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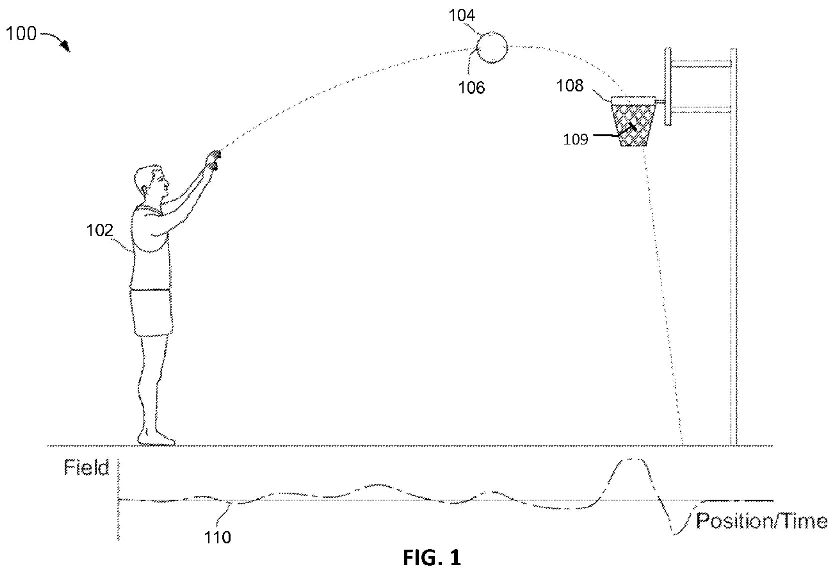

FIG. 1

(57) **Abstract**: An instrumented athletic sporting device that can be handled by a user, such as a basketball or soccer ball, includes electronics that can detect motion and magnetic fields. For example, an instrumented basketball can be used in conjunction with a magnetic basketball goal net such that made and missed shots can be detected.

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OPERATIONS WITH INSTRUMENTED GAME BALL

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Serial No. 62/013,956 filed June 18, 2014. This disclosure of the prior application is considered part of (and is incorporated by reference in) the disclosure of this application.

TECHNICAL FIELD

[0002] This document relates to systems and techniques for operating an instrumented game device that can be handled by a user, such as a basketball or soccer ball that includes electronics that can detect motion and magnetic fields. For example, this document relates to an instrumented basketball that can be used in conjunction with a magnetic basketball net such that made or missed shots can be detected.

BACKGROUND

[0003] Athletics has become an integral part of society, with multiple television channels dedicated to sporting events, with professional athletes promoting all sorts of products, and with the public holding star athletes—both amateur and professional—in high regard, so as to support financial rewards such as college scholarships, sponsorship opportunities, and other revenue-generating careers. Millions of people watch professional and collegiate athletic events on any given night, and hundreds of millions or billions watch major events like the Super Bowl, Final Four, the soccer World Cup, and other championships.

[0004] As a result, athletes can make large sums of money, as can the teams and others that support them. The relative increase in importance of athletics has been accompanied by attempts to increase athletic performance at all levels of development, from young children to professionals. Collection of athletic performance data can provide objective feedback to an athlete as they endeavor to improve. The athletic performance data can be used by the athlete to set goals for improvement, to track the athlete's improvement progress, and for competitions between the athlete and other athletes.

SUMMARY

[0005] This document describes systems and techniques that may be used in combination with an instrumented human-manipulable sporting device such as a soccer ball or basketball. For example, this document describes an instrumented basketball that can be used in conjunction with a magnetic basketball net and a computerized algorithm, such that made or missed shots can be detected. In particular, the systems and techniques described here relate to instruments in sporting devices such as sensors for measuring movement (e.g., gyros and accelerometers) and for measuring magnetic fields around the ball (e.g., magnetometers). Further, the systems and techniques described here relate to and nets (e.g., a basketball goal net, soccer net, etc.) that include one or more magnets. The movement data (inertial data) and the magnetic field data collected by the sporting device can be processed in an algorithm by which a shot make/miss determination can be performed. In addition, the algorithm can make a determination of a type of make and a type of miss. For example, the algorithm can distinguish between a made basketball shot that was a “swish” versus a made basketball shot that hit the rim before falling through the net. Such data can be used in a variety of ways, such as to provide statistics to an athlete undergoing training, to compare one athlete’s performance to the performance of other athletes (whose performance metrics based on ball motion data may be stored in a computing device), to provide data in association with entertainment (such as showing motion-derived statistics or other data overlaid on the screen of a television of a sporting event that is in progress), or in using motion data to affect the play of a videogame, such as by using motion data from a person to affect the manner in which his or her avatar performs in a videogame.

[0006] The earth’s magnetic field is affected by ferromagnetic objects (e.g., a steel basketball rim). When an instrumented basketball is close to a basketball rim, the magnetometer of the basketball will sense a disturbance in the earth’s magnetic field signal. When the signature of the sensed disturbance reflects a change that is known to relate to the basketball passing near the rim (perhaps by the magnetic data alone, or in combination with other data, such as accelerometer or gyro data that indicates a player recently released the ball in the form of a shot, or slammed it down in the form of a dunk, and also in combination with after-occurred data, such as a sudden but soft deceleration and change in rotation that is indicative of the ball “swishing” through the net in basketball), the ball can record an event that is associated with a made shot (e.g., by storing a flag that relates to such an event along with a clock time for the event) or a missed shot. The ball may then wirelessly communicate that data to an external computing device – either immediately while the ball is being used, or later such as when the ball is at rest or when the ball is laid in an inductive charging cradle that also includes wireless communication capabilities for communicating with the electronics inside the ball.

[0007] Through such mechanisms as Bluetooth wireless or Wi-Fi data connections, associated electronics in the ball may be paired with a communication and/or computing device such as a smartphone or tablet computer. A sensor unit in the ball may have a pairing table memory that stores several previously paired Bluetooth- or other-enabled devices. An application installed on such a device, such as an application downloaded to the device from an application stored, can be purchased or obtained for free, and may provide for enhanced interactivity with such a ball. For example, an athlete may charge a ball on a charging base or dock, and may at that time or another time pair the ball or the dock with a smartphone. The athlete may, after charging the electronics in the ball, perform a number of predetermined, instructed (e.g., from a web site or an app on their smartphone) drills, such as dribbling (e.g., regular dribbling, crossovers, etc.) and shooting drills (e.g., set shots and jump shots from various locations and distances). While the drills are being performed, the ball may collect motion data and may process the data into a usable form by employing on-board processing algorithms and circuitry. (The ball may turn on automatically upon sensing a certain number of hard bounces, and may turn off automatically when placed in a charging base or dock, or upon the expiration of a predetermined time without a hard bounce, e.g., an acceleration similar to a bouncing of the ball on a hard floor, like in a typical dribble). During the drills or upon completion of the drills, the data may be transmitted in whole or in part to the smartphone or other external computing device, and a user may employ a GUI on the device to ascertain his or her performance, including by seeing his or her performance compared to one or more (e.g., aggregated or individual) other players of like skill levels. Such an application may also communicate with a server system, and may provide grades or other scores on aspects of the athlete's performance in particular aspects of the drills, and may also provide targeted recommendations for improving performance in certain aspects of the athlete's game.

