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(54) **BALL GAME TRAINING APPARATUS**

BALLSPIELÜBUNGSVORRICHTUNG

APPAREIL D'ENTRAÎNEMENT AU JEU DE BALLON

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Description

BACKGROUND

Technical field

[0001] The present invention relates to a ball game-related training system. More specifically, the present invention relates to a ball game-related training system to supply or shoot the ball to allow the player to practice a variety of ball games practices, including kicking or shooting the ball on the play field, hitting the ball falling onto the play field by a hand for a spike type attack, and receiving and shooting the ball over the air by a hand.

Related Art

[0002] In general, a variety of ball game practice aids are used to improve athlete's attack and defense skill in ball games, such as soccer, volleyball, and basketball. Using these exercise aids can reduce the fatigue of leaders, that is, coaches. Further, athletes can learn a variety of skills quickly and easily. As an example of football, such practice aids allow players to practice volley shoots, ground shoots, and heading shoots. As examples of such ball game practice aids, Japanese Patent Application Laid-Open No. H9-276463 (published on October 28, 1997) tilted as "Ball shooting apparatus" (hereinafter referred to as Patent Document 1) and U.S. Patent No. 8,371,964 B2 (issued on February 12, 2013) tilted as "Volleyball spiking training device" (hereinafter referred to as "Patent Document 2") are disclosed.

[0003] In the ball shooting apparatus disclosed in Patent Document 1, a ball is inserted between two pitching rollers rotated by two motors, and the ball is fired by the rotational force of the pitching rollers. Therefore, there is a problem that the shooting angle is not constant when using repeatedly the apparatus. Further, there is an inconvenience that many balls fired must be manually collected and put in a ball container. In addition, the ball shooting apparatus described in Patent Document 1 is not suitable for practicing various ball games since the ball is shot in a straight line at a relatively high position from the apparatus.

[0004] The foot volleyball is a ball game that originated from Korea. In this game, a net is set up between the two teams' courts, and the team uses their head and feet to pass the ball to the opponent's team. In the conventional ball shooting apparatus disclosed in the patent document 1, the ball is inserted between the two pitching rollers, and the ball is fired forward by the pitching rollers. Therefore, there is a problem that the ball hits the net directly. Moreover, this apparatus is very expensive and is not suitable for general sports activities. This problem applies equally to a volleyball game having the similar game rules to the foot volleyball. For example, in the ball shooting apparatus disclosed in Patent Document 1, only the horizontal direction in which the ball is blown and the angle of inclination of the shot ball may be adjusted. Therefore, this shooting apparatus is not suitable for basketballs where that the players grab and toss the aerial ball falling vertically from above the play field to the floor, volleyballs where the players hit the aerial ball falling vertically from above the play field to the floor using the hand, and the foot volleyballs where the players hit the aerial ball falling vertically from above the play field to the floor using a foot.

[0005] The volleyball spike training system as disclosed in the patent document 2 comprises a ball holder and an optional net. The training holder comprises a wheeled chassis supporting a vertical stanchion projecting upwardly that supports a hopper and a ball feeding apparatus. The stanchion includes a crank system for vertically adjusting telescoped stanchion segments. Balls dropping from the hopper travel by gravity down an inclined ramp at the top of the frame towards a discharge throat. Balls travelling down the ramp are indexed by a Z-shaped lever that serially separates them. A pair of downwardly projecting hands, one fixed and one pivoted, receive dropping balls and temporarily hold them for shooting. The pivoting hand controls the indexing lever to jam successive balls when the device is loaded. When a ball is shot and removed from between the feed hands, another ball is freed by the indexing lever to automatically drop into a shooting position between the hands. However, in the ball supply apparatus disclosed in Patent Document 2, since the training ball supplied from the ramp is held at the end portion of the discharge throat, the player may only spike-attack the stopped ball. The user may not practice throwing or catching the flying balls. In other words, the practitioners may not do various basketball-related practices, nor may they kick or shoot a ball that is flying in the air. Further, in the case of volleyball, the user may not practice toss action.

[0006] Prior art patent document 1: Japanese Patent Application Laid-Open No. H9-276463 (published on October 28, 1997) tilted as "Ball shooting apparatus".

[0007] Prior art patent document 2: U.S. Patent No. 8,371,964 B2 (issued on February 12, 2013) tilted as "Volleyball spiking training device".

Prior art documents

[0008] US 4054197, US 2002/112713 A1, and US 5097985 A disclose ball discharging system according to state of the art.

SUMMARY

[0009] The present disclosure has been made in order to solve the above problems. The present disclosure is aimed to providing a ball shooting apparatus that automatically fires the training ball toward a pre-standardized play field for various ball games such as soccer, futsal, foot volleyball, volleyball, basketball, etc., and a ball collection apparatus which automatically collects the training ball fired into the play field and automatically supplies

the collected training ball to the ball shooting apparatus, so that the ball game may be practiced more easily with minimum cost and time.

[0010] Another object of the present invention is to provide a ball game-related training system configured to detect the movement of a player on the play field and fire a ball towards a position associated with the sensed movement to allow the player to practice the ball receive operation, or to dropping the ball from above the play field onto a bottom to allow the player to practice the ball spike attack.

[0011] Still another object of the present invention is to provide a ball game-related training system including a ball shooting apparatus capable of shooting the training ball in various directions using a hydraulic actuator cylinder, and a ball collection device that automatically collects the ball launched into the play field at the corner or at the middle region of the end line or at the end line on the play field and automatically supplies the ball to the ball shooting apparatus.

[0012] Still another object of the present invention is to provide a ball game-related training system including a ball supply apparatus that falls down the ball downward from above the play field onto the bottom, to allow the player to hit the ball by a hand or foot or handing it over the net to the opposing court.

[0013] Still another object of the present invention is to provide a ball game-related training system including a ball shooting apparatus for detecting a player's movement on the play field and firing the ball at regular intervals in the motion detection direction, or for launching a ball based on detection of a player's predetermined movement type.

[0014] Still another object of the present invention is to provide a ball game-related training system including a ball shooting apparatus to shoot the ball by striking the ball that is seated in the distal end of an elongate hollow shooting tube via the action of a hydraulic actuator cylinder operated at high pressure by a hydraulic accumulator.

[0015] Still another object of the present invention is to provide a ball game-related training system including a score counter to assign and display a scored based on a ball passing-through sub-region in a rectangular region defined by the rectangular goalpost installed on the football play field or the futsal play field, thereby maximizing the exercise effect and inducing exercise interest.

[0016] Still another object of the present invention is to provide a ball game-related training system to fire a ball toward the player on the play field so that the player may smoothly practice the receive operation of the fired ball.

[0017] As used herein, the play field or court may refer to a soccer field, a basketball court, a volleyball court, and a foot volleyball court.

[0018] The invention is defined by the appended set of claims.

[0019] In one aspect of the present disclosure, there is provided a ball game-related training system comprising: a play field defined by a half line, both opposing end lines, and both opposing side lines, wherein the play field is configured to be downwardly inclined from the half line to each end line, wherein the play field has a ball guide groove line defined therein along each end line, wherein the ball guide groove line is configured to be downwardly inclined from one end to the other end thereof, a ball shooting apparatus configured to shoot a ball toward a target position on the play field, wherein the ball shooting apparatus is disposed on a corner of the paly field, wherein the ball shooting apparatus has a ball container receiving a ball from above; a ball supply apparatus disposed at a higher position of a net disposed on the half line of the play field, wherein the ball supply apparatus has an upper ball receiving opening to receive a ball from above, and the ball supply apparatus has a lower rotatable ball discharge tube, and the ball supply apparatus is configured to fall down the received ball on the play field via the ball discharge tube based on a ball discharge command signal; a ball convey tube line having one end vertically overlapping the upper ball receiving opening of the ball supply apparatus, wherein the ball convey tube line is downwardly inclined from the other end to one end thereof; and a ball collection apparatus disposed on the other end of the ball guide groove line, wherein the ball collection apparatus includes a vertical hollow ball guide elongate cylinder, and the ball is collected from the groove line and moves upwardly in and along the vertical hollow ball guide elongate cylinder using a collection motor, and the ball collection apparatus has an upper rotatable ball discharge tube, and the upper rotatable ball discharge tube is rotated such that a discharge hole thereof selectively overlaps vertically and above the ball container, the upper ball receiving opening, and/or the other end of the ball convey tube.

[0020] In one aspect of the present disclosure, there is provided a ball game-related training system comprising: a play field defined by a half line, both opposing end lines, and both opposing side lines, wherein the play field is configured to be downwardly inclined from the half line to each end line, wherein the play field has a ball guide groove line defined therein along each end line, wherein the ball guide groove line is configured to be downwardly inclined from one end to the other end thereof; a ball shooting apparatus configured to shoot a ball toward a target position on the play field, wherein the ball shooting apparatus is disposed on a corner of the paly field, wherein the ball shooting apparatus has a ball container receiving a ball from above; a ball collection apparatus disposed on the other end of the ball guide groove line, wherein the ball collection apparatus includes a vertical hollow ball guide elongate cylinder, and the ball is collected from the groove line and moves upwardly in and along the vertical hollow ball guide elongate cylinder using a collection motor, and the ball collection apparatus has an upper rotatable ball discharge tube, and the upper rotatable ball discharge tube is rotated such that a discharge

hole thereof selectively overlaps vertically and above the ball container, and/or an upper ball receiving opening of a ball supply apparatus; a guide rail extending along and spaced from the side line on the play field; a vertical post having at least one wheel on a bottom thereof so as to move along and on the guide rail, wherein the vertical post has a height higher than a height of a net disposed along the half line on the play field; and the ball supply apparatus coupled to a top portion of the vertical post, and configured to drop a ball onto the play field, wherein the ball supply apparatus has an upper ball receiving opening to receive a ball from above, wherein when the ball supply apparatus moves toward the ball collection apparatus together with the movement of the post coupled thereto, the ball supply apparatus receives the ball from the upper rotatable ball discharge tube of the ball collection apparatus via the ball receiving opening thereof, and the ball supply apparatus has a lower rotatable ball discharge tube, and the ball supply apparatus is configured to fall down the received ball on the play field via the ball discharge tube based on a ball discharge command signal.

[0021] In one aspect of the present disclosure, there is provided a ball game-related training system comprising: a play field defined by a half line, both opposing end lines, and both opposing side lines, wherein the play field is configured to be downwardly inclined from the half line to each end line and each side line, wherein the play field has a ball guide groove line defined therein along each end line, wherein the ball guide groove line is configured to be downwardly inclined from one end and the other end to a middle portion thereof; a basketball goalpost disposed behind the middle portion of the end line; a ball shooting apparatus configured to shoot a ball toward a target position on the play field, wherein the ball shooting apparatus is disposed behind the goalpost, wherein the ball shooting apparatus has a ball container receiving a ball from above; a ball collection apparatus disposed on the middle portion of the ball guide groove line, wherein the ball collection apparatus includes a vertical hollow ball guide elongate cylinder, and the ball is collected from the groove line and moves upwardly in and along the vertical hollow ball guide elongate cylinder using a collection motor, and the ball collection apparatus has an upper rotatable ball discharge tube, and the upper rotatable ball discharge tube is rotated such that a discharge hole thereof selectively overlaps vertically and above the ball container, and/or an upper ball receiving opening of a ball supply apparatus; and a ball supply apparatus configured to drop a ball onto the play field, wherein the ball supply apparatus has an upper ball receiving opening to receive a ball from above, and the ball supply apparatus has a lower rotatable ball discharge tube.

[0022] In one aspect of the present disclosure, a diameter of a distal end of the hollow shooting tube is smaller than a diameter of the training ball so that the training ball is seated at the distal end of the hollow tube.

[0023] In one aspect of the present disclosure, the system further includes the ball collection apparatus disposed on the other end of the ball guide groove line, wherein the ball collection apparatus includes a vertical hollow ball guide elongate cylinder, and the ball is collected from the groove line and moves upwardly in and along the vertical hollow ball guide elongate cylinder using a collection motor, and the ball collection apparatus has an upper rotatable ball discharge tube, and the upper rotatable ball discharge tube is rotated such that a discharge hole thereof selectively overlaps vertically and above the ball container of the ball shooting apparatus.

[0024] In one aspect of the present disclosure, the ball collection apparatus comprises: a vertical cylindrical hollow tube having a bottom ball inlet hole and a top ball discharge hole and disposed on the other end of the ball guide groove line; a vertical shaft concentrically received in the cylindrical hollow tube, where the shaft is spaced from an inner face of the hollow tube; a vertically helically extending blade extending along and on an outer face of the vertical shaft; and a collection motor configured to allow rotation of the vertical shaft, when the collection motor is activated, the ball collected into the groove line is guided upwards along the vertically helically extending blade and is discharged out of the discharge hole.

[0025] In one aspect of the present disclosure, the system further include an elongate vibration plate embedded in the ball guide groove line, wherein the vibration plate is vibrated in the longitudinal direction of the groove line by a rotation of a vibration motor such that the ball collected in the groove line moves toward the bottom ball inlet hole defined in the ball collection apparatus, wherein the elongate vibration plate is downwardly inclined toward the bottom ball inlet hole.

[0026] In one aspect of the present disclosure, the hydraulic pressure circuit further includes: nitrogen tank connected to the hydraulic pressure inlet via the hydraulic pressure discharge solenoid valve, wherein a nitrogen tube filled with nitrogen is disposed inside the nitrogen tank; the hydraulic pressure tank connected to the hydraulic pressure outlet via the hydraulic pressure recovery solenoid valve; the hydraulic pressure pump interposed between the hydraulic pressure tank and the nitrogen tank, wherein the hydraulic pressure supply solenoid valve is disposed between the hydraulic pressure pump and the nitrogen tank; and the pressure gauge for checking a nitrogen pressure in the nitrogen tube, wherein the controller is further configured to control the hydraulic pressure circuit based on the predetermined shooting mode and/or the predetermined shooting period.

[0027] In one aspect of the present disclosure, the system further comprises cameras for photographing the play field, wherein the cameras are installed on different sides of the body frame, wherein the controller is configured to receive image information from the cameras and to determine whether the image information contains a predetermined movement of the player on the play field, and to activate the actuator cylinder upon determination

that the image information contains the predetermined movement of the player.

Advantageous effects

[0028] According to the present invention, in the ball game-related training system, the training ball shooting apparatus that fires a ball by hydraulic actuator cylinder operation is installed at a corner of a soccer field or behind a goalpost of a basketball court. This allows the user to practice penalty kicks, volley kicks, and heading shots. In addition, the training ball may be fired in a set mode by the user to allow the player to kick or hit the fired ball with the kick or the hand. In this way, the player may practice various ball game related exercises. The apparatus also flies the training ball horizontally over the play field or drop the training ball from the vertical direction to the play field floor. This allows the player to practice the spikes and tossing exercises. Then, the training ball, which has fallen to the bottom of the play field, may be automatically collected at the goal line or the end line and is supplied to the training ball shooting apparatus to operate an unmanned ball game practice system.

BRIEF DESCRIPTION OF DRAWINGS

[0029]

FIG. 1 is a schematic configuration diagram of a training ball shooting apparatus according to an embodiment of the present invention.

FIG. 2 is a front cross-sectional view of a training ball shooting apparatus according to an embodiment of the present invention.

FIG. 3 is a side cross-sectional view of a training ball shooting apparatus according to an embodiment of the present invention.

FIG. 4 is an exploded perspective view showing an internal construction of a training ball shooting apparatus according to an embodiment of the present invention.

FIG. 5 is a cross-sectional view of a hollow shooting tube for firing a training ball in accordance with an embodiment of the present invention;

FIG. 6 is a control block diagram for a training ball shooter according to an embodiment of the present invention.

FIG. 7 is a flowchart of an operation of a training ball shooting apparatus according to an embodiment of the present invention.

FIG. 8 is a flowchart of an operation of a training ball shooting apparatus according to another embodiment of the present invention.

FIG. 9 is a specific configuration diagram of a ball collection apparatus according to an embodiment of the present invention.

FIG. 10 is a side cross-sectional view of a ball supply apparatus according to an embodiment of the present invention.

FIG. 11 is a schematic configuration view of a soccer-related training system, which does not belong to the present invention.

FIG. 12 is a cross-sectional view of a play field shown in FIG. 11, which does not belong to the present invention.

FIG. 13 is an enlarged view of a ball shooting apparatus and a ball collection apparatus shown in FIG. 11, which does not belong to the present invention.

FIG. 14 is a schematic view of a ball sensing gate for determining a score for a ball pass-through subregion in a rectangular planer region defined by a goalpost according to an embodiment of the present invention, which does not belong to the present invention.

FIG. 15 is a circuit diagram of a score counter according to an embodiment of the present invention, which does not belong to the present invention.

FIG. 16 is a schematic configuration diagram of a foot volleyball-related training system according to an embodiment of the present invention;

FIG. 17 is a schematic configuration diagram of a volleyball-related training system according to an embodiment of the present invention.

FIG. 18 is a schematic configuration diagram of a basketball-related training system, which does not belong to the present invention.

FIG. 19 is a cross-sectional view showing a configuration of a ball guide groove line formed behind an end line of a basketball court as shown in FIG. 18, which does not belong to the present invention.

DETAILED DESCRIPTIONS

[0030] Hereinafter, preferred embodiments of the present invention will be described in more detail with reference to the accompanying drawings. It should be understood, however, that the invention may be embodied in many different forms and should not be construed

as limited to the embodiments set forth herein. It should be noted that the embodiments of the present invention described below are intended to sufficiently convey the present invention to those skilled in the art. In addition, the present invention is used to practice soccer, volleyball, and basketball games and a foot volleyball game which is a Korean ball game. The names of the lines drawn on the soccer field, volleyball court, basketball court, and foot volleyball court differ from each other. However, the half line on the soccer field, and center lines on the volleyball court, basketball court, and foot volleyball court all are drawn at a center thereof to bisect them. Therefore, as used herein, the line drawn at the center thereof will be referred to as a half line irrespective of the type of the ball games.

[0031] Referring to FIG. 1 to FIG. 5, a ball shooting apparatus 100 according to the present invention will be described. Referring to FIG. 1 to FIG. 4, the ball shooting apparatus 100 includes a body frame 102 having an internal space of a predetermined size defined therein. One side of the body frame 102, preferably the front side thereof, is opened. Further, a training ball shooter 105 for launching a training ball is disposed in the inner space. In this connection, a plurality of components are built in the body frame 100 to rotate the training ball shooter 105 left and right, up and down, and operate the training ball shooter 105. These components have a functionally close connection, and these components and their operations will be described later. As used herein, the training ball may refer to a conventional soccer ball, basketball ball, foot volleyball game ball, or volley ball. In addition, a first camera CAM1 and a second camera CAM2 are installed on a front and side surfaces of the body frame 102 of the training ball shooting apparatus 100 respectively. The cameras CAM1 and CAM2 may capture subjects around the body frame 102 and acquire corresponding image information.

[0032] Although not shown in the drawings, the lower end of the body frame 102 of the training ball shooting apparatus 100 may be provided with wheels for moving the apparatus 100. In this case, in order to fix the body frame 102, it is possible to additionally provide fixing means of a known type preventing rotation of the wheels at either the front or the rear portion of the body frame. Further, it is preferable that the front wheels have a known structure such that the wheels can be changed in a direction thereof freely when the body frame 102 is moved.

[0033] The ball container 104 having an outer wall of a predetermined size for accommodating the training balls is coupled to the top end of the body frame 102. The ball container 104 is manufactured in the shape of a rectangular barrel having open top and bottom. In order to allow the amount of the training balls loaded therein to be visible, the container 104 may be configured as a mesh structure.

