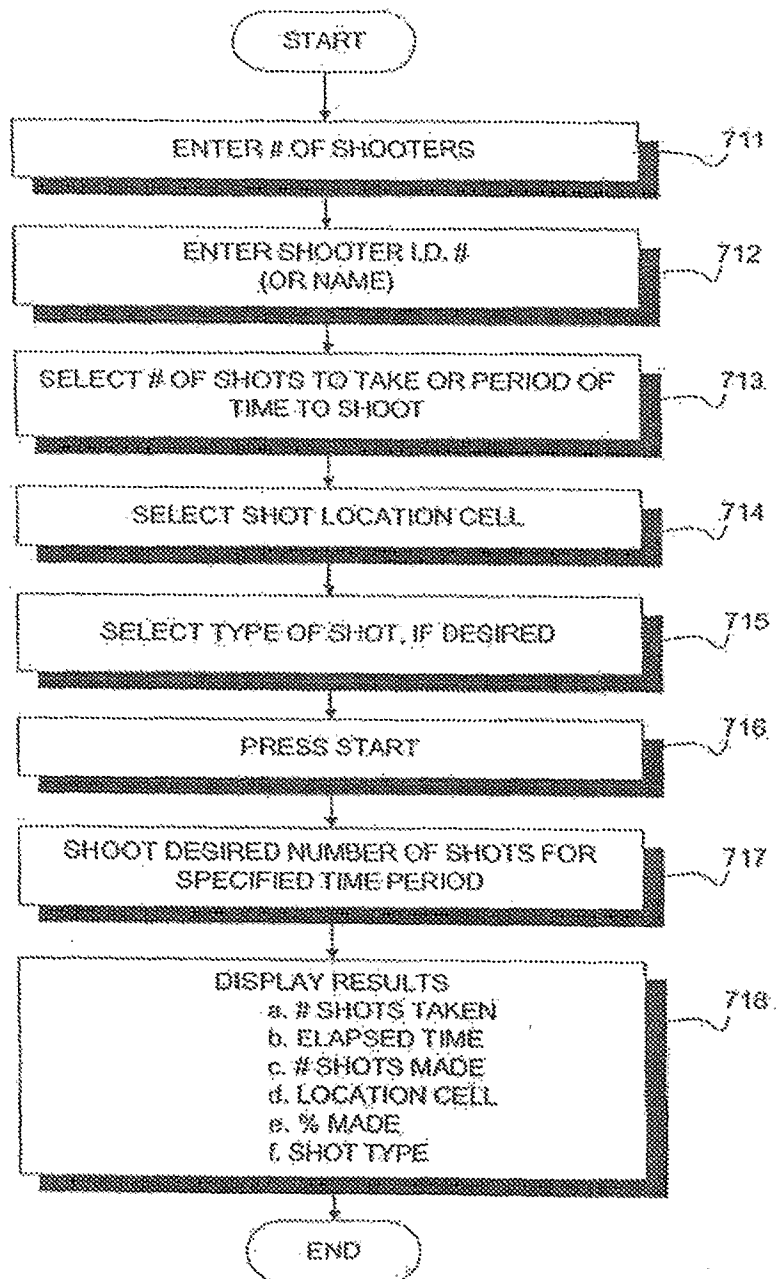
Fig. 6

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*Fig. 7A*

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*Fig. 7B*

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800

HISTORICAL OUTPUT - ARCHIVE

SESSION SHOOTER ID DATE TIME SHOT LOCATION SHOT TYPE ELAPSED TIME SHOTS TAKEN SHOTS MADE SHOOTING %

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.
- 7.
- 8.
- 9.
- 10.

Fig. 8A

+

Report Output

Report 1 Weekly Summary by Day

Week 1	Shooter	Shot Type	Shot Location	Shots Taken	Shots Made	Shooting %	Shots Made Per Minute
--------	---------	-----------	---------------	-------------	------------	------------	-----------------------