[0008] In certain implementations, such systems and technique may provide one or more advantages. For example, an instrumented ball and magnetic net can be provided whereby a shot can be detected and a make/miss determination can be made. Data pertaining to the make/miss determinations can be collected and wirelessly transmitted to an external computing device for display to the user. In some embodiments, the type of make and/or the type of miss can be determined using the systems and techniques provided herein. For example, a 'swish' can be distinguished from a shot that hit the rim and then fell through. In some embodiments, a missed shot that hit the front of the rim can be distinguished from a missed shot that hit the back of the rim. Such information can be valuable for evaluating athletes and for providing insights to the athlete in regard to what areas to work on to improve shooting performance and consistency. More complete and accurate statistics may be maintained by a system, in that the precise time of a basket being scored may be determined (to small fractions of a second), and shot hang time can also be computed by subtracting from such a “made” time, a time at which motion sensor data indicates that the ball left a player’s hand. Moreover, automatic scoring and statistics gathering systems may be employed and may be less expensive than all-human systems and provide greater accuracy and precision. Such make/miss sensing as described here may play a role in a larger system by gathering data about the relative score of a game. With such a system, the role of scorer may also be assigned to one of the game officials, making the administration of a game easier (fewer people who have to be located) and less expensive.

[0009] In one implementation, a magnetic net for a basketball goal includes a standard basketball net and one or more magnets coupled to the standard basketball net.

[0010] Such a magnetic net for a basketball goal may optionally include one or more of the following features. The one or more magnets may be configured to be removed from the basketball net and recoupled to the standard basketball net without damaging the standard basketball net. The one or more magnets may be disposed within an open space within strings of the standard basketball net such that the one or more magnets are not directly visible. The the one or more magnets may comprise four or more magnets.

[0011] In another implementation, an athletic game ball system includes an athletic game ball comprising and a magnetic basketball goal net. The athletic game ball includes a multi-layer ball shell sealed from an area around the ball shell and one or more electronic sensors located within a periphery of the athletic game ball. The magnetic basketball goal net includes a standard basketball goal net and one or more magnets coupled to the standard basketball goal net.

[0012] Such an athletic game ball system may optionally include one or more of the following features. The athletic game ball may further comprise a circuit board supporting the one or more electronic sensors and associated circuitry for monitoring motion of the athletic game ball and magnetic field signals near the athletic game ball. The associated circuitry may comprise a wireless communication chip or chip set. The one or more electronic sensors may comprise (i) an accelerometer or angular rate sensor, (ii) a magnetometer, and (iii) a near field communications sensor. The associated electronics may be programmed to identify disturbances in a magnetic field of the earth around the athletic game ball so as to identify when the athletic game ball has contacted or passed near a rim of a basketball goal. The associated electronics may be programmed to identify a magnetic field of the one or more magnets coupled to the standard basketball goal net so as to identify when the athletic game ball has passed through the magnetic basketball goal net.

[0013] In another implementation, a computer-implemented method includes identifying, with a computer system located in a sporting device, data captured from one or more sensors positioned within the sporting device and configured to sense a magnetic field around the sporting device as part of an actual sporting occurrence; analyzing the data, by the computer system, to identify a temporary change in the magnetic field around the sporting device; and determining, by the computer system, that the temporary change in the magnetic field around the sporting device indicates that the sporting device passed through a magnetic goal net.

[0014] Such a computer-implemented method may optionally include one or more of the following features. Analyzing the data may comprise identifying changes in the magnetic field around the sporting device that are equal to or greater than a predefined threshold value. The computer-implemented method may further comprise analyzing inertial data, by the computer system, to identify a motion of the sporting device. The computer-implemented method may further comprise determining, by the computer system, that the motion of the sporting device indicates that the sporting device impacted a goal rim before the sporting device passed through the magnetic goal net. The computer-implemented method may further comprise determining, by the computer system, that the motion of the sporting device indicates that the sporting device did not impact a goal rim before the sporting device passed through the magnetic goal net. The sporting device may be a basketball that comprises a magnetometer. The computer-implemented method may further comprise wirelessly transmitting data from the sporting device to an external computing device that is configured to display an indication that the sporting device passed through the magnetic goal net.

[0015] The details of one or more embodiments are set forth in the accompanying drawings and the description below. Other features and advantages will be apparent from the description and drawings, and from the claims.

DESCRIPTION OF DRAWINGS

[0016] FIG. 1 depicts an athlete shooting an instrumented basketball through a goal that includes a net with integral magnets.

[0017] FIGS. 2A and 2B are schematic top views of a basketball goal with an example net that includes integral magnets.

[0018] FIG. 3 is a schematic top view of a basketball goal with another example net that includes integral magnets.

[0019] FIG. 4 is a schematic top view of a basketball goal with another example net that includes integral magnets.

[0020] FIGS. 5A and 5B are perspective views of a basketball goal with another example net that includes integral magnets.

[0021] FIG. 6 is a perspective view of a basketball goal with another example net that includes schematically represented integral magnets.

[0022] FIG. 7 are example time-based plots of inertial data and magnet field data taken from an instrumented basketball that was shot towards a basketball goal with a net that includes integral magnets.

[0023] FIG. 8 are additional example time-based plots of inertial data and magnet field data taken from an instrumented basketball that was shot towards a basketball goal with a net that includes integral magnets.

[0024] FIG. 9 are additional example time-based plots of inertial data and magnet field data taken from an instrumented basketball that was shot towards a basketball goal with a net that includes integral magnets.

[0025] FIG. 10 are additional example time-based plots of inertial data and magnet field data taken from an instrumented basketball that was shot towards a basketball goal with a net that includes integral magnets.

[0026] FIG. 11 are additional example time-based plots of inertial data and magnet field data taken from an instrumented basketball that was shot towards a basketball goal with a net that includes integral magnets.

[0027] FIG. 12 are additional example time-based plots of inertial data and magnet field data taken from an instrumented basketball that was shot towards a basketball goal with a net that includes integral magnets.

[0028] FIG. 13 are additional example time-based plots of inertial data and magnet field data taken from an instrumented basketball that was shot towards a basketball goal with a net that includes integral magnets.