[0034] A ball inlet 107 of a predetermined size is formed in the upper portion of the body frame 102 so that the training ball supplied from the ball container 104 can be introduced into the ball shooter 105 in the body frame 102. The upper portion of the body frame 102 is formed to have a downward inclined surface at a predetermined angle toward the ball inlet 107 so that the training ball can be easily introduced into the ball shooter 105. In this connection, the body frame 102 and the ball container 104 may be combined in various ways. For example, they may be joined together by welding. Alternatively, fitting grooves may be formed in the edge of the upper portion of the body frame 102, and corresponding fitting protrusions may be formed on the bottom edge of the ball container 104, and the fitting protrusions may be fitted into the fitting grooves.

[0035] Although not shown in the drawings, an operation switch of the shooter, a display device for displaying the operation of the ball shooter, and operation key buttons for setting an operation mode of the shooter may be provided outside the body frame 102. In one embodiment, such a display device, and operation key buttons may be implemented with a touch screen.

[0036] The training ball shooter 105 installed in the inner space of the body frame 102 receives the training ball from the ball container 104 coupled to the upper portion of the body frame 100 and may be configured to shoot the training ball. A connection flexible tube 116 of a predetermined diameter extending from the bottom of the ball inlet 107 formed at the lower end of the downwardly inclined faces 103 of the body frame 100 is connected to the shooter 104 for introduction of the training ball into the shooter 104. The connection flexible tube 116 is connected to a ball receiving hole 115 opened at a front of a elongate hollow shooting tube 114 shown in FIG. 4, wherein the tube 114 constitutes a part of the training ball shooter 105.

[0037] The training ball introduced into the ball receiving hole 115 of the elongate hollow shooting tube 114 is seated at a shooting point as shown in FIG 5. In this connection, at a distal end of the elongate hollow shooting tube 114, there is formed an inwardly rounded protrusion 114a. Thus, due to the protrusion, the training ball introduced into the ball receiving hole 115 is prevented from flowing out of the elongate hollow shooting tube 114 in the absence of a strike. In addition, at the distal end of the elongate hollow shooting tube 114, a sensor is installed to discriminate the presence or absence of the training ball therein. The sensor may transmit the sensed information to a controller MPU as shown in FIG. 6. As such a sensor, a photo sensor or the like may be used.

[0038] The elongate hollow shooting tube 114 is coupled to and supported on and by an orientation-variable support 112. The orientation-variable support 114 is supported by its rotatable support bracket 110. Both side faces of the orientation-variable support 114 are pivotally coupled to both side flanges of the rotatable support bracket 110 respectively. More specifically, on one side face of the orientation-variable support 112, a rack gear 118 is integrally formed therewith. The rack gear 118 is intermeshed with a drive gear 119 integrally formed on

an inner face of one side flange of the rotatable support bracket 110. A tilt-changing motor 117 connected to the drive gear 119 allows the orientation-variable support 114 and, hence, the elongate hollow shooting tube 114 to pivot up and down. In addition, a direction-changing motor 120 is provided below the rotatable support bracket 110. A rotatable plate 128 is coupled to a distal end of a rotating shaft from the direction-changing motor 120. The rotatable support bracket 110 is screw-coupled to the rotatable plate 128. Accordingly, the orientation-variable support 112 and thus, the elongate hollow shooting tube 114 can be rotated in the clockwise or counterclockwise direction by driving the direction-changing motor 120.

[0039] In this manner, according to the present invention, the training ball shooter 105 of the training ball shooting apparatus 100 is rotated in a clockwise or counterclockwise direction via the rotation of the rotatable support bracket 110 and pivotally moves upward or downward via the upward or downward pivotal movement of the orientation- variable support 112. Thus, the elongate hollow shooting tube 114 can be oriented freely in the left, right, up and down directions. This allows the training ball located in the elongate hollow shooting tube 114 to be fired freely in the left, right, up and down directions

[0040] The training ball introduced into the elongate hollow shooting tube 114 is fired by operation of an actuator cylinder 130 coupled to the proximal end of the elongate hollow shooting tube 114. A movable piston 132 of the actuator cylinder 130 is insertable into and withdrawn from the interior of the elongate hollow shooting tube 112, as shown in FIG. 5. A striking plate 134 is coupled to the distal end of the movable piston 132. In this connection, the actuator cylinder 132 may use a hydraulic or pneumatic actuator cylinder. It is desirable to use a hydraulic actuator cylinder to fire the training ball farther away.

[0041] The hydraulic actuator cylinder 132 typically has a hydraulic inlet and a hydraulic outlet. The hydraulic inlet is connected to the outlet of a nitrogen tank 144 via a hydraulic pressure discharge solenoid valve 150. The hydraulic outlet is connected to the hydraulic tank 140 through a hydraulic pressure recovery solenoid valve 146. A hydraulic pump 142 is interposed between the hydraulic tank 140 and the nitrogen tank 144 and is connected thereto. In this connection, a hydraulic pressure supply solenoid valve 148 is connected between the hydraulic pump 142 and the nitrogen tank 144. In this connection, a nitrogen tube filled with nitrogen is disposed inside the nitrogen tank 144. There is provided a pressure gauge for checking the nitrogen pressure of the nitrogen tube. When the hydraulic pressure is supplied to the nitrogen tank 114 having such a configuration, a pressure is applied to the nitrogen tube in proportion to the supplied hydraulic pressure, so that the internal pressure of the nitrogen tube increases. This increase in the internal pressure is provided to the controller MPU.

[0042] The operation of the hydraulic circuit thus configured will be briefly described below. In order to insert the movable piston 132 of the actuator cylinder 30 into the elongate hollow shooting tube 114, the controller drives the hydraulic pump 142 at an open state of the hydraulic pressure supply solenoid valve 148 so that the hydraulic pressure in the hydraulic tank 140 is supplied to the nitrogen tank 144. By such continuous pumping, when the hydraulic pressure supplied into the nitrogen tank 144 increases, pressure is applied to the nitrogen tube installed therein, and this pressure increase level is provided to the controller. When the sensed pressure of the nitrogen tube has a predetermined pressure value, the operation of the hydraulic pump 142 is stopped, and at the same time, the hydraulic pressure supply solenoid valve 148 is closed. Therefore, the nitrogen tank 148 is filled with a high-pressure hydraulic nitrogen.

[0043] When the shooting command is input from the external touch screen to the controller, or when the preset shooting cycle from a software program is reached, the controller opens the hydraulic pressure discharge solenoid valve 150 only for a certain period of time. With this operation, when the hydraulic pressure discharge solenoid valve 150 is opened, the hydraulic pressure filled in the nitrogen tank 144 at a high pressure is supplied to the hydraulic inlet of the actuator cylinder 130. This causes the movable piston 130 in the actuator cylinder 130 to advance. By this action, the striking plate 134 attached to the distal end of the piston strikes the training ball placed at the distal end of the elongate hollow shooting tube 114. As a result, the training ball is fired.

[0044] After opening the hydraulic pressure discharge solenoid valve 150 for the period of time, the controller opens the hydraulic pressure recovery solenoid valve 146 and the hydraulic pressure supply solenoid valves 148 and drives the hydraulic pump 142. Thereby, the hydraulic pressure filled in the actuator cylinder 130 is recovered to the hydraulic tank 140. As a result, the movable piston 132 enters back the actuator cylinder.

[0045] The controller may control the rotation of the direction-changing motor 120 and the tilt-changing motor 117 coupled to the rotatable support bracket 110, as well as the drive of the hydraulic circuit described above. Thereby, the elongate hollow shooting tube 114 may be rotated in the clockwise or counterclockwise direction or may pivotally move in the upward or downward direction.

[0046] FIG. 6 is a block diagram of a controller to control the ball shooter according to an embodiment of the present invention. The controller may be provided in an inner space of the body frame 102 of the training ball shooting apparatus 100. However, the present invention is not limited thereto. Referring to FIG. 6, the shooting controller is connected to the first and second cameras CAM1 and CAM2 installed on at least one side face of four side faces of the body frame 102. This camera(s) images the play field 10 on which a player is located. The two cameras CAM1 and CAM2 are configured to photograph an area in front of the training ball shooting apparatus 100 and the half line on the play field respectively. In addition, the touch screen TS may be installed on one

side of the four sides of the body frame 102. As described above, the operation switch, the display device for displaying the operation of the shooter, and the key buttons for setting the operation mode of the shooter are provided on the touch screen.

[0047] A mode (manual mode, automatic mode, camera mode, direction setting mode, penalty kick mode, head shoot mode, volley shoot mode, etc.) selected by the user through the touch screen TS is supplied to the controller. Further, image signals photographed from the first and second cameras CAM1 and CAM2 are input to the controller MPU. The controller MPU controls all operations of the training ball shooting apparatus 100 based on those information. Mainly used modes are manual mode, auto mode, and camera mode. However, the present disclosure is not limited thereto.

[0048] In the case of the manual mode, the controller MPU receives a direction setting key selection (vertical or horizontal direction) from the touch screen and accordingly drives the direction-changing motor 120 and the tilt-changing motor 117. In this way, the shooting direction of the training ball shooter 105 is set. The actuating cylinder 130 is actuated through a solenoid valve driving unit (SOD) via a fire command from the touch screen by the user to fire the training ball. In the case of the automatic mode, the controller MPU receives a direction setting key selection (vertical or horizontal direction) from the touch screen and accordingly drives the direction-changing motor 120 and the tilt-changing motor 117. In this way, the shooting direction of the training ball shooter 105 is set. The actuating cylinder 130 is actuated through a solenoid valve driving unit (SOD) per a preset shooting initiation period (for example, every 15 seconds). In the case of the camera mode, the controller MPU controls the direction-changing motor 120 and the tilt-changing motor 117 such that the shooting tube 114 is oriented toward the direction of the player in the play field photographed by the first and second cameras CAM1 and CAM2. Further, when the player starts move with a predetermined movement (for example, when the player lifts his arm up maximally), the actuating cylinder 130 is operated through the solenoid valve drive SOD 1 to 2 seconds after the start of the movement. Thus, the training ball is fired toward to the player.

[0049] FIG. 7 is a flowchart of the operation of the training ball shooting apparatus according to an embodiment of the present invention. This drawing is intended to explain the operations in the case of the manual mode and the automatic mode. FIG. 8 is a flowchart of the operation of the training ball shooting apparatus according to another embodiment of the present invention. This figure is directed to a scenario where the firing direction is set based on the imaging information captured by the first and second cameras CAM1 and CAM2 installed on the side of the body frame 102 and the training ball is fired based on the movement of the player photographed by the first and second cameras CAM1 and CAM2.

[0050] First, with reference to FIG. 6 and FIG. 7, the operation of the training ball shooting apparatus 100 shown in FIG. 1 to FIG. 5 described above will be described.

[0051] The training ball shooting apparatus 100 includes the touch screen TS disposed on an outer surface of the body frame 102 as described above. This touch screen TS is connected to the controller MPU incorporated in the body frame 102. When the user inputs data through the touch screen TS, the controller MPU controls the operation of the components provided in the body frame 102 based on the inputs. That is, the controller begins to control the operation of the tilt-changing motor 117 and the direction-changing motor 120, the hydraulic pump 142, and the various solenoid valves 146, 148, 150 disposed in the body frame 102 based on the inputs.

[0052] The training ball shooting apparatus 100 may be driven by the controller MPU in a manual mode and a motion detection mode. In the manual mode, the user uses the touch screen TS installed in the body frame 102 to select one of the exercise modes (penalty kick, corner kick set play, ground ball shoot, volley shoot, head shoot modes or any combination thereof), and a shooting period (for example, about 15 seconds), then press the shooting button to fire the training ball to the play field 10. Alternatively, the user may select one of the exercise modes (penalty kick, corner kick set play, ground ball shoot, volley shoot, head shoot modes or any combination thereof), and press the shooting button. In this connection, the orientation of the elongate hollow shooting tube 114 may be adjusted via the tilt and/or direction-changing motors 117 and/or 120 based on the selected mode and, then, the training ball is fired continuously in a predetermined cycle. In this connection, although the example of the shooting button on the touch screen TC has been described, the present invention is not limited thereto. The shooting button may be provided on a remote controller carried by a player using a normal remote control device.

Manual/automatic mode for training ball shooting apparatus

[0053] When the training ball shooting apparatus 100 is operated, the controller MPU checks the pressure in the nitrogen tank 144 at Si operation to determine whether it is at a pressure capable of advancing the movable piston 132 of the actuator cylinder 130 at a predetermined speed. When the pressure of the nitrogen tube in the nitrogen tank 140 does not reach the preset pressure, the controller opens the hydraulic pressure recovery and supply solenoid valves 146 and 148 through the solenoid valve drive unit SOD in operation S6. Accordingly, the hydraulic pressure in the actuator cylinder 130 is recovered to the hydraulic tank 140 and then supplied to the nitrogen tank 144. When the hydraulic pressure is continuously supplied to the nitrogen tank 144, the pressure applied to the nitrogen tube installed therein is increased to reach the predetermined pressure.

[0054] When it it is determined in S2 operation that the pressure of the nitrogen tank is at the predetermined pressure, the controller MPU closes the hydraulic pressure recovery, supply and discharge solenoid valves 146, 148, 150. Then, in S4 operation, the controller determine whether the shooting button on the touch screen or remote control device is pressed. When it is determined in S4 operation that the shooting button is pressed, the controller MPU opens the hydraulic pressure discharge solenoid valve 148 for a preset time T in S5 operation. In this connection, the hydraulic pressure filled at the high pressure in the nitrogen tank 144 is supplied to the hydraulic inlet of the actuator cylinder 130 through the hydraulic pressure discharge solenoid valve 148 at a high speed due to the expansion of the compressed nitrogen tube.

[0055] Thus, the actuator cylinder 130 advances the movable piston 132, which is located therein, by hydraulic pressure introduced at a very high pressure. Thus, the striking plate 134 coupled to the distal end of the movable piston 132 strikes the training ball placed at the distal end of the elongate hollow shooting tube 114 to fire the ball. In this connection, the firing angle of the ball from the training ball shooter 105 located in the interior space of the body frame 102 of the training ball shooting apparatus 100 is controlled by the controller controlling the tilt and direction changing motors 117 and 120.

[0056] The controller MPU, upon having performed the S5 operation, opens the hydraulic pressure recovery and supply solenoid valves 146 and 148 through the solenoid valve drive unit SOD in operation S6 and then drives the hydraulic pump 142 in operation S7. In this way, the nitrogen tank 142 is filled with hydraulic pressure.

[0057] If the shooting button on the touch screen TS is not activated in the S4 operation described above, the controller MPU adjusts the horizontal angle and vertical angle and the shooting period for the elongate hollow shooting tube 114 of the training ball shooter 105. Thereafter, the aforementioned S5 operation is performed. The mode set in the S8 operation refers to the automatic firing mode and the camera mode.

[0058] When the mode set in operation S8 is the automatic firing mode, the controller MPU drives the direction-changing motor 120 and the tilt-changing motor 117 based on a direction setting input (vertical direction or horizontal direction) from the touch screen to set the shooting direction of the training ball shooter 105. Then, the controller activates the actuator cylinder 130 of the hydraulic circuit through the solenoid valve driving unit SOD based on every predetermined time period to fire the training ball. If it is determined that the mode set in operation S8 is the camera mode, the controller MPU controls the operation of the training ball shooting apparatus 100 as shown in FIG. 8. When the mode set in the S8 operation is a stop mode, the controller does not perform any operation.

Movement sensing mode

[0059] In the movement sensing mode, the shooting direction is set based on the information captured by the first and second cameras CAM1 and CAM2 installed on the sides of the body frame 102, and then the training ball is fired based on the player's movement in front of and/or at both sides of or around the shooter as imaged by the first and second cameras CAM1 and CAM2.

[0060] Referring to FIG. 8, the controller MPU determines whether the current mode is the camera operation mode in operation S104. If the determination result indicates that the current mode is not the camera operation mode, the process jumps to operation S17 where the shooter fires the training ball according to the manual/automatic modes operation as described above.

[0061] When it is determined in the operation S12 that the current mode is the camera operation mode, the controller MPU receives the image signals photographed by the first and second cameras CAM1 and CMA2 installed on the sides of the body frame 102 in operation S11. In S12 operation, the controller may detect the movement of the player in the front or side of the training ball shooting apparatus 100. After detecting the movement of the player, the controller MPU determines the position of the detected player, and thereafter controls the tilt-changing motor 117 and the direction-changing motor 120 in operation S13 based on the position to adjust the vertical angle and the horizontal angle, that is, the shooting angle of the training ball shooter 105.

[0062] Then, in S14 operation, the controller MPU analyzes the image signals transmitted from the first and second cameras CAM1 and CAM2 to determine the motion of the subject. In operation S15, the controller determines whether the movement of the player is of a preset movement type. For example, the player determines whether the player has lifted her/his arm up maximally. This determination can be easily made by comparing a one-second previous frame image and a current frame image.

[0063] When, in operation S15, it is determined that the player movement determined from the video signal received through the first and second cameras CAM1 and CAM2 is of the predetermined motion type, the controller MPU controls the solenoid valve driving unit SOD in operation S16 such that the striking plate 134 mounted at the distal end of the movable piston 132 of the actuator cylinder 130 strikes the training ball as previously described. Thereby, the training ball is fired towards the player.

[0064] The ball fired from the training ball shooter 105 of the training ball shooting apparatus 100 will be directed in a specific direction, that is, toward the player. The training ball fired toward the player will be hit by the body member (e.g., foot, hand, etc.) of the player and will fly or roll towards a touch line or goal line and eventually will fall on the court of the play field.

[0065] Although the driving unit for the training ball

shooter 105 has been described by way of example using a hydraulic actuator cylinder in the above embodiment, the present disclosure is not limited thereto. It is apparent that a pneumatic actuator cylinder may be used as the driving unit by a person skilled in the art who understands the specification of the present invention.

[0066] FIG. 9 shows a specific configuration of a ball collection apparatus according to an embodiment of the present invention. The ball collection apparatus may be installed at one corner of the bottom of the play field 10. In this connection, the play field mentioned above may refer to the soccer field, the basketball court, the volleyball court, and the foot volleyball court, etc. In order to allow the training ball that has fallen onto the play field 10 to be guided from the half line toward the goal line or the end line, the play field is inclined at an angle of $\theta 2$ from the half line toward the goal line or the end line thereof. The ball collection apparatus 200 shown in FIG. 9 may be installed near a ball guide groove line 14 formed in the rear of the goal line or the end line of the play field 10, as shown in FIG. 9.

[0067] The ball guide groove line 14 is formed such that one end of the ball guide groove line 14 is inclined downward to the other end or to an intermediate point thereof. Therefore, the training ball falling down on the play field downwardly inclining from the half line to the goal line or the end line is rolled from the half line HL in the direction of the goal line or end line and eventually to the ball guide groove line 14. The training ball collected in the ball guide groove line 14 rolls in the direction of a bottom portion of a cylindrical collecting tube of the ball collection apparatus 200. The training ball introduced into the lower end of the ball collection apparatus 200 flows into the lower end gate G of the ball collection apparatus 200.

[0068] As shown in FIG. 9, when a collection motor 206 installed in a top of the ball collection apparatus 200 is rotated, a vertical rotation shaft 208 connected to the motor is rotated. In this connection, a vertically helically extending blade 210 having a vertical pitch (for example, 220 mm) larger by about 1 cm than a diameter of the training ball is formed on the outer circumferential surface of the rotation shaft 208.

[0069] In this connection, a distance f1 between the rotation shaft 208 and an inner surface of an outer hollow cylindrical body of the ball collection apparatus 200 is 2 mm to 3 mm smaller than the diameter r2 of the training ball. Accordingly, when the rotation shaft 208 is rotated, the training ball introduced into the lower gate G of the ball collection apparatus 200 is transferred to an upper portion thereof along a screw type conveyor 212 including the rotation shaft 208 and the vertically helically extending blade 210. In this connection, the distance r2 between the rotation shaft 208 and the inner surface of the outer hollow body of the ball collection apparatus 200 is smaller than the diameter r1 of the training ball, and, thus, the training ball is slightly distorted therebetween. In this way, the upward movement of the ball is carried out reliably.