Fig. 8B

REPORT GRAPHS

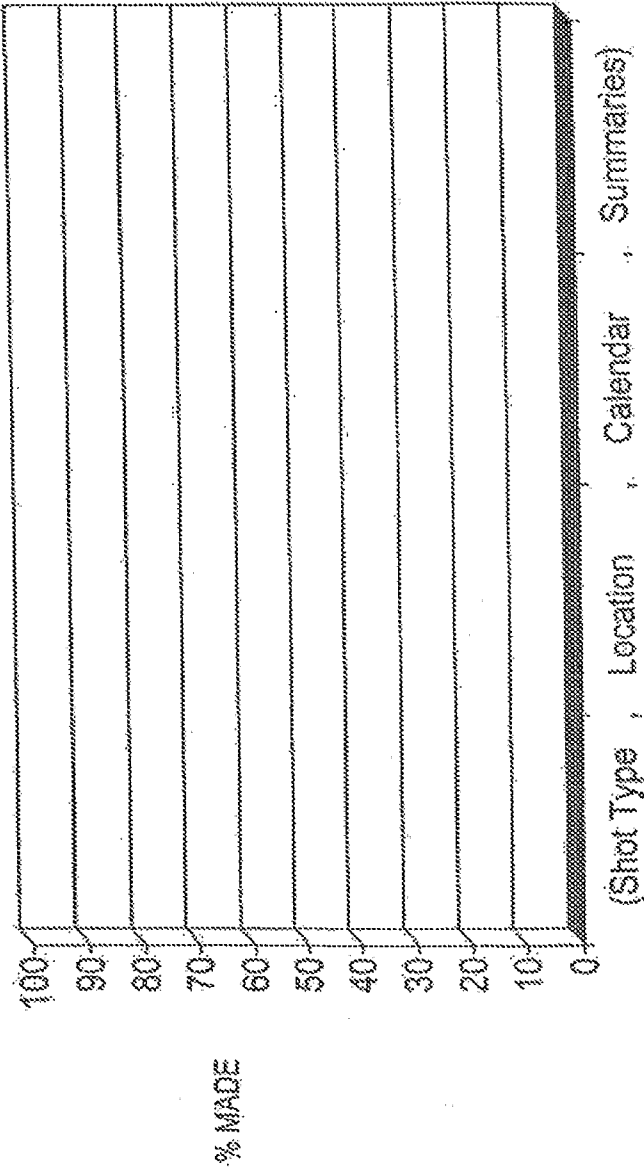


Fig. 8C

SHOTMASTER PC TRANSFER SOFTWARE

FILE VIEW UPGRADE HELP
└ EXPORT └ SORT └ FIRMWARE └ ABOUT
EXIT

CONNECT		DISPLAY		DELETE		REPORTS		SEND		UP LOAD/ DOWN LOAD
	FILE NAME									

STATUS: SHOTMASTER IS NOT CONNECTED

Fig. 9

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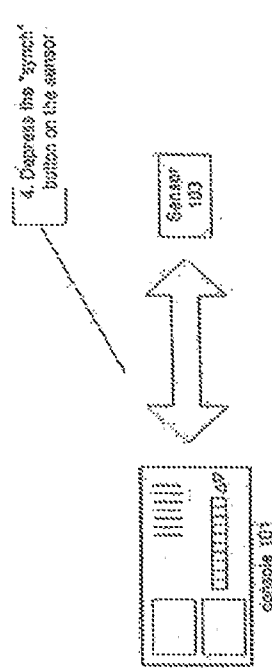