[0029] Like reference symbols in the various drawings indicate like elements.

DETAILED DESCRIPTION

[0030] This document describes systems and techniques for operating an instrumented game device that can be handled by a user, such as a basketball or soccer ball that includes electronics that can detect motion and magnetic fields. For example, this document describes an instrumented basketball that can be used in conjunction with a magnetic basketball net such that made or missed shots can be detected.

[0031] **FIG. 1** depicts a scenario 100 for determining made and/or missed basketball shots electronically. The view here is an elevation view of a single player 102 who has just taken a straightway basketball shot, such as a free throw or a shot from the top of the key. The ball 104 is provided with one or more instruments 106 (e.g., accelerometers, gyroscopes, magnetometers, coils, or other field sensing devices) for sensing motion and for sensing a magnetic field through which the ball 104 passes. The basketball goal 108 includes one or more magnets 109 that are integrated with the net of the goal 108. As the ball passes through the goal 108, the magnetic field emanating from the magnet(s) 109 is detected by the instrument(s) 106 in the ball 104.

[0032] A graph of the magnetic field strength 110 sensed by the instrument(s) 106 against time or location (which are the same here, since the motion is from left to right along with time), shows an example (for illustration only) of the sensed field strength 110. As can be seen, the field 110 is relatively constant throughout the main arc of the ball, because the ball is far away from anything electric or magnetic (other than the earth). However, as the ball 104 passes through the basketball goal 108, the field 110 spikes, (first in one polarity, and then in another polarity in this example), as the ball 104 approaches the magnet 109 and retreats from the magnet 109, and then settles down again (as the ball 104 falls to the floor).

[0033] In some embodiments, the detection and the determination of a made and/or a missed shot occurs using electronics and algorithms on the ball 104 itself. That is, in some embodiments the ball 104 includes an integral microprocessor running one or more algorithms that can determine a made shot and/or a missed shot based on data collected from the instrument(s) 106 (e.g., motion data from accelerometers and/or gyroscopes, and magnetic field data from one or more magnetometers). In some embodiments, the outputs of the algorithm (also known as performance metric data) can be wirelessly transmitted to an external computing device for display to the user. For example, in some implementations such performance metric data can be wirelessly transmitted (e.g., using Bluetooth technology) to a smartphone that is running an application pertaining to the instrumented basketball 104.

[0034] In some embodiments, the motion data and magnetic field data from the instrument(s) 106 may be transmitted from the ball 104 to an external computer that analyzes the data to determine a made and/or missed shot. In some implementations, an event may be triggered to indicate a score or a miss, and the event may be aligned with a timeline of the sporting event, such as to a timeline whose base is a game clock time for the sporting event.

[0035] While certain aspects of the instrumented basketball 104 are common to an ordinary basketball, one different feature is the integrated instruments 106 of the instrumented basketball 104. Such instruments 106 (e.g., accelerometers, gyroscopes, magnetometers, and the like) may be located inside the ball 104, such as inside a shell or bladder of the ball 104, and may move with the ball 104 so as to sense motion imparted on the ball 104, and to sense magnetic fields around the ball 104. For example, raw accelerometer data in three axes may be converted into an indication of the g-force imparted on the ball 104 when the player 102 takes a shot (e.g., a basketball jump shot or a dunk), or kicks a soccer ball. Other raw data may be processed with certain stored assumptions about an athletic event, such as a stored a function about the release height of a basketball shot, so as to provide derived data that characterizes the shot using raw data from the instruments 106.

For example, the instruments 106 can measure angular velocity, acceleration, linear velocity, and/or deceleration. As another example, the instruments 106 can identify the number of times that the basketball 104 is bounced or contacted within a set time period using such measured parameters. As yet another example, the instruments 106 can measure an angle at which basketball 104 contacts a surface (e.g., the floor). As yet another example, the instruments 106 can be used to identify a spin rate of the basketball 104. The instruments 106 can also, for example, be used to measure the spin rate of a spiraling football, the arc of a basketball shot, the spin axis and spin rate of a basketball shot, or the velocity with which a soccer ball is kicked.

[0036] The instruments 106 can also include one or more magnetometer sensors (e.g., a triaxial magnetometer) that can sense magnetic fields around the ball 104. In some embodiments, the magnetometer can sense the earth's magnetic field, and can detect disruptions of the earth's magnetic field. The earth's magnetic field is disrupted by ferromagnetic objects (e.g., a steel basketball rim). Therefore, when the instrumented basketball 104 is close to a basketball rim, the magnetometer of the basketball 104 can sense a disturbance to the earth's magnetic field signal that can be characterized by the electronics of the ball 104 as the presence of the rim. In addition, the magnetometer of the ball 104 can sense the magnetic fields emitted from magnets, such as from the one or more magnets 109 coupled to the net of the basketball goal 108. As such, the electronics of the ball 104 can determine when the ball 104 has made contact with the net of the basketball goal 108.

[0037] In some embodiments, as described in more detail below, the inertial data from the accelerometers and gyroscopes can be used in concert with the magnetic field data from the magnetometer in an algorithm that can determine whether a shot was made or missed, and that can distinguish between types of makes or misses.

[0038] Electronics that are in communication with the instruments 106 and are also located inside the ball 104, such as in the form of a digital signal processor (DSP) and other electronics, may perform processing operations to turn the raw sensor data that does not have a meaning in the context of a particular sport, into derived data (e.g., performance metric data) that is directed specifically to a particular sport.

[0039] Such raw data, derived data, or both may then be provided to a computing system that is external to the ball 104 such as by a wireless data communication formed between a wireless interface in the ball 104 a computer outside the ball 104. For example, the data may be provided to a smartphone or tablet that is executing an application for causing an interface on the smartphone or tablet to communicate data with the electronics in the ball 104. Such an application may have been obtained from an online application store, such as the APPLE ITUNES STORE or the GOOGLE PLAY market, and may convert the data received from the ball 104 into a graphical representation that may be readily viewed and interpreted by the athlete or by one or more other people, such as a coach, a referee, or a spectator of an athletic event. For example, data about the speed that a basketball shot was released, an angle of release of the basketball shot, a number of made shots versus a number of missed shots, types of missed shots, types of made shots, and an amount of time between a player picking up a dribble and releasing the ball, or raising the ball and releasing the ball from a shot, may be displayed as text on a display of a smart phone or a tablet computer. Certain of the data may also be converted into a graphical form and such conversion may happen on the in-ball electronics, the computing device outside the ball 104, or in part on both. As one example, such electronics may compute an arc that a basketball shot took based on information received from the instruments 106 in the ball 104, and the arc may be displayed in a graphical line on a background on the smartphone or tablet device. Such a displayed arc may be shown next to the best practices art that shows how the shot should have been aimed in a perfect world.