[0070] A vibration plate 214 is embedded in the ball guide groove line 14 in the front of the gate G of the ball collection apparatus 200. The vibration plate is vibrated in the longitudinal direction of the line 14 by the rotation of a vibration motor 216. The vibration motor 216 is rotated at the same time as the collection motor 206 in the ball collecting operation. This allows the training ball collected at the end or middle portion of the downwardly inclined ball guide groove line 14 to smoothly enter the gate G of the ball collection apparatus 200.

[0071] The training ball transferred to the upper portion of the screw type conveyor 212 of the ball collection apparatus 200 is discharged to the ball discharge tube 202 by rotation of the vertically helically extending blade 210. The training ball discharged out of the ball discharge tube 202 is inserted into an upper opening of the ball container 104 of the training ball shooting apparatus 100 installed adjacent to the ball collection apparatus 200.

[0072] In this embodiment, the ball collection apparatus 200 includes the rotation shaft 208 installed inside the vertical cylindrical hollow tube 204 and the vertically helically extending blade 210 on the outer circumferential surface of the shaft 208. Further, the collected balls are transported upward along the vertically helically extending blade 210 and the inner wall face of the vertical cylindrical hollow tube 204. The present invention is not limited to this. The ball collection apparatus 200 may be realized by an equivalent screw conveying apparatus thereto.

[0073] In one embodiment, two vertical poles spaced apart from the rotation shaft 208 having the vertically helically extending blade 210 formed on its periphery are arranged. The two vertical poles may be vertically extended along the shaft 208 so as to be separated with spacing from the shaft 208 at a distance of about 1 mm to 2 mm less than the diameter r2 of the training ball. In this embodiment, when the training ball is rolled into the gate of the ball collection apparatus, the ball is positioned between the rotation shaft 208 and the two poles. When the vertically helically extending blade is rotated, the training ball is moved vertically up along the rotation shaft and the two poles. The collected ball is then pushed into the upper opening of the ball container 104 of the training ball shooting apparatus 100.

[0074] As shown in FIG. 9, the ball discharge tube 202 installed on the upper portion of the ball collection apparatus 200 is rotatable configured at the upper portion of the vertical cylindrical hollow tube 204, as shown by "R" in FIG. 9. The ball discharge tube may be configured to rotate manually or rotate automatically by a motor via a ring gear

[0075] FIG. 10 is a detailed block diagram of a ball supply apparatus 300 according to an embodiment of the present invention. The apparatus is mounted on a column 250 erected perpendicular to the bottom surface of the play field 10. This apparatus supply the ball to the player on the play field 10 by dropping the training ball to the

player, or by flying the training ball in the horizontal direction toward the player on the play field 10. This apparatus is useful for practicing the spiking action for the foot volleyball and the volleyball, and for practicing a three-point shoot for the basketball.

[0076] Referring to FIG. 10, the ball supply apparatus 300 has the housing 301 coupled to an upper portion of the column 250. The top of the housing 301 is partially opened. The housing is divided by a partition 308 into a ball storage portion 304 and a ball discharge portion 306. The bottom surface 305 of the ball storage portion 304 is inclined downward toward the ball discharge portion 306. An opening is formed in the bottom of the ball discharge portion 306. A ball discharge tube 316 discharging the training ball is rotatably coupled to the ball discharge portion 306 at the opening thereof.

[0077] Within the ball discharge portion 306, a stopper 314 extends vertically upward from the distal end of the ball discharge tube 316. This stopper acts to limit the movement of the discharged ball. A rotatable opening/closing plate 310 is rotatably coupled to the partition 308. The rotatable opening/closing plate 310 is screw-coupled to a rotation shaft from an opening/closing motor 302 installed in the housing 301. The rotatable opening/closing plate 310 is configured to open/close a discharge hole formed in a lower portion of the partition 308 by rotation of the opening/closing motor 302. Thereby, the training ball accommodated in the ball storage portion 304 is not discharged or is discharged through the discharge hole to the discharge tube.

[0078] A straight bevel gear system 318 is disposed in a lower end of the housing 302. A rack gear of the straight bevel gear system 318 is integrally formed with the outer peripheral face of the upper end of the ball discharge tube 316. The rack gear is engaged with a drive gear of the straight bevel gear system 318. The drive gear is coupled to a rotation shaft 322 of a swing motor 320 installed in the housing. The opening/closing motor 302 and the swing motor 320 are connected to a controller MCU 324. The ball discharge tube 316 is configured to be inclined downward. The other end of the ball discharge tube 316 has a vertically falling outlet 316a formed in a rightly downward direction and a horizontally inclined outlet 316b formed in an inclined horizontal direction. The ball introduced into the ball discharge tube 316 is discharged to the vertical falling outlet 316a or the inclined horizontal outlet 316b by a switching plate 316c coupled between the vertical falling outlet 316a and the horizontally inclined outlet 316b.

[0079] The switching plate 316c opens either the vertical falling outlet 316a or the horizontally inclined outlet 316b via a switching plate driving unit 316d constituted by a motor or the like. When the switching plate drive unit 316d is not used, the switching plate 316c may be opened and closed using a manual switching plate activator. When using the switching plate drive unit 316d, the switching plate drive unit 316d is controlled by a controller 324 that receives a remote control signal from a remote control device.

[0080] For example, when the switching plate drive unit 316d vertically elects the switching plate 316c, the vertical falling outlet 316a is opened and the horizontally inclined outlet 316b is closed. As a result, the training ball ejected from the ball discharge tube 316 goes straight downward. In contrast, when the switching plate drive unit 316d orients the switching plate 316c in the horizontal direction, the vertical falling outlet 316a is closed and the horizontally inclined outlet 316b is opened. As a result, the training ball discharged from the ball discharge tube 316 flies horizontally through the horizontally inclined outlet 316b and then gradually falls down.

[0081] As shown in FIG. 10, when the rotatable opening/closing plate 310, which is shaft-coupled to the rotation shaft 312 of the opening/closing motor 302 rotates one time by 360 degree of a rotation angle, the discharge hole formed in the partition is opened once and then closed. Thereby, a single training ball is discharged through the ball discharge tube 316. At this time, the ball may fall directly onto the bottom surface of the play field 10 through the vertical falling outlet 316a or may horizontally fly through the horizontally inclined outlet 316b and gradually falls to the bottom. This allows the player to practice hitting the balls falling in various directions from above, or allows the player to shooting the training ball flying horizontally. Thus, the player may practice spike attacks with the hand strongly hitting the training ball flying in the horizontal direction or falling directly down onto the bottom of the play field 10. Further, the player may practice kicking the training ball flying in the horizontal direction or falling directly down onto the bottom of the play field 10.

[0082] It is also possible to adjust the position of the ball discharge end of the ball discharge tube 316 by the rotation of the swing motor 320. As a result, the drop position of the ball can be adjusted. This allows the player to practice at various positions.

[0083] The controller 324 may transmit/receive data to control the training ball shooting apparatus 100 in a wired or wireless manner. Thus, the controller may receive the ball distribution control signal by wire or wirelessly, and may control the opening/closing motor 302 and the swing motor 320. For example, when the training ball shooting apparatus 100 is controlled using only a remote controller device, the controller 324 receive the data to control the training ball shooting apparatus 100 in a wireless manner from the remote controller device and drives the opening/closing motor 302 and the swing motor 320 based on the remote control signal transmitted from the remote controller device. Thus, the training ball accommodated in the ball storage portion 304 may be dropped to the bottom of the play field 10.

[0084] The training ball shooting apparatus 100, the ball collection apparatus 200, and the ball supply apparatus 300 as configured as described above may be applied to the ball games, for example, the soccer, the foot volley ball, the volleyball, and the basketball. Depending

on the type of each ball game, the location of the training ball shooting apparatus 100, the ball collection apparatus 200, and the ball supply apparatus 300 on the play field should be properly selected. FIG. 11 to FIG. 15, FIG. 16, FIG. 17 and FIG. 18 show examples of the soccer-related training system, the foot volleyball training system, the volleyball training system and the basketball training system in accordance with various embodiment of the present disclosure respectively.

Embodiment of soccer-related training system

[0085] Referring to FIGS. 11 to 15, the soccer-related training system 1 includes the play field 10 having a predetermined width. In one corner of the end line region of the play field 10, the training ball shooting apparatus 100 for shooting the training ball toward a player on the play field 10 as shown in FIGS. 1 and 3 is installed. The ball collection apparatus 200, which automatically collects the training balls collected toward the goal line and supplies the collected training balls to the training ball shooting apparatus 100, is positioned in the corner of the end line region of the play field 10 nearby the training ball shooting apparatus 100. A pair of the training ball shooting apparatus 100 and the ball collection apparatus 200 may be installed at the diagonal ends of the play field 10, respectively. Each normal soccer goal post 12 is installed in the goal line area at both opposing ends of the play field 10.

[0086] The play field 10 shown in FIG. 11 is formed to be inclined downwards at 1 to 5 degrees θ from the half line HL to the goal line on both opposing ends thereof, as shown in FIG. 12. Each ball guide groove line 14 is formed in rear of the goal line side, more specifically, in rear of each goal post 12. The groove line 14 is downwardly inclined from one corner to the other corner. The training ball, which has fallen to the bottom of the play field 10, rolls along each downward inclined face of the play field into each goal line and enters each ball guide groove line 14. The training ball introduced into each ball guide groove line 14 is collected along each downward inclined face of each ball guide groove line 14 toward each gate G of each ball collection apparatus 200 installed on each corner side.

[0087] In order to use the soccer-related training system 1 configured as shown in FIG. 11, one of the training ball shooting apparatuses 100 installed on both sides of the play field 10 must be activated. This activation can be made by the player's remote control device. When the operation mode of the training ball shooting apparatus 100 activated by using the remote controller is set to the manual/automatic setting mode or the motion detection mode, the training ball shooting apparatus 100 is configured to fire the ball toward the player on the play field 10. Thus, the player in the play field 10 may kick or head the training ball fired from the training ball shooting apparatus 100 in at least one mode of the penalty kick mode, the corner kick set play mode, the ground ball shoot mode, the volley ball shoot mode, or the heading shoot mode. In this connection, when the player kicks the ball fired from the training ball shooting apparatus 10 toward the goalpost 12, the training ball enters the goalpost 12.

[0088] The present aspect of the present disclosure includes a technical arrangement for sensing and scoring the entry of the training ball into the goalpost 12.

[0089] In front or rear of the goalpost 12, a ball sensing gate BSG as shown in FIG. 14 is installed. Preferably, the ball sensing gate BSG is mounted in rear of the goalpost 12. The ball sensing gate BSG may be made of a pipe material as in the goalpost 12. The gate is of a rectangular shape. On the upper side and the left side of the ball sensing gate BSG having the rectangular frame shape, arrays of a plurality of regularly and spacedly arranged light emitting devices (e.g., light emitting diodes, infrared light emitting diodes, etc.) are installed. On the lower side and the right side of the ball sensing gate BSG, arrays of a plurality of regularly spaced light receiving elements (for example, an infrared photodiode or phototransistor, etc.) are provided.

[0090] When the training ball passes through a particular zone within the goalpost 12, the ball sensing gate BSG is configured to determine the particular zone within the goalpost 12. This will be more clearly understood from the following description. In addition, a speed gun SG for measuring the speed of the training ball flying toward the goalpost 12 is installed behind the ball sensing gate BSG.

[0091] The soccer-related training system 1 according to the aspect of the present disclosure has been described with respect to the example of the soccer game where a plurality of people may enjoy together. However, the soccer-related training system 1 is equally applicable to a 5-player mini-soccer game played indoors like futsal. For example, the players may alternate soccer practice and futsal practice. Depending on whether the current played game is football or futsal, the position of the goalpost 12 installed on the play field 10 may vary. For example, installing movable wheels on the bottom of the goalpost 12 may be considered. Thus, the goalpost 12 may be installed on the futsal play field that can be easily configured indoors. Further, the goalpost 12 may be moved to the larger soccer play field.

Score calculation when training ball passes through goalpost

[0092] When the training ball passes through the goalpost 12 shown in FIG. 11, this is sensed by the sensors of the ball sensing gate BSG shown in FIG. 14. The sensors of the ball sensing gate BSG include the arrays of the light emitting devices XL1 to XL4 (left side) and YL1 to YL10 (upper side), and the corresponding arrays of the light receiving device XP1 to XP4 (right side) and YP1 to YP10 (lower side).

[0093] FIG. 14 shows an embodiment of the ball sens-

ing gate BSG. The region within the goalpost is divided into 40 sub-regions. Each score is assigned to each sub-region.

[0094] The ball sensing gate BSG is configured to sense that the training ball passes through a specific sub-region. In FIG. 14, numerals "0 to 10" shown in the sub-regions indicate scores for sub-regions.

[0095] Referring to FIG. 13, the ball sensing gate BSG coupled to the rear portion of the goalpost 12 includes the light emitting devices arrays XL1 to XL4 and YL1 to YL10 arranged along the left and upper sides of the ball sensing gate BSG respectively, and the light receiving elements arrays XP1 to XP4 and YP1 to YP10 arranged along the right and lower sides of the sensing gate BSG respectively. In this connection, the light emitting devices array XL1 to XL4 and the light receiving devices array XP1 to XP4 arranged along the left and right sides of the ball sensing gate BSG in a rectangular box shape respectively are spacedly arranged at a regular interval of 610 mm. The interval of 610mm is equal to a value of a height of 2440 mm of the goalpost 12 divided by 4. In this connection, the light emitting devices array YL1 to YL10 and the light receiving devices array YP1 to YP10 arranged along the upper and lower sides of the ball sensing gate BSG in a rectangular box shape respectively are spacedly arranged at a regular interval of 732 mm. The interval of 732 mm is equal to a value of a length of 7320 mm of the goalpost 12 divided by 10.

[0096] At least three light emitting elements are provided at equal intervals in each of the light emitting elements XL1 to XL4 and YL1 to YL10. At least three light receiving elements are provided at equal intervals in each of the light receiving elements XP1 to XP4 and YP1 to YP10 corresponding to the light emitting elements XL1 to XL4 and YL1 to YL10. Each of the light emitting devices XL1 to XL4 and YL1 to YL10 constituted as described above is driven to emit based on X axis and Y axis driving signals. Each of the light receiving elements XP1 to XP4 and YP1 to YP10 constituted as described above detects each light beam emitted from each of the light emitting elements XL1 to XL4 and YL1 to YL10.

[0097] In the above example, at least three light emitting elements are provided at equal intervals in each of the light emitting elements XL1 to XL4 and YL1 to YL10, and at least three light receiving elements are provided at equal intervals in each of the light receiving elements XP1 to XP4 and YP1 to YP10 corresponding to the light emitting elements XL1 to XL4 and YL1 to YL10. However, the present invention is not limited thereto. In order to improve the sensing intensity, the larger number of the light emitting elements are provided at equal intervals in each of the light emitting elements XL1 to XL4 and YL1 to YL10, and the larger number of the light receiving elements are provided at equal intervals in each of the light receiving elements XP1 to XP4 and YP1 to YP10 corresponding to the light emitting elements XL1 to XL4 and YL1 to YL10.

[0098] A controller (not shown) drives the light emitting elements arrays XL1 to XL4 and YL1 to YL10 of the ball sensing gate BSG and reads the outputs from the light receiving elements arrays XP1 to XP4 and YP1 to YP10, thereby to determine the sub-area within the goalpost 12 through which the ball passes. In addition, the controller receives the ball speed of the training ball sensed at the speed gun SG. The controller may calculate a total score based on scores corresponding to the determined sub-area and the ball speed, and display the total score on the display device (not shown). The controller may be referred to as a score counter SCNT.

[0099] Referring to FIG. 14, the score counter SCNT includes: light emitting drivers arrays LD1 and LD2 configured to drive the light emitting elements arrays XLi and YLj (where i is an integer of 1 to 4 and j is an integer of 1 to 10) provided on the X axis and Y axis of the ball sensor gate BSG via emission control signals; optical signal receivers arrays PR1 and PR2 configured to read the outputs from the light receiving device arrays XPi and YPj corresponding to the X-axis and Y-axis light emitting device arrays XLi and YLj of the ball sensing gate BSG and receiving the light sources (infrared rays) from the light emitting device arrays XLi and YLj; a score calculator SCNT configured to drive the light emitting drivers arrays LD1 and LD2 to turn on the light emitting elements arrays XLi and YLj, to determine a ball passing-through sub-area in the goalpost 12 based on the read output signals from the optical signal receivers arrays PR1 and PR2, to receive an impact signal from an impact sensor IS installed at the goalpost 12 or the ball sensor gate BSG and/or the speed measured by the speed-gun SG installed at the rear of the goalpost 12, and to calculate a total score based on the determined ball passing-through sub-area, the impact signal and/or the speed; and a display DISP for externally displaying the total score calculated from the score calculator. In the above embodiment, the light emitting drivers arrays LD1 and LD2 and the optical receivers arrays PR1 and PR2 are provided. However, the score calculator SCNT itself is configured to drive the light emitting element arrays XLi and YLj collectively and to read the outputs from the light receiving elements arrays XPi and YPj. In this case, it may dispense with the light emitting drivers arrays LD1 and LD2 and the optical receivers arrays PR1 and PR2.

[0100] Referring to FIGS. 13 and 14, the operation of calculation of the score when the training ball passes through the goalpost will be described.

[0101] When the soccer-related training system 1 is operated, the score calculator SCNT as shown in FIG. 14 supplies light emitting signals to the light emitting drivers arrays LD1 and LD2 to turn on the light emitting elements arrays XLi and YLj provided on the X axis and Y axis of the ball sensor gate BSG as shown in FIG. 14. The light emissions from the light emitting elements arrays XLi and YLj are received from the light receiving device arrays XPi and YPj corresponding to the light emitting devices arrays XLi and YLj respectively. Upon receiving the light emissions from the light emitting ele-

ments arrays XLi and YLj, the light receiving device arrays XPi and YPj may transmit sensing signals indicating the light emissions to the optical receivers arrays PR1 and PR2 respectively.

[0102] Normally, since the ball does not pass through within the goalpost 12, all of light beams emitted from the light emitting element arrays XLi and YLj arranged on the left side of the X axis and the upper side of the Y axis are received by the light receiving elements arrays XPi and YPj on without interruption of the light beams. Therefore, when the ball does not enter the goalpost 12, the detection signals detected by the light receiving elements arrays XPi and YPj are identical with each other, and the detection signals are provided to the score calculator SCNT through the optical receivers arrays PR1 and PR2.

[0103] The score calculator SCNT determines whether there are blocked light beams when the light beams corresponding to the detection signals received through the optical receivers arrays PR1 and PR2 are received by the light receiving elements array s XPi and YPj. In this way, which sub-region in the goalpost 12 the ball passed through is determined. When the ball does not pass through within the goalpost 12, all of the sensing signals from the light receiving elements arrays XPi and YPj will remain active logic "high".

[0104] When the training ball shot by the player passes through the "A" sub-region of FIG. 14, the light beams emitted by the light emitting elements XL1 and YL1 are momentarily blocked by the training ball passing through the "A" sub-region. As a result, only the outputs from the two photoreceptors XPi and YP1 instantaneously become inactive logic "low". This inactive logic "low" is supplied to the score calculator SCNT via the optical receivers PR1, PR2. In this connection, the score calculator SCNT determines that the outputs from the two photoreceivers XP1 and YPi are inactive, and recognizes that the training ball has passed through the "A" sub-region of FIG. 14. In this way, the score calculator SCNT assigns "10" points to the current shoot according to the predetermined scoring rule.

[0105] Then, the score calculator SCNT reads the speed information on the training ball detected by the speed gun SG installed behind the goalpost 12. The score calculator SCNT assigns a weight based on the speed information to the goalpost passing score "10", thereby to determine a final goalpost passing score. The score calculator SCN displays the training ball passing sub-region and the final goalpost passing score on the display DISP. As a result, the player may know which sub-zone in the goalpost the ball has passed through. Thus, the player may be more interested in practicing. Regarding the weight, the weight 1 is assigned when the speed of the ball is 60 Km/h or more, while the weight 0.5 is assigned when the speed is less than 60 Km/h. Even though the balls passed through the same sub-region, the scores for the balls differ depending on the speeds of the balls.