Fig. 10D

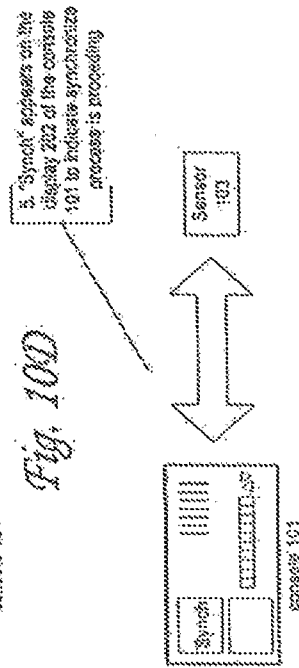


Fig. 10E

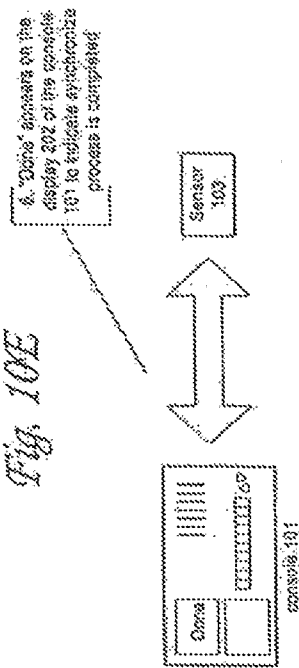


Fig. 10F

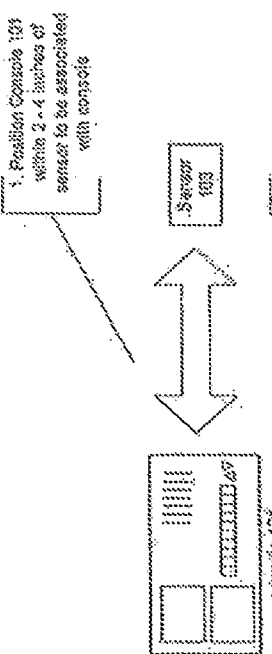


Fig. 10A

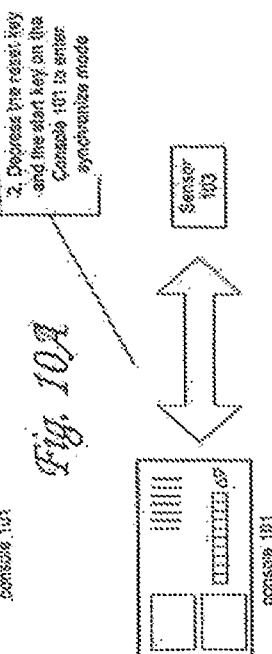


Fig. 10B

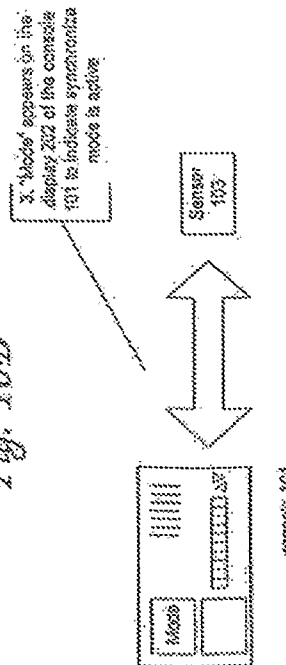


Fig. 10C

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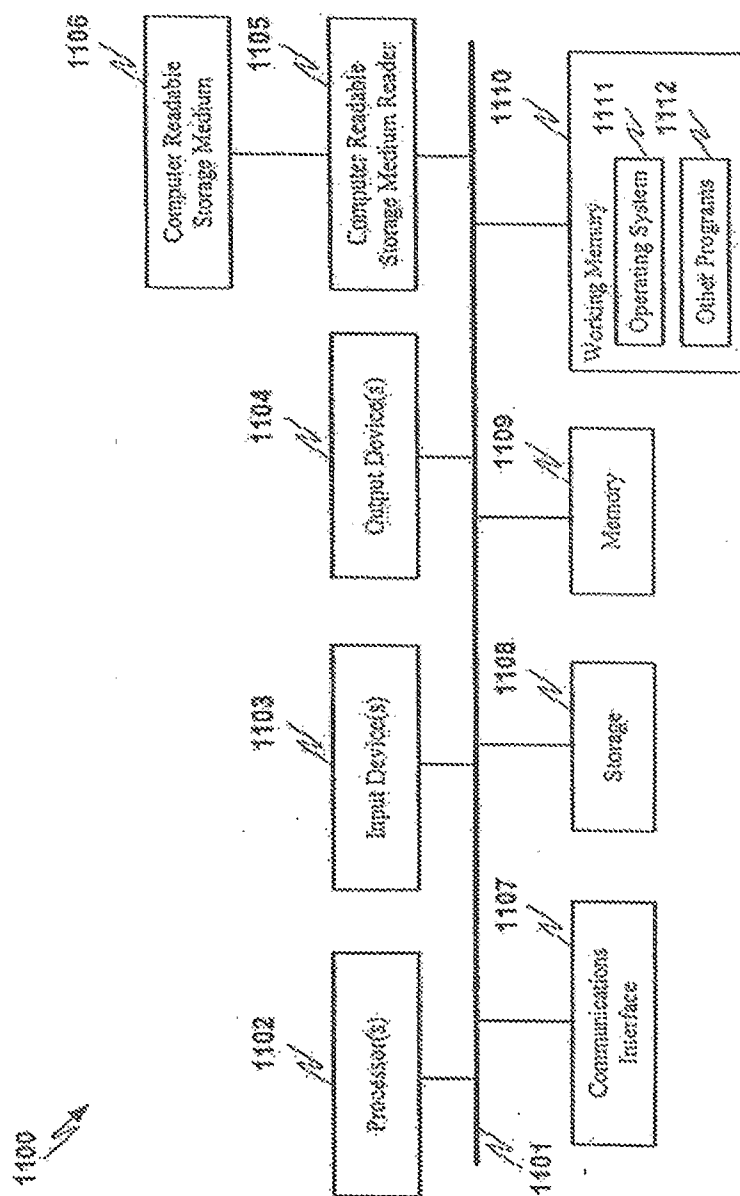


Fig. 11