[0040] In this manner, the systems and techniques discussed here may permit for objective characterizations of the handling of the ball 104 to be captured immediately and displayed in real time, for example in less than a second or 2 seconds of delay, in a visually pleasing manners on a variety of computing devices such as smart phones, tablets, heads-up displays in the form of Google glass head-mounted displays, and on other appropriate manners.

[0041] Referring to **FIG. 2A**, as briefly described above, a net 200 of a basketball goal 200 can include one or more magnets 222a and 222b. It should be understood that the magnets 222a and 222b are illustrated in a schematic manner. That is, while the magnets 222a and 222b are illustrated as being elongated along a radial direction of the basketball goal 200, it should be understood that the FIG.

2A, and FIGS. 2B, 3, and 4, are not intended to depict particular orientations of the physical profiles of the magnets 222a and 222b.

[0042] The basketball goal 200 includes a rim 210 to which the net 220 is coupled. The basketball goal 200 can comprise a standard kind of rim 210 and net 220, with the exception of the addition of the one or more magnets 222a and 222b to the net 220.

[0043] The depicted embodiment of net 220 includes two magnets: magnet 222a and magnet 222b. In some embodiments, one magnet, three magnets, four magnets, five magnets, six magnets, or more than six magnets can be included in a single net 220. In some embodiments, the magnets 222a and 222b are the same or are generally similar to each other. In some embodiments, the magnets 222a and 222b are different from each other. Such differences between the magnets 222a and 222b can include differences in factors such as, but not limited to, size, shape, magnetic strength, materials, mounting means, mounting locations and orientations, colors, orientations of polarity, and the like.

[0044] In the depicted embodiment, the magnet 222a is mounted on the net 220 near the front of the rim 210f, and the magnet 222b is mounted on the net 220 near the back of the rim 210b. This provides just one example embodiment of where the magnets 222a and 222b can be oriented in relation to the net 220 and the rim 210. All other possible orientations of the magnets 222a and 222b in relation to the net 220 and the rim 210 are also envisioned within the scope of this disclosure.

[0045] In the depicted embodiment, the north pole of each of the magnets 222a and 222b is oriented towards the inside of the basketball goal 200. In some embodiments, the south pole of each of the magnets 222a and 222b is oriented towards the inside of the basketball goal 200.

[0046] In some embodiments, the north pole of one of the of the magnets 222a or 222b is oriented towards the inside of the basketball goal 200, and the south pole of the other of the magnets 222a or 222b is oriented towards the inside of the basketball goal 200.

[0047] Referring now also to **FIG. 2B**, a basketball goal 250 includes a rim 260 to which a net 270 is coupled. The net 270 includes one or more magnets 272a and 272b. In this example, the north pole of the magnet 272a is oriented towards the inside of the basketball goal 250, and the south pole of the magnet 272b is oriented towards the inside of the basketball goal 250. In some implementations, such an arrangement may result in the magnetic field strengths of the magnets 272a and 272b complimenting each other. However, such an arrangement is not required for all embodiments.

[0048] While in the depicted embodiments the magnets 222a, 222b, 272a, and 272b are shown with their polarities aligned along the radii of the basketball goals 200 and 250, such an orientation is not required. In some embodiments, the polarities of one or more of the magnets 222a, 222b, 272a, and 272b can be orientated nominally perpendicular to the radii of the basketball goals 200 and 250. In some embodiments, the polarities of one or more of the magnets 222a, 222b, 272a, and 272b can be orientated at an angle between about 0º and about 90º in relation to the radii of the basketball goals 200 and 250.

[0049] Referring to **FIG. 3**, a basketball goal 300 includes a rim 310 to which a net 320 is coupled. The net 320 includes magnets 322a, 322b, 322c, and 322d. The basketball goal 300 can comprise a standard kind of rim 310 and net 320, with the exception of the addition of the magnets 322a, 322b, 322c, and 322d to the net 320.

[0050] The depicted embodiment of net 320 includes four magnets: magnet 322a, magnet 322b, magnet 322c, and magnet 322d. In some embodiments, one magnet, two magnets, three magnets, five magnets, six magnets, or more than six magnets can be included in a single net 320. In some embodiments, the magnets 322a, 322b, 322c, and 322d are the same or are generally similar to each other. In some embodiments, the magnets 322a, 322b, 322c, and 322d are different from each other. Such differences between the magnets 322a, 322b, 322c, and 322d can include differences in factors such as, but not limited to, size, shape, magnetic strength, materials, mounting means, mounting locations and orientations, colors, orientations of polarity, and the like.

[0051] In the depicted embodiment, the magnet 322a is mounted on the net 320 near the front of the rim 310f; the magnet 322b is mounted on the net 320 near the back of the rim 310b; the magnet 322c is mounted on the net 320 on the left side of the rim 310L; and the magnet 322d is mounted on the net 320 on the right side of the rim 310r. This provides another example embodiment of where the magnets 322a, 322b, 322c, and 322d can be oriented in relation to the net 320 and the rim 310. All other possible orientations of the magnets 322a, 322b, 322c, and 322d in relation to the net 320 and the rim 310 are also envisioned within the scope of this disclosure.

[0052] In the depicted embodiment, the north pole of each of the magnets 322a, 322b, 322c, and 322d is oriented towards the inside of the basketball goal 300. In some embodiments, the south pole of each of the magnets 322a, 322b, 322c, and 322d is oriented towards the inside of the basketball goal 300. In some embodiments, the north pole of one or more of the magnets 322a, 322b, 322c, or 322d is oriented towards the inside of the basketball goal 300, while the south pole of the other(s) of the magnets 322a, 322b, 322c, or 322d are oriented towards the inside of the basketball goal 300.

[0053] While in the depicted embodiment the magnets 322a, 322b, 322c, and 322d are each located at approximately 90° intervals around the perimeter of the basketball goal 300, such a relative orientation is not required. For example, also referring now to **FIG. 4**, a basketball goal 400 includes a rim 410 to which a net 420 is coupled. The net 420 includes magnets 422a, 422b, 422c, and 422d which are not at 90° intervals around the perimeter of the basketball goal 400. Rather, two of the magnets (422a and 422b) are biased toward the front of the rim 410f, while the other two magnets (422c and 422d) are biased toward the back of the rim 410b. In some embodiments, magnets may alternately or additionally be located with a bias toward one side or both sides of the rim 410. It should be understood that any and all regular and/or irregular patterns of orientating the magnets on the net in relation to the rim are envisioned within the scope of this disclosure.

[0054] While the embodiments described so far include a single magnet along a vertical direction of the net, the embodiments provided herein are not so limited. That is, in some embodiments two or more magnets may be located on the net approximately directly above and below each other (i.e., at different elevations on the net). In some embodiments, two or more magnets may be located at different elevations and at different radial orientations in relation to each other on the net.