[0106] When the training ball shot by the player passes through the boundary zone between the "A" sub-region and the "B" sub-region of the ball sensing gate BSG, the score calculator SCNT assigns a point "9" which is an average between "10" corresponding to the "A" sub-region and "8" corresponding to the "B" sub-region. Next, a weight according to the speed detected by the speed gun SG is given to the point "9", thereby to determine the goalpost passing score, which, in turn, is displayed on the display DISP. In addition, when the training ball passes through a specific sub-region of the ball sensor gate BSG, the impact sensor IS installed at the goalpost 12 may detect the impact level. In this case, the score calculator SCNT assigns a score of '10' as the goalpost passing score regardless of the sub-regions through which the training ball passes.

[0107] As described above, in the soccer-related training system, when the player shoots a ball toward the goalpost, the ball passing-through sub-region in the goalpost and the speed of the ball are sensed, and, thus, the ball passing-through sub-region in the goalpost and the ball passing-through score are displayed on the display. This allows the player to practice with greater interest. In addition, it is easy to recognize a specific sub-region which the ball has passed through, so that the shooting posture and the like may be corrected more quickly.

[0108] Although not specifically described in the above embodiments, infrared ray or light sensors may be arranged in the longitudinal and vertical directions of the goalpost 12 at an interval equal to a diameter of the ball. Thus, a specific sub-region in the goalpost which the training ball passing through may be detected. The kick corresponding to the training ball may be scored for the specific sub-region in the goalpost 12 which the ball passes through. This allows the player to know the player's score for the kick. For example, when the ball passes through the four corners in the goalpost 12, the score 10 may be assigned. As a specific sub-region in the goalpost 12 which the ball passes through is closer to the central region in the goalpost 12, the score for the kick corresponding to the ball gradually decreases.

Embodiment of foot volleyball-related training system

[0109] In the foot volleyball, a net is placed between the two teams. The player uses only the head and feet to pass the ball towards the opponent's team court. The player receives a ball flying toward his or her court, and attacks the ball at a higher position than the net. The strong attacks of the ball toward the opposing court is referred to as a spike attack.

[0110] The foot volleyball training system 1 according to a preferred embodiment of the present invention includes the play field 10 defined by the end lines, the side lines and the half line, as shown in FIG. 16. Three training ball shooting apparatuses 100, G1 and G2 are installed at the corner portions of the play field 10 where the end lines and the side lines are in contact with each other,

thereby to fire the training ball toward the opposing court of the play field 10. In addition, a ball collection apparatus 200, which automatically collects the training balls collected at the end lines and supplies the collected training ball to the training ball shooting apparatus 100, is installed at the corner of the play field 10. A ball supply apparatus 300 for dropping the ball onto the court of the play field 10 nearby the net is installed at an intersection between the half line and side line, preferably at a position adjacent to a net pole POL where the net NET is installed. Thus, the balls stored in a ball storage portion 304 of the ball supply apparatus 300 is suppled through a lower ball distribution or discharge pipe 316. Although the ball supply apparatus 300 is installed closer to the position adjacent to the net pole POL on the play field 10 in this embodiment, the present disclosure is not limited thereto. It may be recognized that the ball supply apparatus 300 may be installed in various positions.

[0111] The ball supply apparatus 300 may hang on a pipe extending in a transverse direction or a longitudinal direction above the play field 10. However, in this embodiment, the ball supply apparatus 300 is installed on an upper portion of a vertical column 250. However, the present disclosure is not limited thereto. The training ball shooting apparatus 100 and G1 and G2 each has a camera CAM for photographing an object in front of them. The camera may be installed on each of front faces of the training ball shooting apparatuses.

[0112] The ball discharge tube 202 of the ball collection apparatus 200 is connected to one end of a ball convey tube 251. The other end of the ball convey tube 251 is connected to the opening of the ball storage portion 304 of the ball supply apparatus 300. In this connection, said one end of the ball conveying tube 521 is located higher than the other end thereof. For example, when the training ball is placed at said one end of the ball convey tube 251, the ball is naturally transferred to the other end by the ball's own weight because the tube 251 is inclined downwardly toward the other end thereof. Along the half line of the play field 10, the net NET is installed in the lateral direction.

[0113] The play field 10 shown in FIG. 16 is formed to be inclined downwards at 1 to 5 degrees θ from the half line HL to the end lines on both opposing ends thereof, as shown in FIG. 12. Each ball guide groove line 14 is formed in rear of the end line. The groove line 14 is downwardly inclined from one corner to the other corner. The training ball, which has fallen to the bottom of the play field 10, rolls along each downward inclined face of the play field into each end line and enters each ball guide groove line 14. The training ball introduced into each ball guide groove line 14 is collected along each downward inclined face of each ball guide groove line 14 toward each gate G of each ball collection apparatus 200 installed on each corner side.

[0114] Each of the training ball shooting apparatuses G1 and G2 shown in FIG. 1 is also provided with a ball container 104, though this is not specifically shown in the drawing for showing this embodiment of the present invention. The training ball may be manually inserted into the ball container 104 of each of the training ball shooting apparatuses G1 and G2 installed at each corner portion. Alternatively, the ball may be transferred from the ball collection apparatus 200 described above to each of the training ball shooting apparatuses G1 and G2.

Ball receive mode for foot volleyball

[0115] The training ball shooting apparatuses 100, G1 and G2 installed on the play field 10 of the foot volleyball-related training system 2 according to the embodiment of the present invention may be activated using a remote control device as described in the soccer-related training system. When the operation mode of one of the training ball shooting apparatuses 100, G1 and G2 activated by using the remote controller device is a manual/automatic setting mode or a motion detection mode, the training ball shooting apparatus 100 fires the ball toward the player on the opposing court of the play field 10. In this connection, the player may practice the foot volleyball receive practice by receiving the ball shot from the training ball shooting apparatus 100, G1 or G2 with his foot or head and at the same time, pushing the ball over the net toward the opposing court of the play field 10.

[0116] In the foot volleyball-related training system 2 according to this embodiment of the present invention, the ball supply apparatus 200 as illustrated in FIG. 10 is installed on the side line of the play field 10 as shown in FIG. 1.

Spike mode for foot volleyball

[0117] The spike mode for the foot volleyball-related training system 2 is set by the touch screen TS provided on the body frame 102 of the training ball shooting apparatus 100 or the remote control device.

[0118] When the spike mode is set by the key button of the touch screen TS, the control unit MPU shown in FIG. 6 transmits the setting information to the controller 324 in the ball supply apparatus 300 shown in FIG 10. Data transmission/reception between the control unit MPU in FIG. 6 and the controller 324 in the ball supply apparatus 300 may be performed in a wired or wireless manner. This data includes a spike ball distribution control signal based on image information captured by the camera CAM. For example, when the operation mode is the spike mode, and the camera CAM may detect a predetermined motion (e.g., lifting the arm up) of the player, or the spike mode setting signal is received from the remote control device held by the user, the spike ball distribution control signal is transmitted to the controller 324 of the ball supply apparatus 300.

[0119] When the user sets the spike mode using the remote controller device, the ball supply apparatus 300 is driven. When the ball supply apparatus 300 is driven, the training ball is discharged from the vertical falling out-

let 316a or the horizontally inclined outlet 316b of the ball supply pipe 316 of the ball supply apparatus 300, as described above with reference to FIG. 10. That is, the ball falls vertically onto the court of the play field 10 or flies horizontally. As a result, the player may practice spikes by hitting the vertically falling ball or hitting the training ball flying horizontally.

[0120] As described above, the foot volleyball training system according to the present invention fires a service ball at the end line of the foot volleyball court, or vertically drops the ball, or fire the ball horizontally from the position close to the sideline. This allows the foot volleyball player to more efficiently practice the ball receive action and spike action.

Ball supply to ball supply apparatus

[0121] In connection with the supply of the ball from the ball collection apparatus 300 to the ball supply apparatus 200, the ball discharge tube 202 installed on the top of the ball collection apparatus 200 in the configuration of FIG. 9 is rotated in the "R" direction to vertically overlap with the ball conveying tube 251. When the discharge port of the ball discharge tube 202 overlaps the ball conveying tube 251, the collected training balls are discharged from the discharge port and flows along the downwardly inclined ball conveying tube 251 into the upper opening in the storage portion 304 of the ball supply apparatus 300.

Embodiment of volleyball-related training system

[0122] In the volleyball, a net is placed between the two teams. The player uses the hands to pass the ball towards the opponent's team court. The player receives a ball flying toward his or her court, and spike-attacks the ball at a higher position than the net. The strong attacks of the ball toward the opposing court is referred to as a spike attack. This volleyball training system 3 allow the player to practice the ball receive and spike actions.

[0123] The volleyball training system 3 according to a preferred embodiment of the present invention includes the play field 10 defined by the end lines, the side lines and the half line, as shown in FIG. 17. A first training ball shooting apparatus 100 is installed at the corner portion of the play field 10 where the end lines and the side lines are in contact with each other, thereby to fire the training ball toward the opposing court of the play field 10. In addition, a ball collection apparatus 200, which automatically collects the training balls collected at the end lines and supplies the collected training ball to the training ball shooting apparatus 100, is installed at the corner of the play field 10. A second training ball shooting apparatus 100a is installed on the side line of the play field 10. The second training ball shooting apparatus 100a is manually driven. In one example, the ball collection apparatus 200 is adjacent to the training ball shooting apparatus 100 to feed the ball automatically to the training ball shooting apparatus 100. In one example, the ball collection apparatus 200 is coupled via the ball convey tube to the training ball shooting apparatus 100 such that the ball is discharged from the ball discharge tube 202 of the ball collection apparatus 200 and flows along the downwardly inclined convey tube and is inserted into the opening of the ball storage portion of the training ball shooting apparatus 100. The play field 10 shown in FIG. 17 is formed to be inclined downwards at 1 to 5 degrees θ from the half line HL to the end lines on both opposing ends thereof, as shown in FIG. 12. Each ball guide groove line 14 is formed in rear of the end line. The groove line 14 is downwardly inclined from one corner to the other corner. The training ball, which has fallen to the bottom of the play field 10, rolls along each downward inclined face of the play field into each end line and enters each ball guide groove line 14. The training ball introduced into each ball guide groove line 14 is collected along each downward inclined face of each ball guide groove line 14 toward each gate G of each ball collection apparatus 200 installed on each corner side. Each of the training ball shooting apparatuses 100 and 100a is also provided with a ball container 104, though this is not specifically shown in the drawing for showing this embodiment of the present invention. The training ball may be manually inserted into the ball container 104 of the training ball shooting apparatus 100a.

[0124] A ball supply apparatus 300 for dropping the ball onto the court of the play field 10 nearby the net is installed at an intersection between the half line and side line, preferably at a position adjacent to a net pole POL where the net NET is installed. Thus, the balls stored in a ball storage portion 304 of the ball supply apparatus 300 is suppled through a lower ball distribution or discharge pipe 316. Although the ball supply apparatus 300 is installed closer to the position adjacent to the net pole POL on the play field 10 in this embodiment, the present disclosure is not limited thereto. It may be recognized that the ball supply apparatus 300 may be installed in various positions. The ball supply apparatus 300 may hang on a pipe extending in a transverse direction or a longitudinal direction above the play field 10. However, in this embodiment, the ball supply apparatus 300 is installed on an upper portion of a vertical column 250. However, the present disclosure is not limited thereto. The first and second training ball shooting apparatuses 100 and 100a each has a camera CAM for photographing an object in front of them. The camera may be installed on each of front faces of the training ball shooting apparatuses.

[0125] The column 250 may be positioned on a guide rail 252 spaced apart from and parallel to the side line of the play field 10. Thus, the column 250 may be movable along the side line of the play field 10 on the guide rail 252. In this connection, the top of the column 250 is formed to be higher than the height of the net pole POL installed on the play field 10. Roller wheels 253 are attached to the bottom of the column 250. Thus, the column

250 slides in the front-rear direction on and along the guide rail 252. Of course, the roller wheels 253 may be coupled to fixing means such that the wheels 251 is not movable on the guide rail 252.

[0126] Thus, the column 250, coupled with the ball supply apparatus 300, may be moved along the guide rail 252 to be located proximate the ball discharge tube 202 of the ball collection apparatus 200. In this connection, the ball discharge tube 202 of the ball collection apparatus 200 is rotated so that the ball discharge tube 202 overlaps the upper portion of the ball supply apparatus 300. At this time, the training ball supplied from the ball collection apparatus 200 enters the ball storage portion 304 of the ball supply apparatus 300. Alternatively, the ball discharge tube 202 of the ball collection apparatus 200 is connected to one end of the ball convey tube 251. The other end of the ball convey tube 251 is connected to the opening of the ball storage portion 304 of the ball supply apparatus 300. In this connection, said one end of the ball conveying tube 521 is located higher than the other end thereof. For example, when the training ball is placed at said one end of the ball convey tube 251, the ball is naturally transferred to the other end by the ball's own weight because the tube 251 is inclined downwardly toward the other end thereof.

Ball receive and spike modes for foot volleyball

[0127] The training ball shooting apparatus 100 installed on the play field 10 of the volleyball-related training system 2 according to the embodiment of the present invention may be activated using a remote control device as described in the soccer-related training system. When the operation mode of one of the training ball shooting apparatus 100 activated by using the remote controller device is a manual/automatic setting mode or a motion detection mode, the training ball shooting apparatus 100 fires the ball toward the player on the opposing court of the play field 10. In this connection, the player may practice the volleyball receive practice by receiving the ball shot from the training ball shooting apparatus 100 with his hand and at the same time, pushing the ball over the net toward the opposing court of the play field 10.

[0128] The spike mode for the volleyball-related training system 2 is set by the touch screen TS provided on the body frame 102 of the training ball shooting apparatus 100 or the remote control device. When the spike mode is set by the key button of the touch screen TS, the control unit MPU shown in FIG. 6 transmits the setting information to the controller 324 in the ball supply apparatus 300 shown in FIG 10. Data transmission/reception between the control unit MPU in FIG. 6 and the controller 324 in the ball supply apparatus 300 may be performed in a wired or wireless manner. This data includes a spike ball distribution control signal based on image information captured by the camera CAM. For example, when the operation mode is the spike mode, and the camera CAM may detect a predetermined motion (e.g., lifting the arm up) of the player, or the spike mode setting signal is received from the remote control device held by the user, the spike ball distribution control signal is transmitted to the controller 324 of the ball supply apparatus 300. When the user sets the spike mode using the remote controller device, the ball supply apparatus 300 is driven. When the ball supply apparatus 300 is driven, the training ball is discharged from the vertical falling outlet 316a or the horizontally inclined outlet 316b of the ball supply pipe 316 of the ball supply apparatus 300, as described above with reference to FIG. 10. That is, the ball falls vertically onto the bottom of the play field 10 or flies horizontally. As a result, the player may practice spikes by hitting the vertically falling ball or hitting the training ball flying horizontally.

[0129] As described above, the volleyball training system according to the present invention fires a service ball at the end line of the volleyball court, or vertically drops the ball, or fire the ball horizontally from the position close to the sideline. This allows the volleyball player to more efficiently practice the ball receive action and spike action.

Ball supply to ball supply apparatus

[0130] In order that the supply of the ball from the ball collection apparatus 200 to the ball supply apparatus 300, the column 250 is pushed toward the ball collection apparatus 200, and, thus, the column 250 moves along the guide rail 252 in the forward and backward directions using its roller wheels 251. In this way, the ball supply apparatus 300 is adjacent to the ball collection apparatus 200. The ball supply apparatus 300 is positioned below the ball discharge tube 202 of the ball collection apparatus 200. The discharge direction of the ball discharge tube 202 of the ball collection apparatus 200 is directed to toward the upper opening of the ball storage portion 304 of the ball supply apparatus 300. The ball collection apparatus 200 is operated to collect the training ball collected in the ball guide groove line 14 and discharge the ball into the upper ball distribution pipe 316. Then, the collected training ball is introduced into the ball storage portion 304 of the ball supply apparatus 300. Alternatively, in order that the supply of the ball from the ball collection apparatus 300 to the ball supply apparatus 200, the ball discharge tube 202 installed on the top of the ball collection apparatus 200 in the configuration of FIG. 9 is rotated in the "R" direction to vertically overlap with the ball conveying tube 251. When the discharge port of the ball discharge tube 202 overlaps the ball conveying tube 251, the collected training balls are discharged from the discharge port and flows along the downwardly inclined ball conveying tube 251 into the upper opening in the storage portion 304 of the ball supply apparatus 300.

Embodiment of basketball-related training system

[0131] Basketball is a game in which two teams, each

time having five players pass or dribble the ball and throw it into the basket of the opponent team. This basketball-related training system allows the practitioner to practice a ball receive practice by shooting the training ball in the form of a pass action toward the player on the basketball court or to practice a three-point shoot practice by dropping the ball onto a three-point shoot area.

[0132] The basketball training system 4 according to an aspect of the present disclosure includes the play field 10 defined by the end lines, the side lines and the half line. The play field 10 is formed to be inclined downwards at 1 to 5 degrees θ from the half line HL to the end lines on both opposing ends thereof, as shown in FIG. 12. Each ball guide groove line 14 is formed in rear of the end line. The groove line 14 is downwardly inclined from one corner to the other corner. The training ball, which has fallen to the bottom of the play field 10, rolls along each downward inclined face of the play field into each end line and enters each ball guide groove line 14.

[0133] In this aspect of the present disclosure, as shown in FIG. 19, the training ball introduced into each ball guide groove line 14 is collected along each downward inclined face of each ball guide groove line 14 toward each gate G of each ball collection apparatus 200 installed on each corner side. Each downward inclined face of each ball guide groove line 14 is configured such that a first downwardly inclined face is formed from one end of the line toward a middle portion of the line and a second downwardly inclined face is formed from the other end of the line toward the middle portion of the line. Thus, the ball is collected at the middle portion of the line 14 as shown in FIG. 19. In this connection, the ball collection apparatus 200 is installed at the middle portion of the line 14. In addition, the goalpost having a basket BG attached thereto is installed near the end line of the play field 10.

[0134] A training ball shooting apparatus 100 is installed at the corner portion of the play field 10 where the end lines and the side lines are in contact with each other, thereby to fire the training ball toward the player on the play field 10. In addition, a ball collection apparatus 200, which automatically collects the training balls collected at the end lines and supplies the collected training ball to the training ball shooting apparatus 100, is installed at the corner of the play field 10. A second training ball shooting apparatus 100a is installed in rear of the goalpost BG of the play field 10. The second training ball shooting apparatus 100a is manually driven. In one example, the ball collection apparatus 200 is adjacent to the training ball shooting apparatus 100 to feed the ball automatically to the training ball shooting apparatus 100. In one example, the ball collection apparatus 200 is coupled via the ball convey tube to the training ball shooting apparatus 100 such that the ball is discharged from the ball discharge tube 202 of the ball collection apparatus 200 and flows along the downwardly inclined convey tube and is inserted into the opening of the ball storage portion of the training ball shooting apparatus 100.

[0135] A ball supply apparatus 300 for dropping the ball onto the court of the play field 10 may be installed nearby the side line of the play field 10. The balls stored in a ball storage portion 304 of the ball supply apparatus 300 is suppled through a lower ball distribution or discharge pipe 316 onto the 3 point shoot area on the play field 10. The ball supply apparatus 300 may hang on a pipe extending in a transverse direction or a longitudinal direction above the play field 10. Further, in another embodiment, the ball supply apparatus 300 is installed on an upper portion of a vertical column 250. However, the present disclosure is not limited thereto. The first and second training ball shooting apparatuses 100 and 100a each has a camera CAM for photographing an object in front of them. The camera may be installed on each of front faces of the training ball shooting apparatuses. Although the ball supply apparatus 300 is installed closer to the position adjacent to the side or end line on the play field 10 in this embodiment, the present disclosure is not limited thereto. It may be recognized that the ball supply apparatus 300 may be installed in various positions.

[0136] The training ball shooting apparatus 100 installed on the play field 10 may be activated using a remote control device as described in the soccer-related training system. When the operation mode of one of the training ball shooting apparatus 100 activated by using the remote controller device is a manual/automatic setting mode or a motion detection mode, the training ball shooting apparatus 100 fires the ball toward the player on the play field 10. In this connection, the player may practice the ball receive practice by receiving the ball shot from the training ball shooting apparatus 100 with his hand and at the same time, pushing the ball toward the basket BG. When the ball supply apparatus 300 is driven, the training ball is discharged from the vertical falling outlet 316a or the horizontally inclined outlet 316b of the ball supply pipe 316 of the ball supply apparatus 300, as described above with reference to FIG. 10. That is, the ball falls vertically onto the 3 point shoot area on the play field 10 or flies horizontally toward the player in a pass action form. As a result, the player may practice the ball receive or 3 point shoot practice.

[0137] As shown in FIG. 10, when the rotatable opening/closing plate 310, which is shaft-coupled to the rotation shaft 312 of the opening/closing motor 302 rotates one time by 360 degree of a rotation angle, the discharge hole formed in the partition is opened once and then closed. Thereby, a single training ball is discharged through the ball discharge tube 316. At this time, the ball may fall directly onto the bottom surface of the play field 10 through the vertical falling outlet 316a or may horizontally fly through the horizontally inclined outlet 316b and gradually falls to the bottom. This allows the player to practice receiving the balls falling in various directions, and/or to shoot the balls into the basket. It is also possible to adjust the position of the ball discharge end of the ball discharge tube 316 by the rotation of the swing motor 320. As a result, the drop position of the ball can be adjusted. This allows the player to practice the 3 point shoot

practices at various positions.

[0138] The controller 324 may transmit/receive data to control the training ball shooting apparatus 100 in a wired or wireless manner. Thus, the controller may receive the ball distribution control signal by wire or wirelessly, and may control the opening/closing motor 302 and the swing motor 320. For example, when the training ball shooting apparatus 100 is controlled using only a remote controller device, the controller 324 receive the data to control the training ball shooting apparatus 100 in a wireless manner from the remote controller device and drives the opening/closing motor 302 and the swing motor 320 based on the remote control signal transmitted from the remote controller device. Thus, the training ball accommodated in the ball storage portion 304 may be dropped to the 3 point shoot area on the play field 10. This may allow the player to practice the 3 point shoot practices on her/his own.

[0139] In connection with the supply of the ball from the ball collection apparatus 300 to the ball supply apparatus 200, the ball discharge tube 202 installed on the top of the ball collection apparatus 200 in the configuration of FIG. 9 is rotated in the "R" direction to vertically overlap with the ball conveying tube 251. When the discharge port of the ball discharge tube 202 overlaps the ball conveying tube 251, the collected training balls are discharged from the discharge port and flows along the downwardly inclined ball conveying tube 251 into the upper opening in the storage portion 304 of the ball supply apparatus 300.

[0140] As described above, the basketball-related training system fires the balls toward on a player on a basketball court and supplies balls to various areas including a three-point shooting area. Thus, the basketball practitioner receive the training ball supplied at various positions by his hand, and may practice various shoots including the 3 point shoots on his own. In addition, the balls dropped on the play court may be automatically supplied via the ball collection apparatus 200 to the training ball shooting apparatus 100 and the ball supply apparatus 300, which makes basketball practice more efficient.

Claims

1. A ball game-related training system comprising:

a play field (10) defined by a half line, both opposing end lines, and both opposing side lines, wherein the play field (10) has a net extending along the half line;
a vertical column structure (250) adjacent to at least one of the end and side lines; and
a ball supply apparatus (300) coupled to the column structure (250) at an upper portion thereof, wherein the ball supply apparatus (300) includes:
a housing (301) coupled to the upper portion of the column structure (250), wherein a top portion of housing (301) is partially open, wherein the housing (301) is divided by a partition (308) into a ball storage portion (304) and a ball discharge portion (306), wherein a bottom face of the ball storage portion (304) is inclined downward toward the ball discharge portion (306), wherein a first opening is formed in a bottom of the ball discharge portion (306), and a second opening is formed in the partition (308) at a lower portion thereof;
a rotatable opening/closing plate (310) rotatably coupled to the partition (308), wherein the rotatable opening/closing plate (310) is configured to rotate to open/close the second opening; and
a ball discharge tube (316) rotatably coupled to the ball discharge portion (306) at the first opening, wherein the ball discharge tube (316) ball-communicates with the ball discharge portion (306) via the first opening,
characterized in that the upper end of the discharge tube (316) is inserted into the ball discharge portion (306) through the first opening, wherein a straight bevel gear system (318) is disposed in the housing (301), wherein a rack gear (118) of the straight bevel gear system (318) is integrally formed with an outer peripheral face of the upper end of the ball discharge tube (316), and the rack gear (118) is mutual-meshed with a drive gear (119) of the straight bevel gear system (318), wherein the drive gear (119) is coupled to a rotation shaft from a swing motor installed in the housing (301).

2. The system of claim 1, wherein the rotatable opening/closing plate (310) is screw-coupled to a rotation shaft from an opening/closing motor installed in the housing (301), wherein the rotatable opening/closing plate (310) is configured to rotate to open/close the second opening via rotation of the opening/closing motor.

3. The ball game-related training system of claim 1,

wherein the play field (10) is configured to be downwardly inclined from the half line to each end line, wherein the play field (10) has a ball guide groove line (14) defined therein along each end line, wherein the ball guide groove line (14) is configured to be downwardly inclined from one end to the other end thereof,
a ball shooting apparatus (100) configured to shoot a ball toward a target position on the play field, wherein the ball shooting apparatus (100)

is disposed on a corner of the play field, wherein the ball shooting apparatus (100) has a ball container (104) receiving a ball from above;
a ball convey tube (251) having one end vertically overlapping the upper ball receiving opening of the ball supply apparatus (300), wherein the ball convey tube (251) is downwardly inclined from the other end to one end thereof; and
a ball collection apparatus (200) disposed on the other end of the ball guide groove line (14), wherein the ball collection apparatus (200) includes a vertical hollow ball guide elongate cylinder, and the ball is collected from the groove line and moves upwardly in and along the vertical hollow ball guide elongate cylinder using a collection motor, and the ball collection apparatus (200) has an upper rotatable ball discharge tube (316), and the upper rotatable ball discharge tube (316) is rotated such that a discharge hole thereof selectively overlaps vertically and above the ball container (104), the upper ball receiving opening, and/or the other end of the ball convey tube (251).

Patentansprüche

1. Ballspielbezogenes Trainingssystem umfassend:

ein Spielfeld (10), das durch eine Mittellinie, zwei gegenüberliegende Endlinien und zwei gegenüberliegende Seitenlinien definiert ist, wobei das Spielfeld (10) ein Netz hat, das sich längs der Mittellinie erstreckt;
eine vertikale Säulenstruktur (250) angrenzend an wenigstens eine von den End- und Seitenlinien, und
eine Ballzuführvorrichtung (300), die mit der Säulenstruktur (250) an einem oberen Abschnitt davon verbunden ist,
wobei die Ballzuführvorrichtung (300) umfasst:

ein Gehäuse (301), das mit dem oberen Abschnitt der Säulenstruktur (250) verbunden ist, wobei ein oberster Abschnitt des Gehäuses (301) teilweise offen ist,
wobei das Gehäuse (301) durch eine Trennwand (308) in einen Ballaufbewahrungsabschnitt (304) und einen Ballabgabeabschnitt (306) unterteilt ist, wobei eine Bodenfläche des Ballaufbewahrungsabschnitts (304) nach unten zu dem Ballabgabeabschnitt (306) geneigt ist, wobei eine erste Öffnung in einem Boden des Ballabgabeabschnitts (306) ausgebildet ist, und eine zweite Öffnung in der Trennwand (308) an einem unteren Abschnitt davon ausgebildet ist;

eine drehbare Öffnungs-/Schließplatte (310), die drehbar mit der Trennwand (308) verbunden ist, wobei die drehbare Öffnungs-/Schließplatte (310) so konfiguriert ist, dass sie sich dreht, um die zweite Öffnung zu öffnen/schließen; und
ein Ballabgaberohr (316), das drehbar mit dem Ballabgabeabschnitt (306) an der ersten Öffnung verbunden ist, wobei das Ballabgaberohr (316) über die erste Öffnung mit dem Ballabgabeabschnitt (306) in Ballverbindung steht,
dadurch gekennzeichnet, dass das obere Ende des Abgaberohrs (316) durch die erste Öffnung in den Ballabgabeabschnitt (306) eingeführt ist, wobei ein Kegelstirnradgetriebesystem (318) in dem Gehäuse (301) angeordnet ist, wobei eine Zahnstange (118) des Kegelstirnradgetriebesystems (318) einstückig mit einer Außenumfangsfläche des oberen Endes des Ballabgaberohrs (316) ausgebildet ist, und die Zahnstange (118) in gegenseitigem Eingriff mit einem Antriebsrad (119) des Kegelstirnradgetriebesystems (318) steht, wobei das Antriebsrad (119) mit einer Drehwelle eines in dem Gehäuse (301) installierten Schwenkmotors verbunden ist.

2. System nach Anspruch 1, wobei die drehbare Öffnungs-/Schließplatte (310) mit einer Drehwelle eines in dem Gehäuse (301) installierten Öffnungs-/Schließmotors schraubverbunden ist, wobei die drehbare Öffnungs-/Schließplatte (310) so konfiguriert ist, dass sie sich dreht, um die zweite Öffnung über Drehung des Öffnungs-/Schließmotors zu öffnen/schließen.

3. Ballspielbezogenes Trainingssystem nach Anspruch 1,
wobei das Spielfeld (10) so konfiguriert ist, dass es von der Mittellinie zu jeder Endlinie nach unten geneigt ist, wobei das Spielfeld (10) eine Ballführungsnutlinie (14) aufweist, die darin längs jeder Endlinie definiert ist, wobei die Ballführungsnutlinie (14) konfiguriert ist, um von ihrem einen Ende zu ihrem anderen Ende nach unten geneigt zu sein, umfassend eine Ballschussvorrichtung (100), die dazu konfiguriert ist, einen Ball zu einer Zielposition auf dem Spielfeld zu schießen, wobei die Ballschussvorrichtung (100) in einer Ecke des Spielfelds angeordnet ist, wobei die Ballschussvorrichtung (100) einen Ballbehälter (104) aufweist, der einen Ball von oben aufnimmt;
ein Ballförderrohr (251), das ein Ende aufweist, das die obere Ballaufnahmeöffnung der Ballzufuhrvorrichtung (300) vertikal überlappt, wobei das Ballförderrohr (251) von seinem anderen Ende zu seinem

einen Ende nach unten geneigt ist; und
eine Ballsammelvorrichtung (200), die am anderen Ende der Ballführungsnutlinie (14) angeordnet ist, wobei die Ballsammelvorrichtung (200) einen vertikalen hohlen länglichen Ballführungszylinder aufweist und der Ball von der Nutlinie aufgenommen wird und sich in und entlang des vertikalen hohlen länglichen Ballführungszylinders nach oben bewegt, wobei ein Sammelmotor verwendet wird, und die Ballsammelvorrichtung (200) ein oberes drehbares Ballabgaberohr (316) aufweist, und das obere drehbare Ballabgaberohr (316) derart gedreht wird, dass sein Abgabeloch selektiv vertikal und oberhalb des Ballbehälters (104) die obere Ballaufnahmeöffnung überlappt und/oder das andere Ende des Ballförderrohrs (251) überlappt.

Revendications

1. Système d'entraînement lié à un jeu de ballon, comprenant :

un terrain de jeu (10) défini par une ligne médiane, deux lignes d'extrémité opposées, et deux lignes latérales opposées, dans lequel le terrain de jeu (10) présente un filet s'étendant le long de la ligne médiane,
une structure en colonne verticale (250) adjacente à au moins l'une des lignes d'extrémité et latérales, et
un appareil de distribution de ballons (300) couplé à la structure en colonne (250) au niveau d'une partie supérieure de celle-ci,
dans lequel l'appareil de distribution de ballons (300) comporte :

- un logement (301) couplé à la partie supérieure de la structure en colonne (250), où une partie de dessus du logement (301) est en partie ouverte, où le logement (301) est divisé par une cloison (308) en une partie de stockage des ballons (304) et une partie de sortie des ballons (306), où une face de fond de la partie de stockage des ballons (304) est inclinée vers le bas vers la partie de sortie des ballons (306), où une première ouverture est formée dans un fond de la partie de sortie des ballons (306), et une seconde ouverture est formée dans la cloison (308) au niveau d'une partie inférieure de celle-ci,
- une plaque d'ouverture/fermeture rotative (310) couplée de manière rotative à la cloison (308), où la plaque d'ouverture/fermeture rotative (310) est configurée pour tourner afin d'ouvrir/fermer la seconde ouverture, et
- un tube de sortie des ballons (316) couplé de manière rotative à la partie de sortie des ballons (306) au niveau de la première ouverture, où le tube de sortie des ballons (316) communique des ballons avec la partie de sortie des ballons (306) par le biais de la première ouverture,

caractérisé en ce que l'extrémité supérieure du tube de sortie (316) est insérée dans la partie de sortie des ballons (306) à travers la première ouverture, où un système d'engrenage conique droit (318) est disposé dans le logement (301), où un engrenage à crémaillère (118) du système d'engrenage conique droit (318) est formé d'un seul tenant avec une face périphérique extérieure de l'extrémité supérieure du tube de sortie des ballons (316), et l'engrenage à crémaillère (118) est engrené mutuellement avec une roue d'entraînement (119) du système d'engrenage conique droit (318), où la roue d'entraînement (119) est couplée à un arbre de rotation à partir d'un moteur de pivotement installé dans le logement (301).

2. Système selon la revendication 1, dans lequel la plaque d'ouverture/fermeture rotative (310) est couplée par vissage à un arbre de rotation à partir d'un moteur d'ouverture/fermeture installé dans le logement (301), où la plaque d'ouverture/fermeture rotative (310) est configurée pour tourner afin d'ouvrir/fermer la seconde ouverture par le biais de la rotation du moteur d'ouverture/fermeture.

3. Système d'entraînement lié à un jeu de ballon selon la revendication 1,
dans lequel le terrain de jeu (10) est configuré pour être incliné vers le bas à partir de la ligne médiane jusqu'à chaque ligne d'extrémité, où le terrain de jeu (10) présente une ligne de rainure de guidage des ballons (14) définie à l'intérieur le long de chaque ligne d'extrémité, où la ligne de rainure de guidage des ballons (14) est configurée pour être inclinée vers le bas à partir d'une extrémité jusqu'à l'autre extrémité de celle-ci,
un appareil de tir des ballons (100) configuré pour tirer un ballon vers une position cible sur le terrain de jeu, où l'appareil de tir des ballons (100) est disposé sur un coin du terrain de jeu, où l'appareil de tir des ballons (100) présente un conteneur à ballons (104) recevant un ballon par le haut,
un tube de transport des ballons (251) présentant une extrémité chevauchant verticalement l'ouverture supérieure de réception des ballons de l'appareil de distribution des ballons (300), où le tube de transport des ballons (251) est incliné vers le bas à partir de l'autre extrémité jusqu'à une extrémité de celui-ci, et

un appareil de collecte des ballons (200) disposé à l'autre extrémité de la ligne de rainure de guidage des ballons (14), où l'appareil de collecte des ballons (200) comporte un cylindre allongé creux vertical de guidage des ballons, et le ballon est collecté à partir de la ligne de rainure et se déplace vers le haut dans le cylindre allongé creux vertical de guidage des ballons et le long de celui-ci à l'aide d'un moteur de collecte, et l'appareil de collecte des ballons (200) présente un tube supérieur rotatif de sortie des ballons (316), et le tube supérieur rotatif de sortie des ballons (316) est tourné de telle sorte qu'un orifice de sortie de celui-ci chevauche de manière sélective verticalement et au-dessus le conteneur à ballons (104), l'ouverture supérieure de réception des ballons , et/ou l'autre extrémité du tube de transport des ballons (251).