[0055] Referring to **FIGS. 5A and 5B**, a basketball goal 500 is shown in two different perspective views. The basketball goal 500 includes a rim 510 to which a net 520 is coupled. The basketball goal 500 can comprise a standard kind of rim 510 and net 520, with the exception of the addition of the magnets, 522a, 522b, 522c, and 522d to the net 520 (the magnet 522d is also on the front of net 520 but not visible in the views provided). While the depicted embodiment of net 520 includes four magnets 522a, 522b, 522c, and 522d, as described above one, two, three, five, six, or more than six magnets are included in some embodiments.

[0056] In the depicted embodiment, the magnets 522a, 522b, 522c, and 522d are flexible strip magnets. Such flexible strip magnets are just one example of a type of magnet that can be used in conjunction with the net 520. In some embodiments, one or more of the magnets 522a, 522b, 522c, and 522d can be cylindrical, rectangular bars, spherical, horseshoes, rings or donuts, disks, rectangles, multi-fingered rings, and other custom shapes.

[0057] As described above, the polarities of the magnets 522a, 522b, 522c, and 522d can be oriented in any configuration as desired. For example, the magnets

522a, 522b, 522c, and 522d can be polarized axially, through the thickness, with multi-poles on one face only, and so on.

[0058] In the depicted embodiment, the magnets 522a, 522b, 522c, and 522d are attached to the inside surface of net 520. In some embodiments, the magnets 522a, 522b, 522c, and 522d are attached to the outside surface of net 520. In some embodiments, the magnets 522a, 522b, 522c, and 522d are attached to both the inside and the outside surface of net 520. In some embodiments, the magnets 522a, 522b, 522c, and 522d are concealed inside of the strings of the net 520.

[0059] In the depicted embodiment, the magnets 522a, 522b, 522c, and 522d are attached to the surface of net 520 using a hook and loop fastener system. That is, the magnets 522a, 522b, 522c, and 522d have either a hook or loop back surface, and a corresponding mounting strip has the reverse (hook or loop) surface. The magnets 522a, 522b, 522c, and 522d are attached to the net by engaging the mounting strips to the magnets 522a, 522b, 522c, and 522d with the net 520 sandwiched therebetween. This technique for mounting the magnets 522a, 522b, 522c, and 522d to the net 520 allows the magnets 522a, 522b, 522c, and 522d to be added to, and/or removed from, the net 520 without modifying the net 520. However, in some embodiments the magnets 522a, 522b, 522c, and 522d are essentially permanently attached to the net 520.

[0060] In some embodiments, the magnets 522a, 522b, 522c, and 522d are attached to or within the net 520 using various techniques such as, but not limited to, clamping, lashing, using clips, using tape, using adhesives, weaving, stitching, and so on, and using combinations of such techniques.

[0061] Referring to **FIG. 6**, a basketball goal 600 is shown in a perspective view. The basketball goal 600 includes a rim 610 to which a net 620 is coupled. The basketball goal 600 can comprise a standard kind of rim 610 and net 620, with the exception of the addition of the magnets, 622a, 622b, 622c, and 622d to the net 620. While the depicted embodiment of net 620 includes four magnets 622a, 622b, 622c, and 622d, as described above one, two, three, five, six, seven, eight, or more than eight magnets are included in some embodiments.

[0062] In the depicted implementation of the magnets, 622a, 622b, 622c, and 622d with the net 620, the magnets, 622a, 622b, 622c, and 622d are disposed within the inner space of the strings of the net 620. That is, the strings of net 620 are tubular, and the magnets, 622a, 622b, 622c, and 622d are thereby located inside of the strings of the net 620. Using this technique, in some embodiments there is no visible indication that the net 620 includes the magnets, 622a, 622b, 622c, and 622d. The net 620 can look like any ordinary basketball net 620.

[0063] In some embodiments, the magnets, 622a, 622b, 622c, and 622d are elongated magnets, such as cylindrical magnets. For example, in some embodiments the magnets, 622a, 622b, 622c, and 622d can be a #D36-N52 magnet or a #D36 magnet sold by K&J Magnetics, Inc. of Pipersville, PA. The outer diameter of such example magnets is well-suited to being installed within the tubular strings of the net 620.

[0064] Referring to **FIG. 7**, a chart 700 includes a graph of inertial sensor signals 710 and a graph of magnetometer sensor signals 740. The chart 700 illustrates the outputs of such sensors that are located within an instrumented basketball (e.g., the sensors 106 located within the instrumented basketball 104 of FIG. 1). More specifically, the chart 700 illustrates the outputs of such sensors (on the y-axes) versus time (on the x-axes).

[0065] In the depicted chart 700, plot 710_{sum} is the sum of a tri-axial angular rate gyroscope in a basketball and plot 712_{sum} is the sum of a tri-axial accelerometer in the basketball. The magnetometer sensor is also a tri-axial sensor located within the basketball, and is summed together to create plot 740_{sum}. By inputting plots 710_{sum} and 712_{sum} into an algorithm, it can be determined that the basketball was propelled into the air at about time=400. In other words, a shot began. At about time=1300, the basketball hit an object which in this example was the rim of a basketball goal. At about time=1700, the basketball again hit an object which in this example was the floor.

[0066] Plot 740_{sum} is the output of the magnetometer within the basketball. It can be seen that from time=0 to about time=1300, and from about time=1500 to time=2000, the output of the magnetometer indicates an undisturbed sensing of the earth's magnetic field. However, from about time=1300 to about time=1500 the magnetometer detected substantial magnetic field changes. Those changes in the detected magnetic field can be related to two conditions: (1) the near proximity of the magnetometer in the basketball to the basketball rim and (2) the near proximity of the magnetometer in the basketball to the magnets in the net. Those two conditions each have distinct magnetic signal signatures that the algorithm can distinguish between. Further, the magnetic signature of a made shot that swishes through the net is unique to the signature of a shot that first impacts the rim, bounces up and then falls through the net. Still further, since the back of the rim has more metal than the front of the rim, an impact by the ball with the front of the rim has a unique magnetic signature as compared to an impact by the ball with the back of the rim.

[0067] By using both the graph of inertial sensor signals 710 and the graph of magnetometer sensor signals 740, the algorithm can determine that a shot was attempted and whether the shot was made or missed. In this example, the shot was made because the signal of the magnets in the net was detected by the magnetometer as indicated in plot 740_{sum}. The algorithm is also able to detect the passage of the basketball through the net from the inertial sensor signals. That is the case because, for example, the basketball is slowed by the friction of the net as the basketball passes through the net.

[0068] Referring to **FIG. 8**, a chart 800 includes a graph of inertial sensor signals 810 and a graph of magnetometer sensor signals 840. The chart 800 illustrates the outputs of such sensors that are located within an instrumented basketball (e.g., the sensors 106 located within the instrumented basketball 104 of FIG. 1). More specifically, the chart 800 illustrates the outputs of such sensors (on the y-axes) versus time (on the x-axes).

[0069] In the chart 800, plot 810_{sum} is the sum of a tri-axial angular rate gyroscope in a basketball and plot 812_{sum} is the sum of a tri-axial accelerometer in the basketball. The magnetometer sensor is also a tri-axial sensor located within the basketball, and is summed together to create plot 840_{sum}. By inputting plots 810_{sum} and 812_{sum} into an algorithm, it can be determined that the basketball was propelled into the air at about time=400. In other words, a shot began. At about time=1200, the basketball hit an object which in this example was the rim of the basketball goal. At about time=1900, the basketball again hit an object which in this example was the floor.

[0070] Plot 840_{sum} is the output of the magnetometer within the basketball. It can be seen that from time=0 to about time=2000 the output of the magnetometer indicates an undisturbed sensing of the earth's magnetic field.

[0071] By using both the graph of inertial sensor signals 810 and the graph of magnetometer sensor signals 840, the algorithm can determine that a shot was attempted and whether the shot was made or missed. In this example, the shot was missed because the signal of the magnets in the net was not detected by the magnetometer as indicated in plot 840_{sum}. More particularly, the algorithm can determine that a shot was attempted and that it hit the rim but did not go in.

[0072] Referring to **FIG. 9**, a chart 900 includes a graph of inertial sensor signals 910 and a graph of magnetometer sensor signals 940. The chart 900 illustrates the outputs of such sensors that are located within an instrumented basketball (e.g., the sensors 106 located within the instrumented basketball 104 of FIG. 1). More specifically, the chart 900 illustrates the outputs of such sensors (on the y-axes) versus time (on the x-axes).

[0073] In the chart 900, plot 912 is the sum of a tri-axial accelerometer in the basketball. Plot 942 is the expected value of the magnetometer if no magnet or soft-iron (e.g., the rim of the basketball goal) is near the basketball. The algorithm can determine that the basketball was propelled into the air at about time=100. In other words, a shot began. At about time=1250, the basketball hit an object which in this example was the rim of the basketball goal. The algorithm can also determine that the signals from the magnetometer in graph 940 do not appreciably deviate from the expected value of the magnetometer if no magnet or soft-iron (e.g., the rim of the basketball goal) is near the basketball as expressed by plot 942.

[0074] By using both the graph of inertial sensor signals 910 and the graph of magnetometer sensor signals 940, the algorithm can determine that a shot was attempted and whether the shot was made or missed. In this example, the shot was missed because the signal of the magnets in the net was not detected by the magnetometer as indicated in graph 940. More particularly, the algorithm can determine that a shot was attempted and that it hit the rim but did not go in. Moreover, the algorithm can determine that the ball made contact with the front of the rim because very minimal disruption of the magnetometer signals were detected at the time of the impact with the rim.

[0075] Referring to **FIG. 10**, a chart 1000 includes a graph of inertial sensor signals 1010 and a graph of magnetometer sensor signals 1040. The chart 1000 illustrates the outputs of such sensors that are located within an instrumented basketball (e.g., the sensors 106 located within the instrumented basketball 104 of FIG. 1). More specifically, the chart 1000 illustrates the outputs of such sensors (on the y-axes) versus time (on the x-axes).

[0076] In the chart 1000, plot 1012 is the sum of a tri-axial accelerometer in the basketball. Plot 1042 is the expected value of the magnetometer if no magnet or soft-iron (e.g., the rim of the basketball goal) is near the basketball. The algorithm can determine that the basketball was propelled into the air at about time=100. In other words, a shot began. At about time=1350, the basketball hit an object which in this example was the rim of the basketball goal. The algorithm can also determine that the signals from the magnetometer in graph 1040 do significantly deviate from the expected value of the magnetometer if no magnet or soft-iron (e.g., the rim of the basketball goal) is near the basketball as expressed by plot 1042. However, the magnetic signal signature of plot 1042 does not include the signature related to the ball passing by magnets placed in the net.

[0077] By using both the graph of inertial sensor signals 1010 and the graph of magnetometer sensor signals 1040, the algorithm can determine that a shot was attempted and whether the shot was made or missed. In this example, the shot was missed because the signal of the magnets in the net was not detected by the magnetometer as indicated in graph 1040. More particularly, the algorithm can determine that a shot was attempted and that it hit the rim but did not go in. Moreover, the algorithm can determine that the ball made contact with the rear of the rim because a significant disruption of the magnetometer signals were detected at the time of the impact with the rim. The significant disruption can be correlated to a contact between the basketball and an substantial amount of soft-iron, such as the back of the rim of the basketball goal.

[0078] Referring to **FIG. 11**, a chart 1100 includes a graph of inertial sensor signals 1110 and a graph of magnetometer sensor signals 1140. The chart 1100 illustrates the outputs of such sensors that are located within an instrumented basketball (e.g., the sensors 106 located within the instrumented basketball 104 of

FIG. 1). More specifically, the chart 1100 illustrates the outputs of such sensors (on the y-axes) versus time (on the x-axes).

[0079] In the chart 1100, plot 1110_{sum} is the sum of a tri-axial accelerometer in the basketball. The magnetometer sensor is also a tri-axial sensor located within the basketball, and is summed together to create plot 1140_{sum}. By inputting plots 1110_{sum} and 1112_{sum} into an algorithm, it can be determined that the basketball was propelled into the air at about time=100. In other words, a shot began. At about time=1300, the basketball softly decelerated by making contact, in this example, with the net of the basketball goal but not the rim. At about time=1900, the basketball again hit an object which in this example was the floor.

[0080] Plot 1140_{sum} is the output of the magnetometer within the basketball. It can be seen that from time=0 to about time=1300 the output of the magnetometer indicates an undisturbed sensing of the earth's magnetic field. However, at about time=1300 all components of the magnetometer data show a sharp change, indicating that the magnetometer was affected by the magnetic field of one or more magnets in the net of the basketball goal.

[0081] By using both the graph of inertial sensor signals 1110 and the graph of magnetometer sensor signals 1140, the algorithm can determine that a shot was attempted and whether the shot was made or missed. In this example, the shot was made because the signal of the magnets in the net were detected by the magnetometer as indicated in plot 1140_{sum}. More particularly, the algorithm can determine that a shot was attempted and that it was a 'swish' because it was made but it did not have an impact with the rim of the basketball goal.