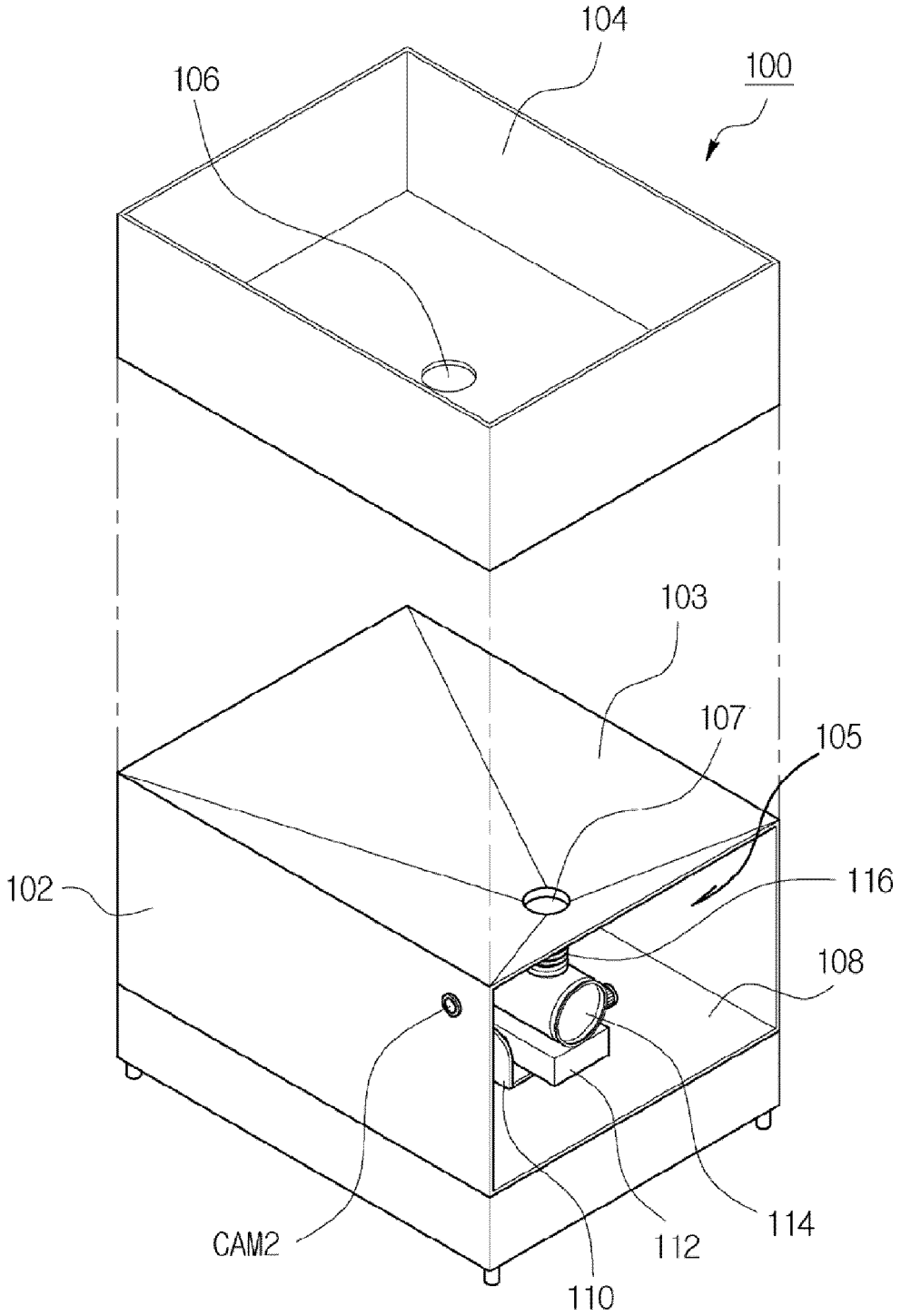

FIG. 1

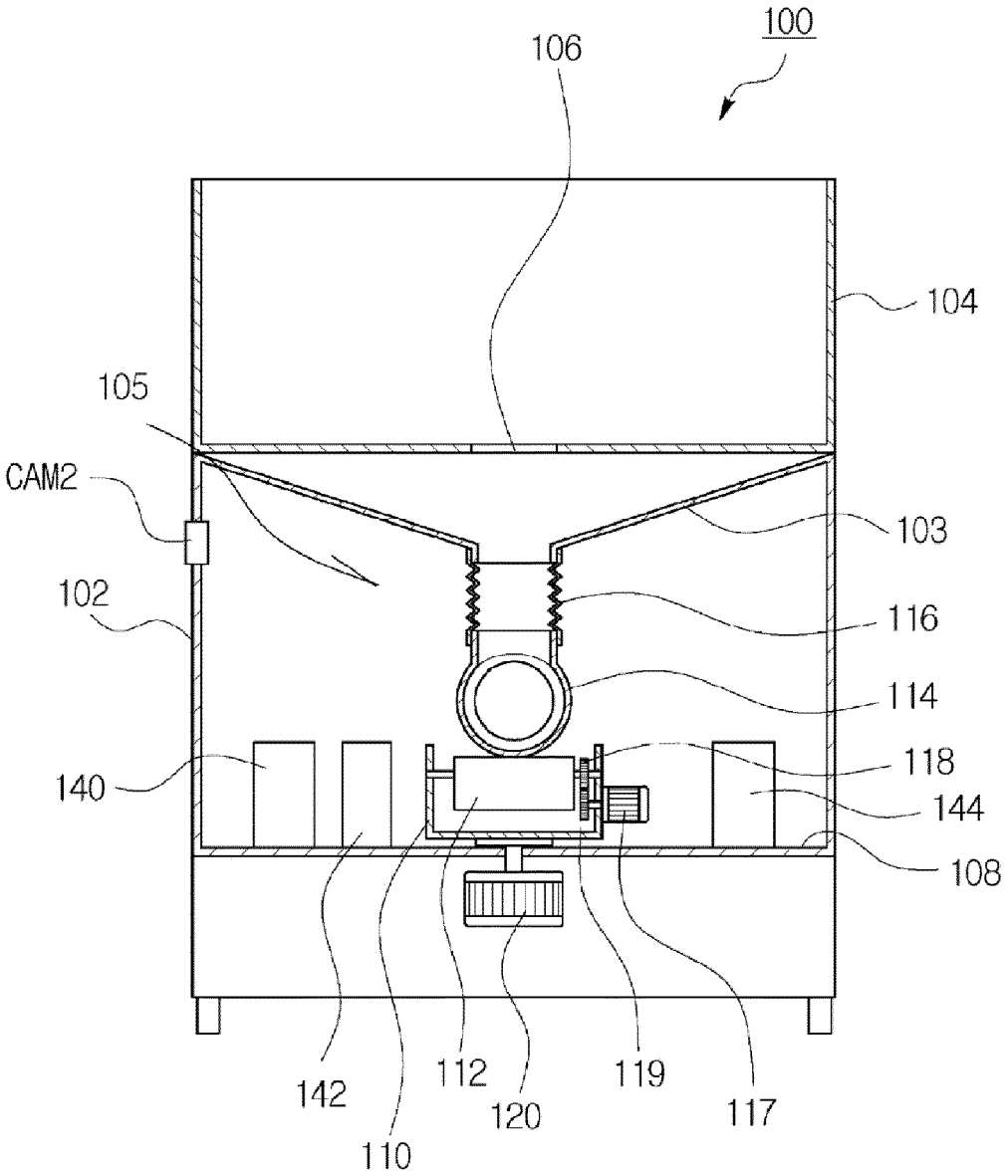
100
106
104
105
CAM2
103
102
116
114
140
118
144
108
142
112
119
117
110
120

FIG. 2

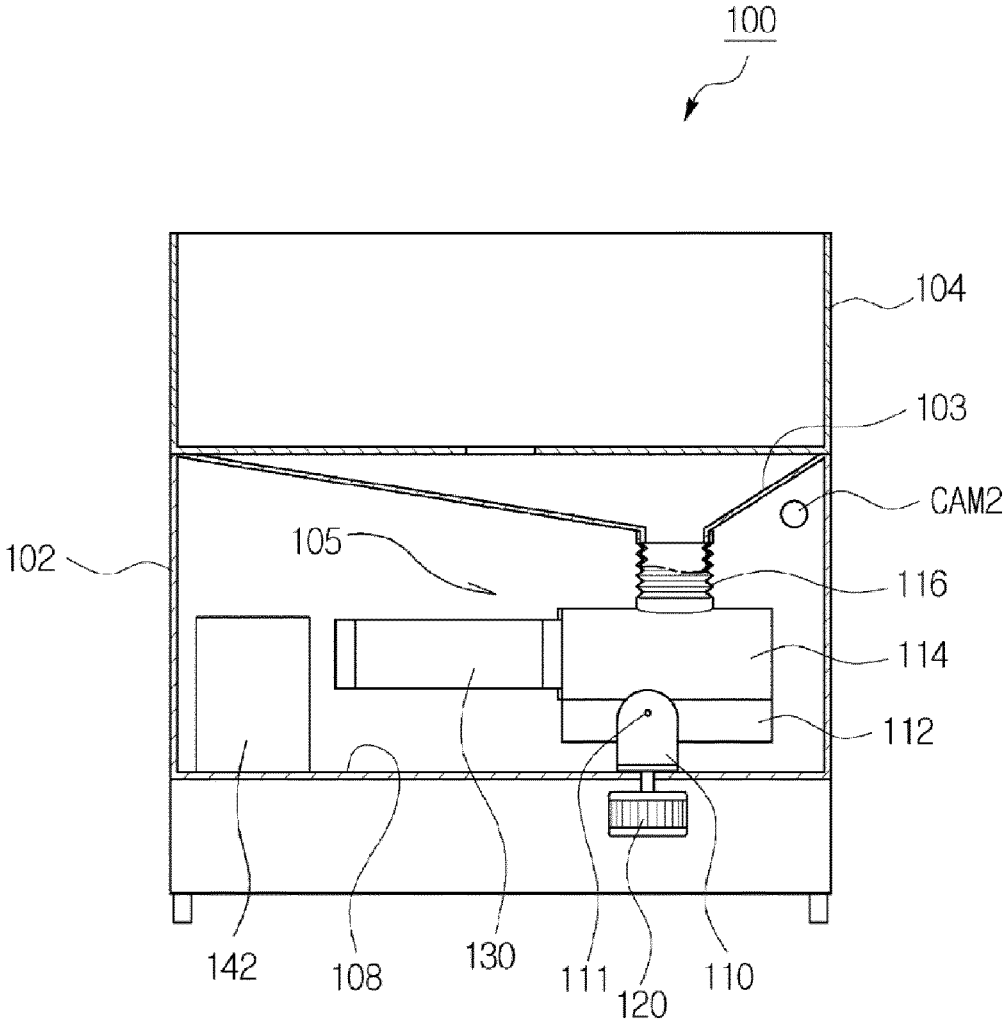

FIG. 3

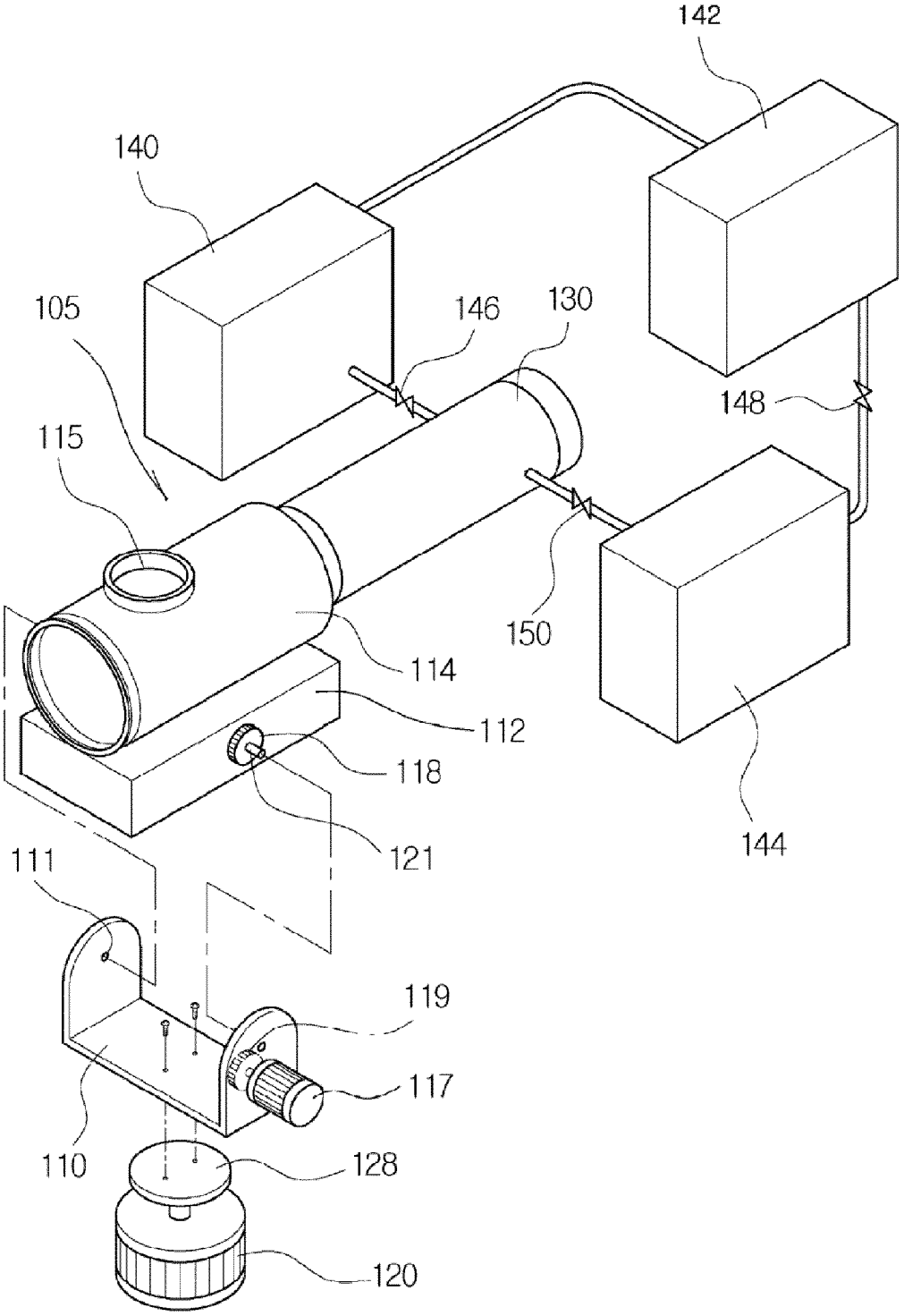
142
140
105
146
130
148
115
150
114
112
118
121
144
111
119
117
110
128
120

FIG. 4

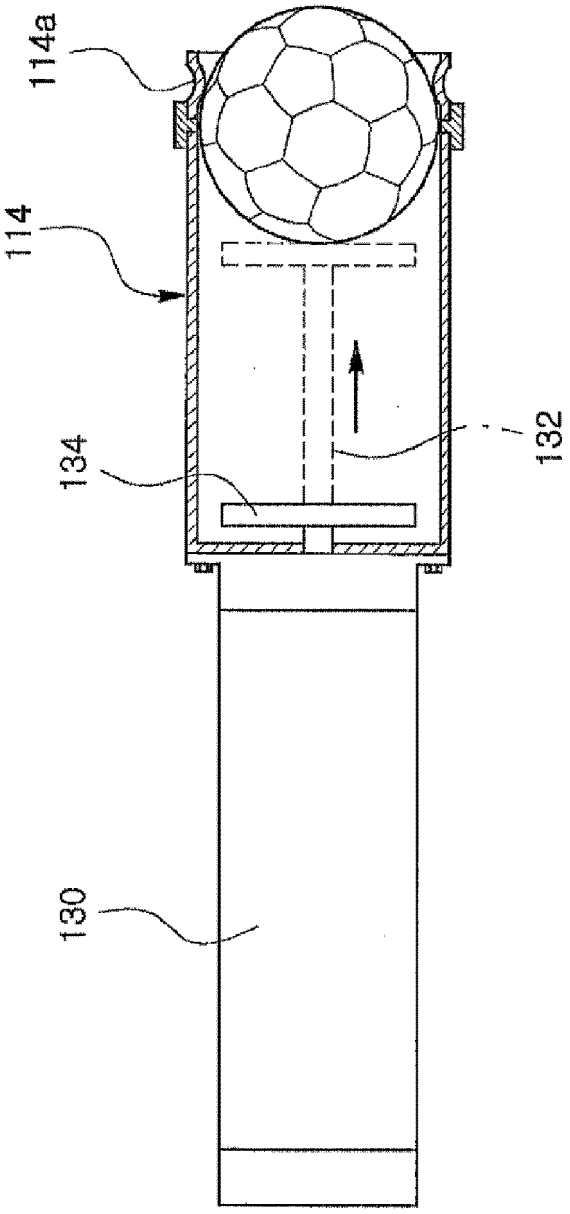

FIG. 5

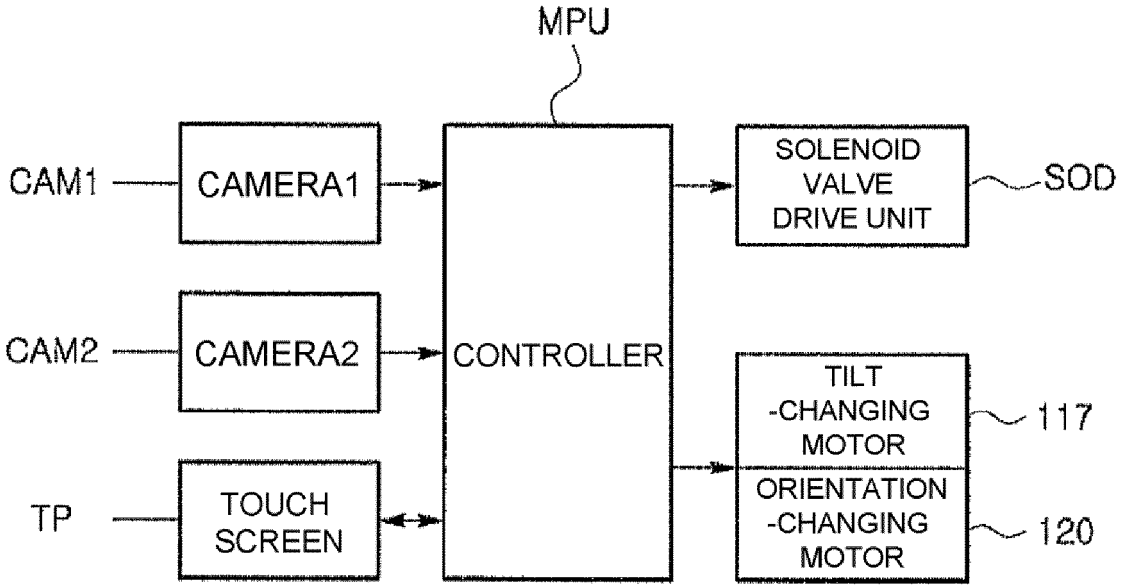
MPU
CAM1
CAMERA1
CAM2
CAMERA2
TP
TOUCH SCREEN
CONTROLLER
SOLENOID VALVE DRIVE UNIT
SOD
TILT -CHANGING MOTOR
117
ORIENTATION -CHANGING MOTOR
120

FIG. 6

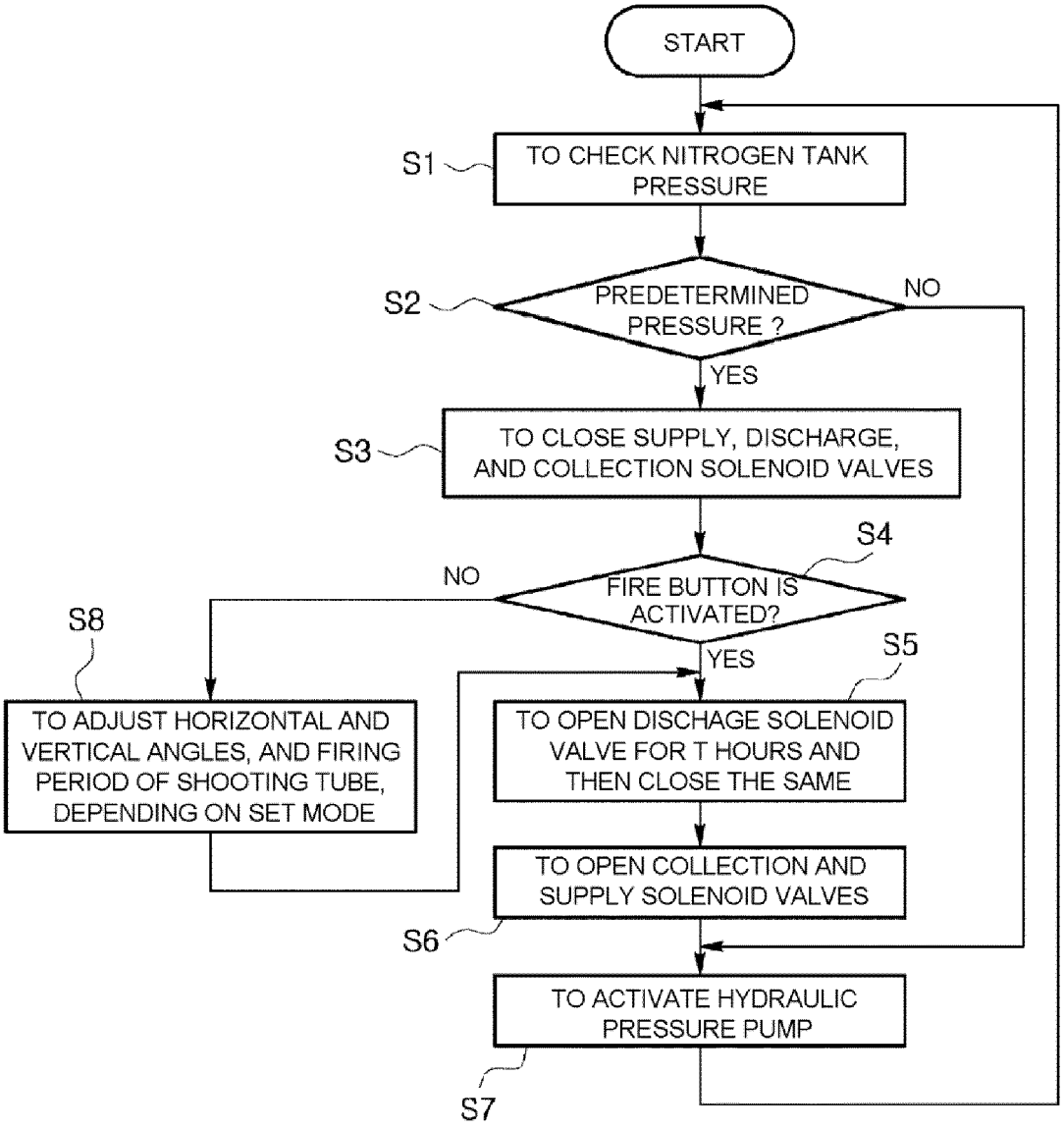
START
S1
TO CHECK NITROGEN TANK PRESSURE
S2
PREDETERMINED PRESSURE ?
NO
YES
S3
TO CLOSE SUPPLY, DISCHARGE, AND COLLECTION SOLENOID VALVES
S4
FIRE BUTTON IS ACTIVATED?
NO
YES
S8
TO ADJUST HORIZONTAL AND VERTICAL ANGLES, AND FIRING PERIOD OF SHOOTING TUBE, DEPENDING ON SET MODE
S5
TO OPEN DISCHAGE SOLENOID VALVE FOR T HOURS AND THEN CLOSE THE SAME
TO OPEN COLLECTION AND SUPPLY SOLENOID VALVES
S6
TO ACTIVATE HYDRAULIC PRESSURE PUMP
S7