[0082] Referring to **FIG. 12**, a chart 1200 includes a graph of inertial sensor signals 1210 and a graph of magnetometer sensor signals 1240. The chart 1200 illustrates the outputs of such sensors that are located within an instrumented basketball (e.g., the sensors 106 located within the instrumented basketball 104 of FIG. 1). More specifically, the chart 1200 illustrates the outputs of such sensors (on the y-axes) versus time (on the x-axes).

[0083] In the depicted chart 1200, plot 1210_{sum} is the sum of a tri-axial angular rate gyroscope in a basketball and plot 1212_{sum} is the sum of a tri-axial accelerometer in the basketball. The magnetometer sensor is also a tri-axial sensor located within the basketball, and is summed together to create plot 1240_{sum}. By inputting plots 1210_{sum} and 1212_{sum} into an algorithm, it can be determined that the basketball was propelled into the air at about time=100. In other words, a shot began. At about time=1200, the basketball hit an object which in this example was the rim of a basketball goal. At about time=1700, the basketball again hit an object which in this example was the floor.

[0084] Plot 1240_{sum} is the output of the magnetometer within the basketball. It can be seen that from time=0 to about time=1300, and from about time=1350 to time=2000, the output of the magnetometer indicates an undisturbed sensing of the earth's magnetic field. However, from about time=1300 to about time=1350 the magnetometer detected substantial magnetic field changes. Those changes in the detected magnetic field can be related to two conditions: (1) the near proximity of the magnetometer in the basketball to the basketball rim and (2) the near proximity of the magnetometer in the basketball to the magnets in the net. Those two conditions each have distinct magnetic signal signatures that the algorithm can distinguish between. Further, the magnetic signature of a made shot that swishes through the net is unique to the signature of a shot that first impacts the rim, bounces up and then falls through the net. Still further, since the back of the rim has more metal than the front of the rim, an impact by the ball with the front of the rim has a unique magnetic signature as compared to an impact by the ball with the back of the rim.

[0085] By using both the graph of inertial sensor signals 1210 and the graph of magnetometer sensor signals 1240, the algorithm can determine that a shot was attempted and whether the shot was made or missed. In this example, the shot was made because the signal of the magnets in the net was detected by the magnetometer as indicated in plot 1240_{sum}. The algorithm is also able to detect the passage of the basketball through the net from the inertial sensor signals. That is the case because, for example, the basketball is slowed by the friction of the net as the basketball passes through the net. In this example, the algorithm can determine that the shot was made after a small contact with the rim (as indicated by plot 1212_{sum}).

[0086] Referring to **FIG. 13**, a chart 1300 includes a graph of inertial sensor signals 1310 and a graph of magnetometer sensor signals 1340. The chart 1300 illustrates the outputs of such sensors that are located within an instrumented basketball (e.g., the sensors 106 located within the instrumented basketball 104 of FIG. 1). More specifically, the chart 1300 illustrates the outputs of such sensors (on the y-axes) versus time (on the x-axes).

[0087] In the chart 1300, plot 1310_{sum} is the sum of a tri-axial accelerometer in the basketball. The magnetometer sensor is also a tri-axial sensor located within the basketball, and is summed together to create plot 1340_{sum}. By inputting plots 1310_{sum} and 1312_{sum} into an algorithm, it can be determined that at about time=700, the basketball abruptly decelerated by making contact, in this example, with the rim of the basketball goal. The bouncing on the rim continued until about time=1600.

[0088] Plot 1340_{sum} is the output of the magnetometer within the basketball. It can be seen that from time=0 to about time=1800 the output of the magnetometer indicates a generally undisturbed sensing of the earth's magnetic field. However, at about time=1800 all components of the magnetometer data show a sharp change, indicating that the magnetometer was affected by the magnetic field of one or more magnets in the net of the basketball goal.

[0089] By using both the graph of inertial sensor signals 1310 and the graph of magnetometer sensor signals 1340, the algorithm can determine that a shot was attempted and whether the shot was made or missed. In this example, the shot was made because the signal of the magnets in the net were detected by the magnetometer as indicated in plot 1340_{sum}. More particularly, the algorithm can determine that a shot was attempted and that it bounced multiple times on the rim of the basketball goal and then fell through the net.

[0090] It should be understood that one or more design features of the magnetic basketball nets provided herein can be combined with other features of other magnetic basketball nets provided herein. In effect, hybrid designs that combine various features from two or more of the magnetic basketball net designs provided herein can be created and are within the scope of this disclosure.

[0091] While this specification contains many specific implementation details, these should not be construed as limitations on the scope of any invention or of what may be claimed, but rather as descriptions of features that may be specific to particular embodiments of particular inventions. Certain features that are described in this specification in the context of separate embodiments can also be implemented in combination in a single embodiment. Conversely, various features that are described in the context of a single embodiment can also be implemented in multiple embodiments separately or in any suitable subcombination. Moreover, although features may be described above as acting in certain combinations and even initially claimed as such, one or more features from a claimed combination can in some cases be excised from the combination, and the claimed combination may be directed to a subcombination or variation of a subcombination.

[0092] In addition to being directed to the teachings described above and claimed below, devices and/or methods having different combinations of the features described above and claimed below are contemplated. As such, the description is also directed to other devices and/or methods having any other possible combination of the dependent features claimed below.

[0093] Numerous characteristics and advantages have been set forth in the preceding description, including various alternatives together with details of the structure and function of the devices and/or methods. The disclosure is intended as illustrative only and as such is not intended to be exhaustive. It will be evident to those skilled in the art that various modifications may be made, especially in matters of structure, materials, elements, components, shape, size and arrangement of parts including combinations within the principles of the invention, to the full extent indicated by the broad, general meaning of the terms in which the appended claims are expressed. To the extent that these various modifications do not depart from the spirit and scope of the appended claims, they are intended to be encompassed therein. All references, publications, and patents referred to herein, including the figures and drawings included therewith, are incorporated by reference in their entirety.

[0094] In the specification and the claims the term “comprising” shall be understood to have a broad meaning similar to the term “including” and will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps. This definition also applies to variations on the term “comprising” such as “comprise” and “comprises”.

[0095] The reference to any prior art in this specification is not, and should not be taken as an acknowledgement or any form of suggestion that the referenced prior art forms part of the common general knowledge in Australia.

WHAT IS CLAIMED IS:

1. A magnetic net for a basketball goal having a rim, the magnetic net comprising:

a standard basketball net; and

one or more magnets coupled to the standard basketball net and not coupled to the rim.

2. The magnetic net of claim 1, wherein the one or more magnets are configured to be removed from the basketball net and recoupled to the standard basketball net without damaging the standard basketball net.

3. The magnetic net of claim 1, wherein the one or more magnets are disposed within an open space within strings of the standard basketball net such that the one or more magnets are not directly visible.