FIG. 7

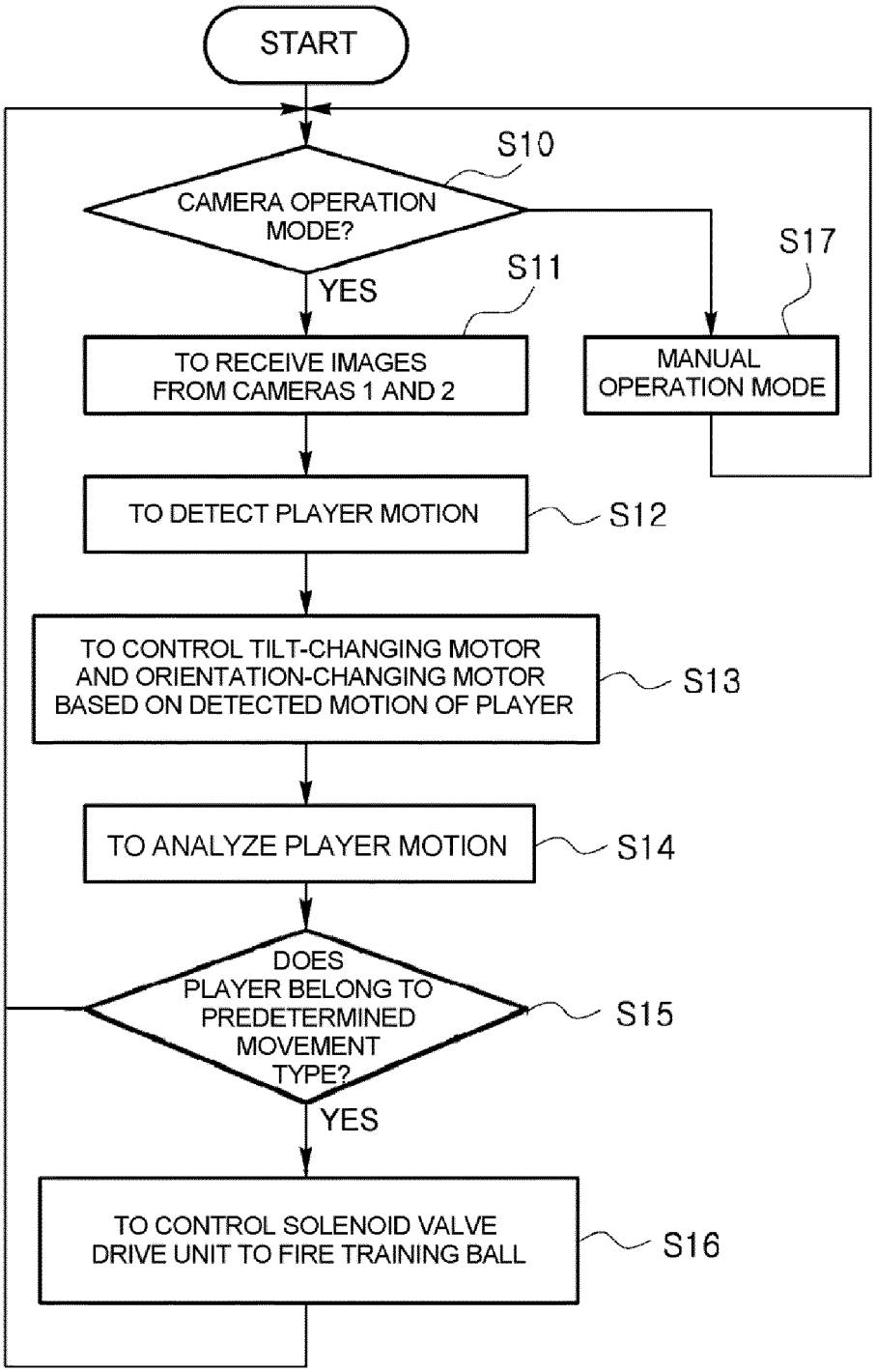
START
S10
CAMERA OPERATION MODE?
YES
S11
TO RECEIVE IMAGES FROM CAMERAS 1 AND 2
S17
MANUAL OPERATION MODE
TO DETECT PLAYER MOTION
S12
TO CONTROL TILT-CHANGING MOTOR AND ORIENTATION-CHANGING MOTOR BASED ON DETECTED MOTION OF PLAYER
S13
TO ANALYZE PLAYER MOTION
S14
DOES PLAYER BELONG TO PREDETERMINED MOVEMENT TYPE?
S15
YES
TO CONTROL SOLENOID VALVE DRIVE UNIT TO FIRE TRAINING BALL
S16

FIG. 8

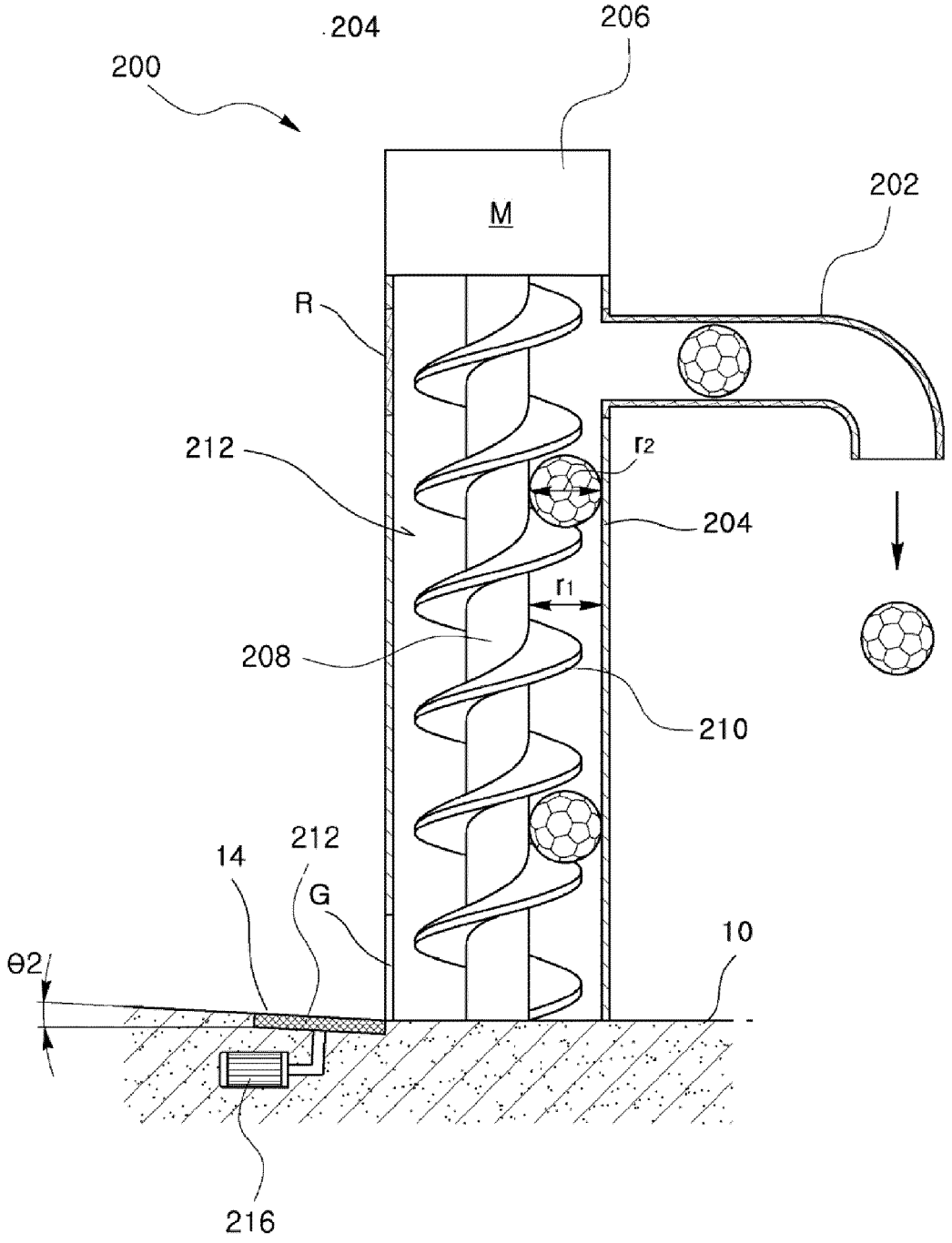

FIG. 9

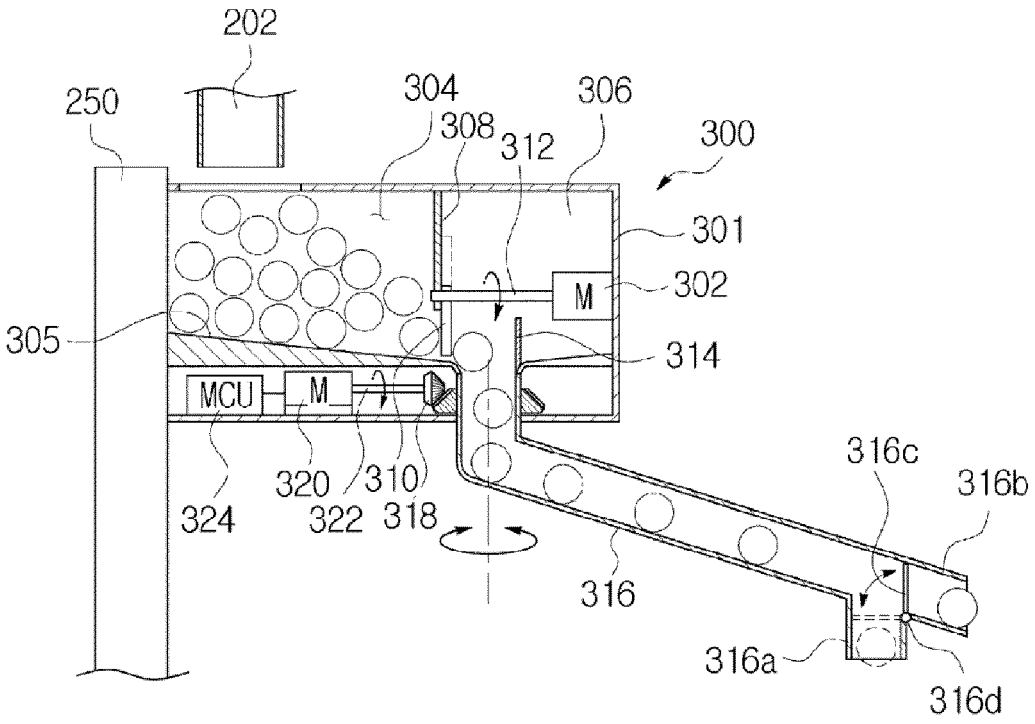
202
250
304
308
312
306
300
301
M
302
305
314
MCU
M
320
322
310
318
324
316
316c
316b
316a
316d

FIG. 10

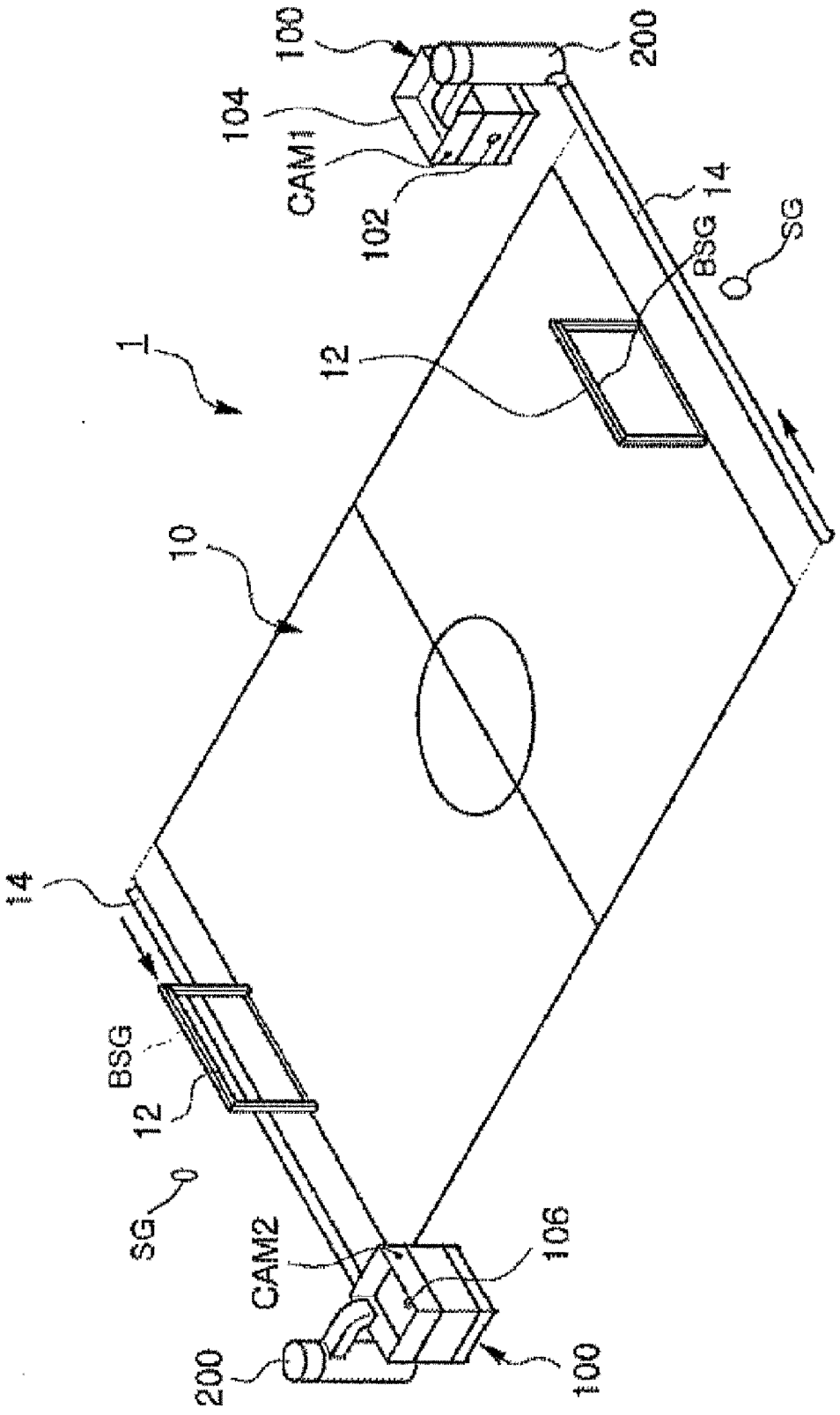
100
200
104
CAM1
102
BSG
14
SG
1
12
10
14
BSG
12
SG
CAM2
106
200
100

FIG. 11

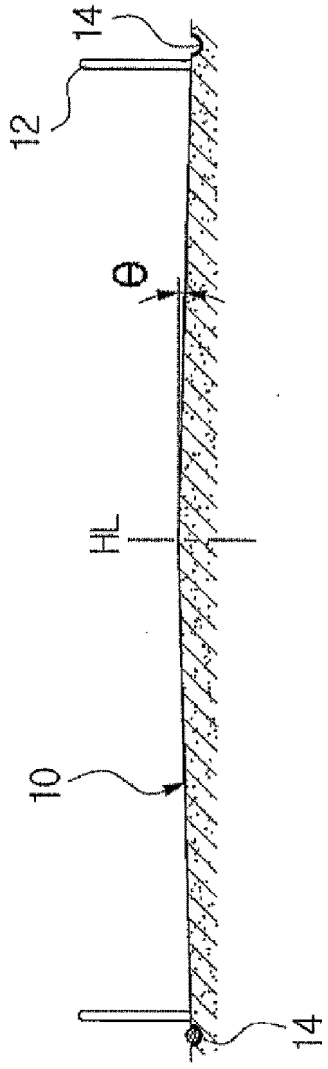

FIG. 12

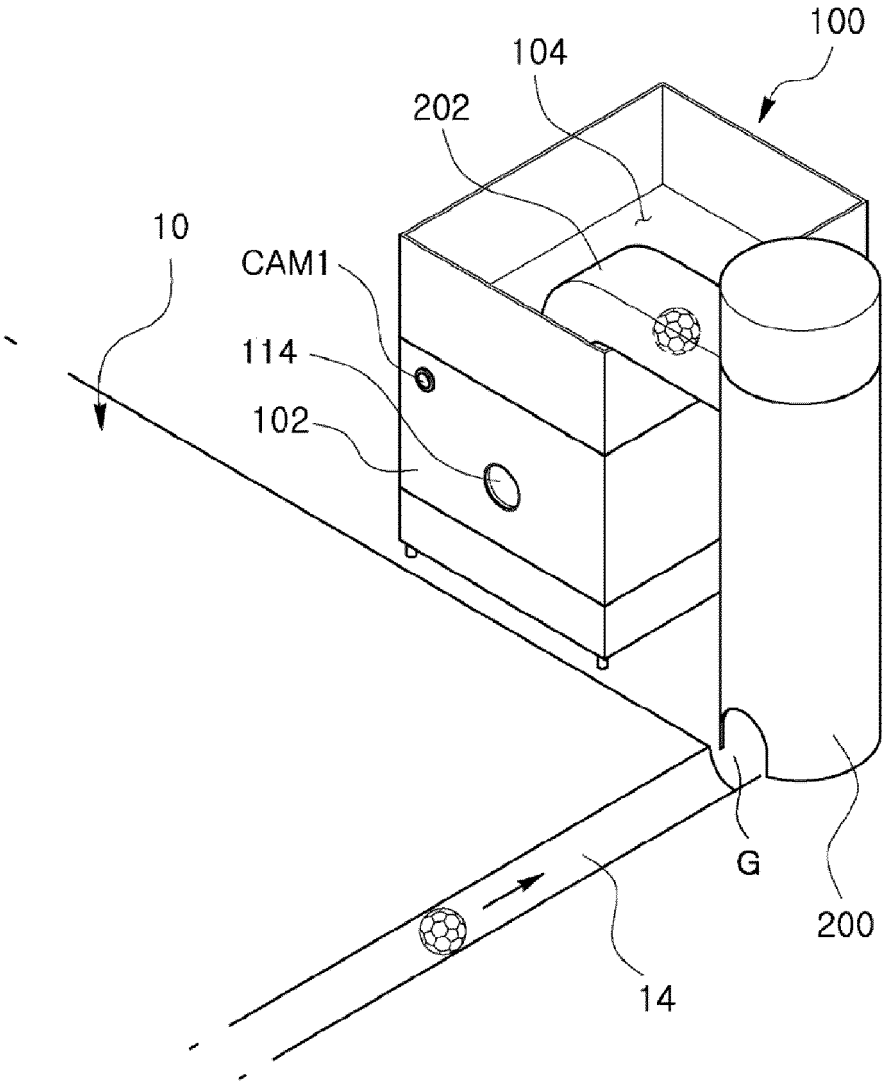

FIG. 13

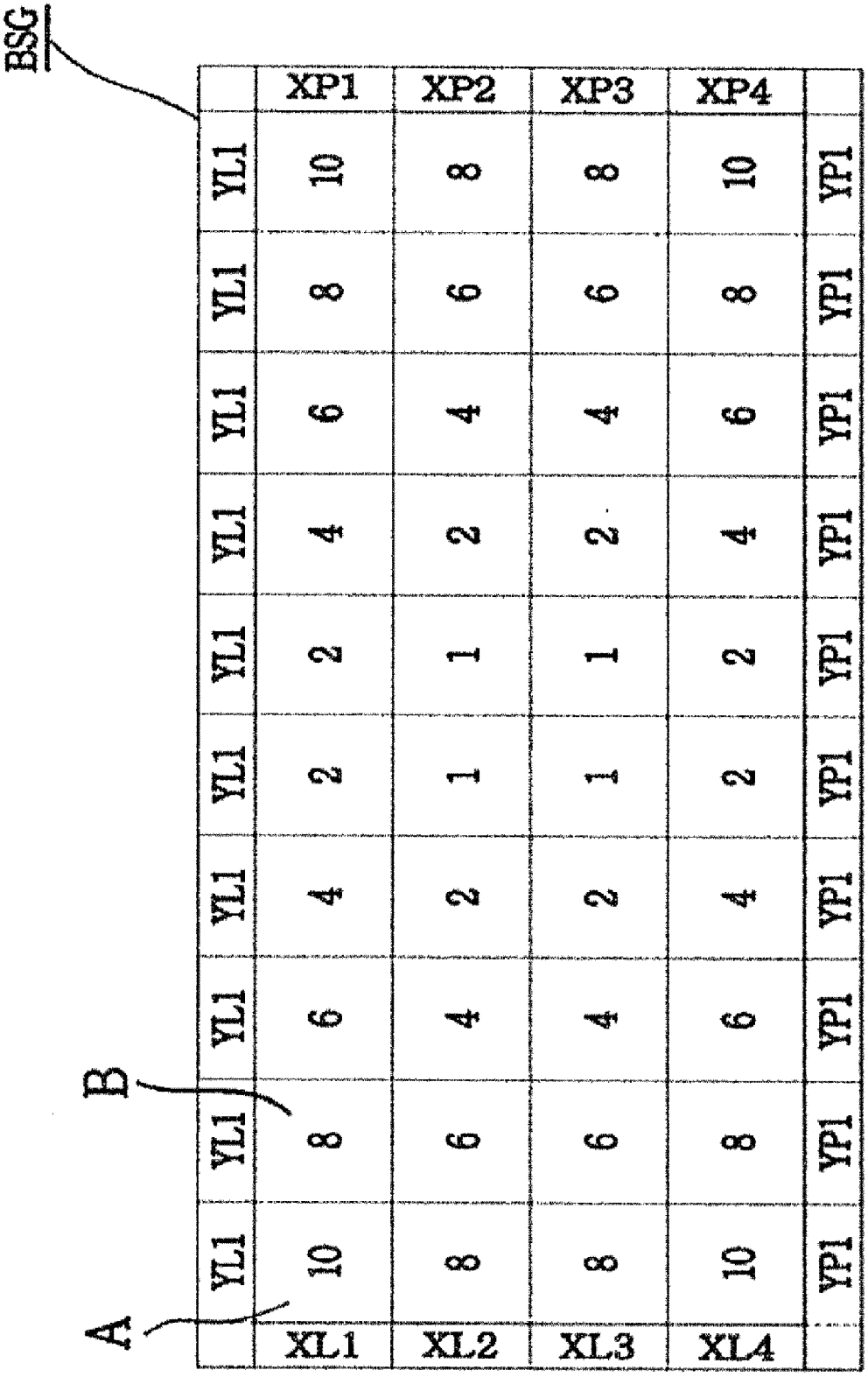
BSG
A
B
XP1
XP2
XP3
XP4
YL1
YP1
XL1
XL2
XL3
XL4
10 8 8 10
8 6 6 8
6 4 4 6
4 2 2 4
2 1 1 2
2 1 1 2
4 2 2 4
6 4 4 6
8 6 6 8
10 8 8 10

FIG. 14

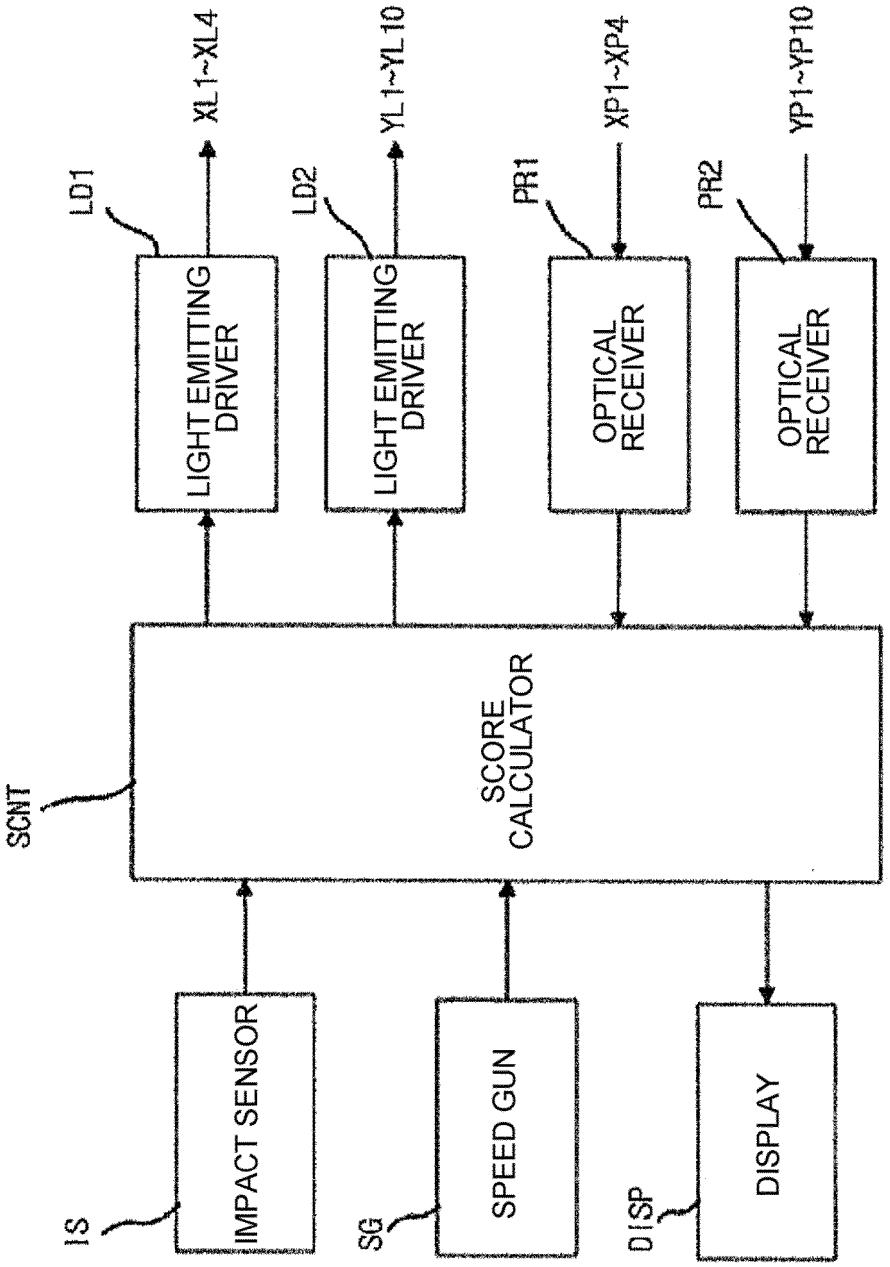
LD1
XL1~XL4
LD2
YL1~YL10
PR1
XP1~XP4
PR2
YP1~YP10
LIGHT EMITTING DRIVER
LIGHT EMITTING DRIVER
OPTICAL RECEIVER
OPTICAL RECEIVER
SCNT
SCORE CALCULATOR
IS
IMPACT SENSOR
SG
SPEED GUN
DISP
DISPLAY

FIG. 15

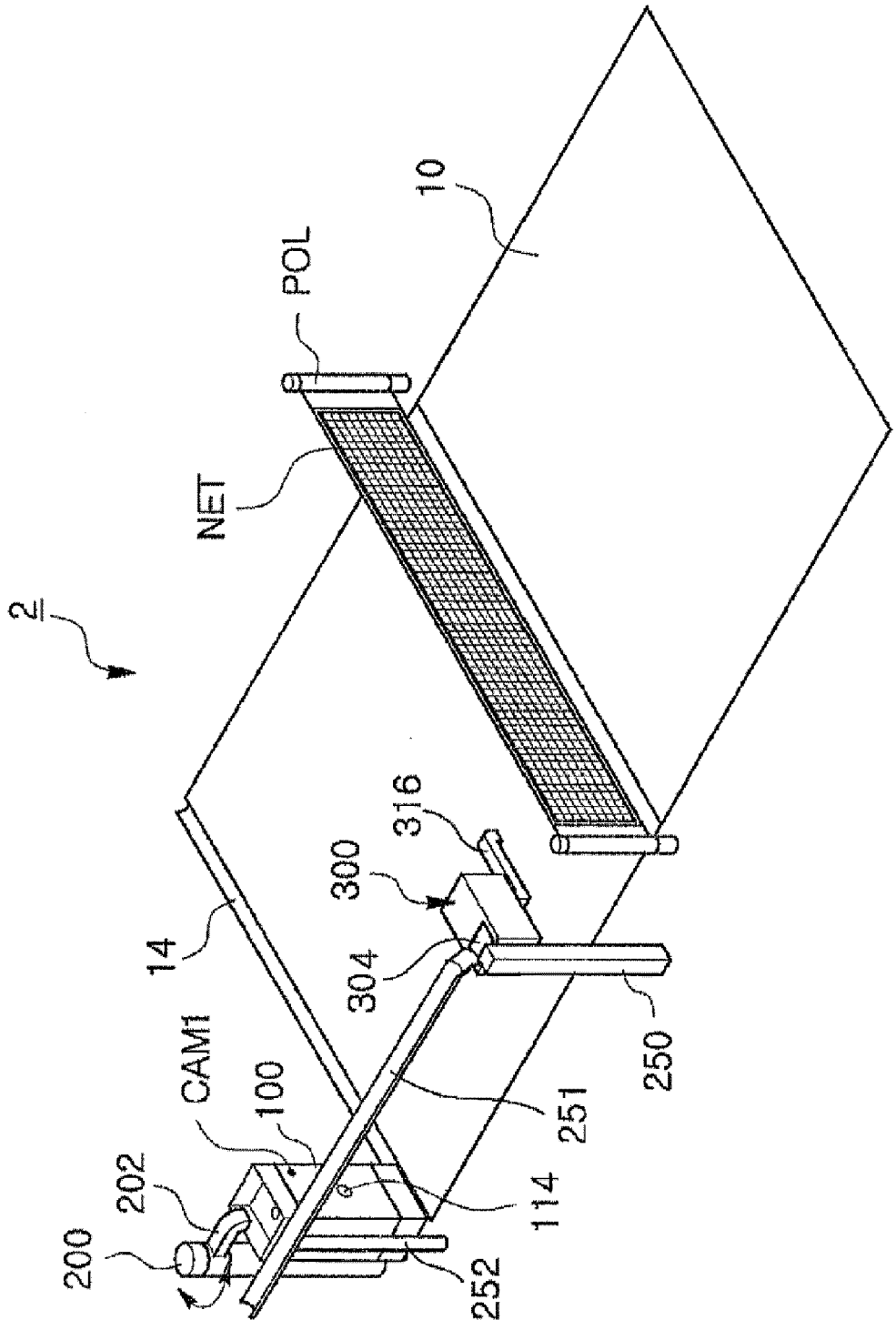

FIG. 16

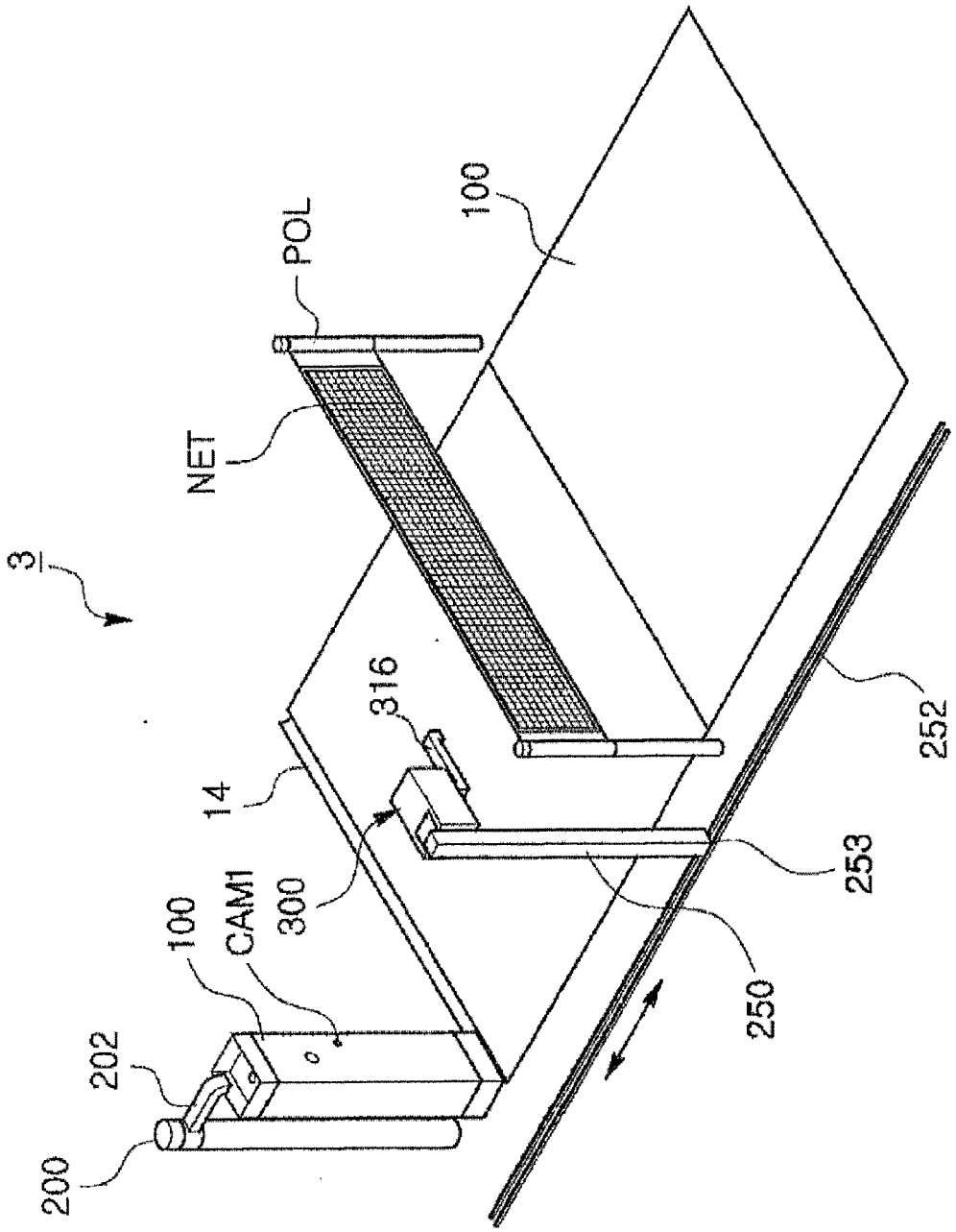

FIG. 17

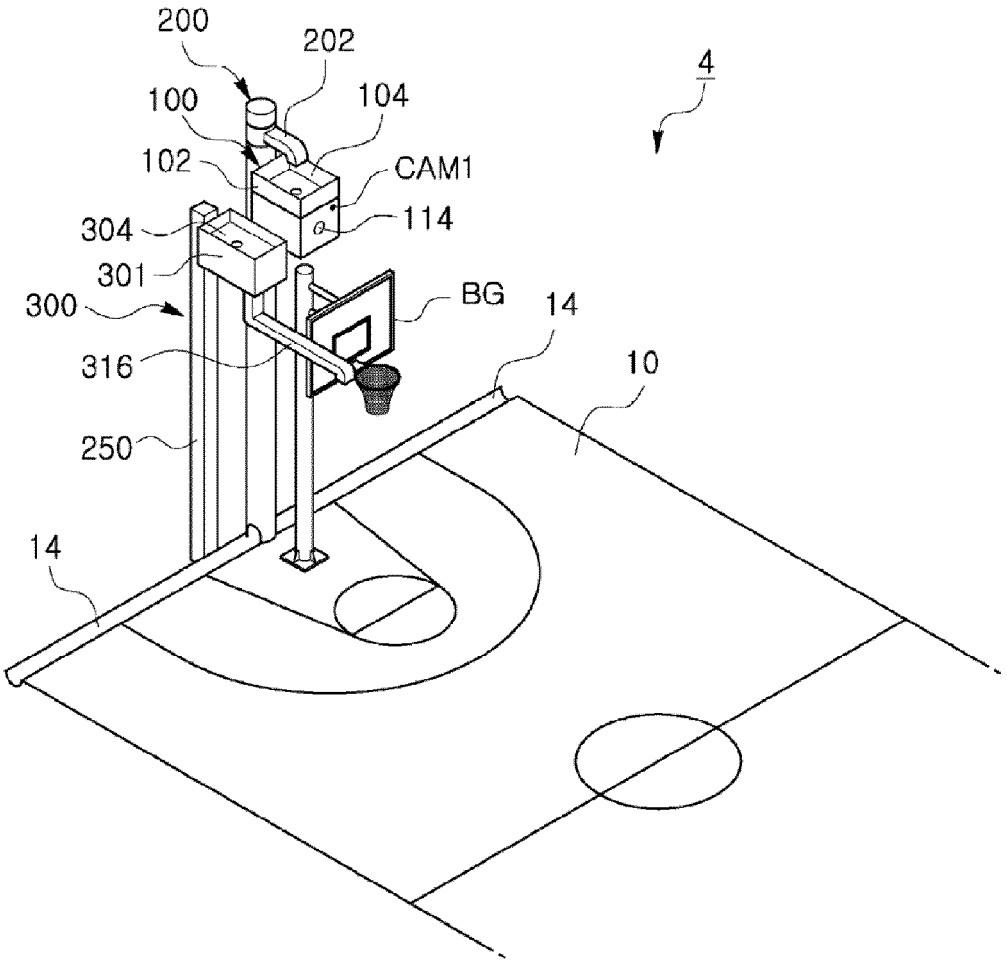

FIG. 18

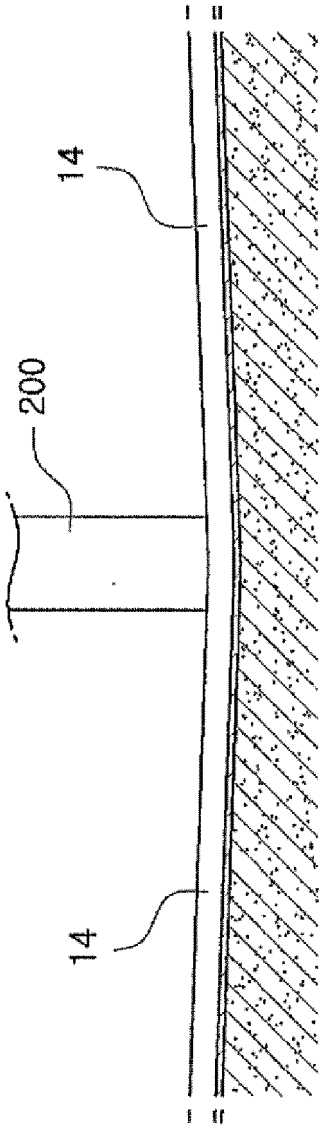

FIG. 19

REFERENCES CITED IN THE DESCRIPTION

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- US 8371964 B2 **[0002] [0007]**
- US 4054197 A **[0008]**
- US 2002112713 A1 **[0008]**
- US 5097985 A **[0008]**