4. The magnetic net of claim 1, wherein the one or more magnets comprise four or more magnets.

5. An athletic game ball system, comprising:

an athletic game ball comprising:

a multi-layer ball shell sealed from an area around the ball shell; and

one or more electronic sensors located within a periphery of the athletic game ball; and

a magnetic basketball goal net, the magnetic basketball goal net comprising:

a standard basketball goal net; and

one or more magnets coupled to the standard basketball goal net.

6. The athletic game ball system of claim 5, further comprising a circuit board supporting the one or more electronic sensors and associated circuitry for monitoring motion of the athletic game ball and magnetic field signals near the athletic game ball.

7. The athletic game ball system of claim 6, wherein the associated circuitry comprises a wireless communication chip or chip set.

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8. The athletic game ball system of claim 7, wherein the one or more electronic sensors comprise (i) an accelerometer or angular rate sensor, (ii) a magnetometer, and (iii) a near field communications sensor.

9. The athletic gaming ball system of claim 8, wherein the associated electronics are programmed to identify disturbances in a magnetic field of the earth around the athletic game ball so as to identify when the athletic game ball has contacted or passed near a rim of a basketball goal.

10. The athletic gaming ball system of claim 8, wherein the associated electronics are programmed to identify a magnetic field of the one or more magnets coupled to the standard basketball goal net so as to identify when the athletic game ball has passed through the magnetic basketball goal net.

11. A computer-implemented method comprising:

identifying, with a computer system located in a sporting device, data captured from one or more sensors positioned within the sporting device and configured to sense a magnetic field around the sporting device as part of an actual sporting occurrence;

analyzing the data, by the computer system, to identify a temporary change in the magnetic field around the sporting device; and

determining, by the computer system, that the temporary change in the magnetic field around the sporting device indicates that the sporting device passed through a magnetic goal net.

12. The computer-implemented method of claim 11, wherein analyzing the data comprises identifying changes in the magnetic field around the sporting device that are equal to or greater than a predefined threshold value.

13. The computer-implemented method of claim 11, further comprising analyzing inertial data, by the computer system, to identify a motion of the sporting device.

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14. The computer-implemented method of claim 13, further comprising determining, by the computer system, that the motion of the sporting device indicates that the sporting device impacted a goal rim before the sporting device passed through the magnetic goal net.

15. The computer-implemented method of claim 13, further comprising determining, by the computer system, that the motion of the sporting device indicates that the sporting device did not impact a goal rim before the sporting device passed through the magnetic goal net.

16. The computer-implemented method of claim 11, wherein the sporting device is a basketball that comprises a magnetometer.

17. The computer-implemented method of claim 11, further comprising wirelessly transmitting data from the sporting device to an external computing device that is configured to display an indication that the sporting device passed through the magnetic goal net.

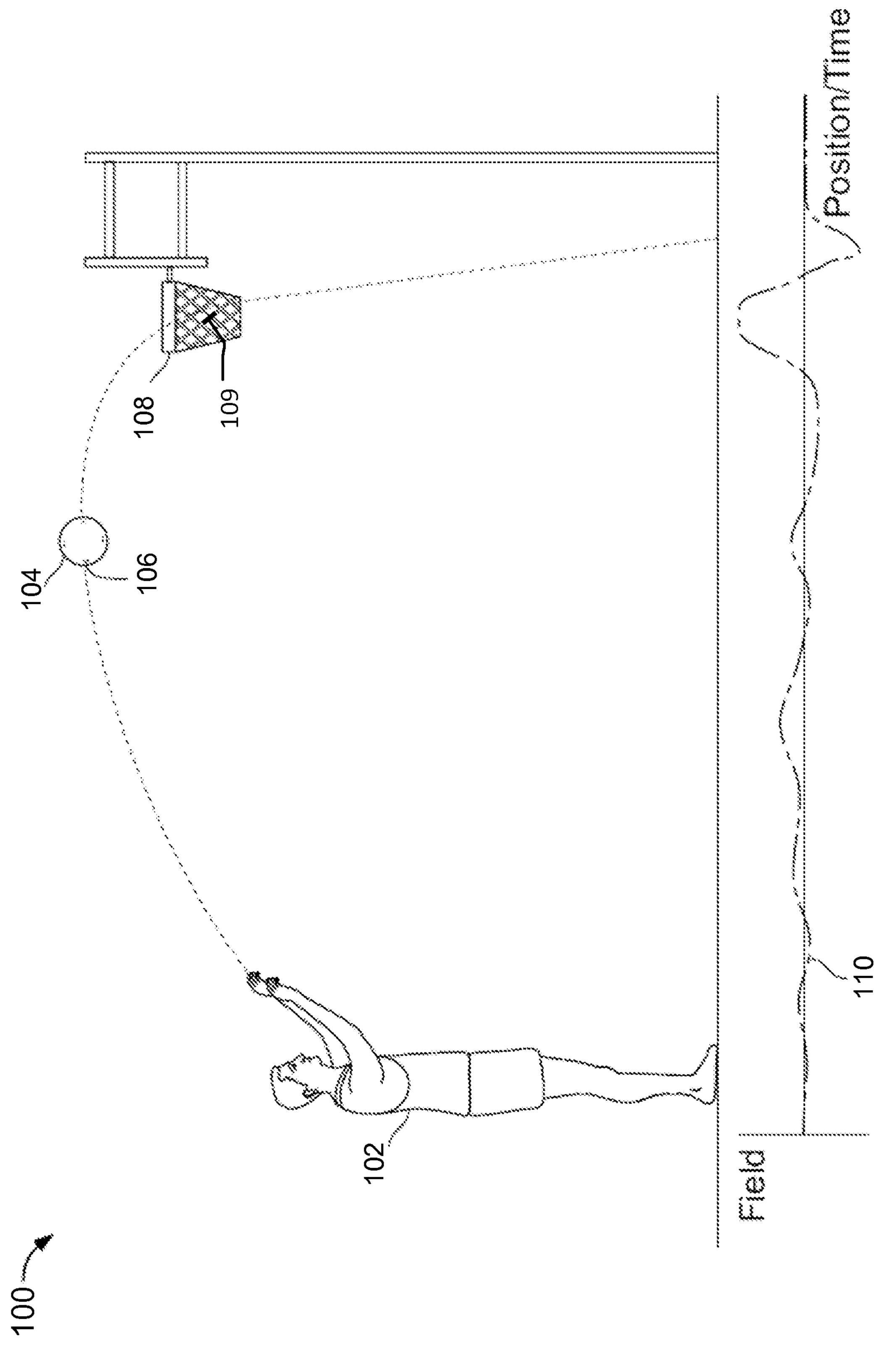

FIG. 1

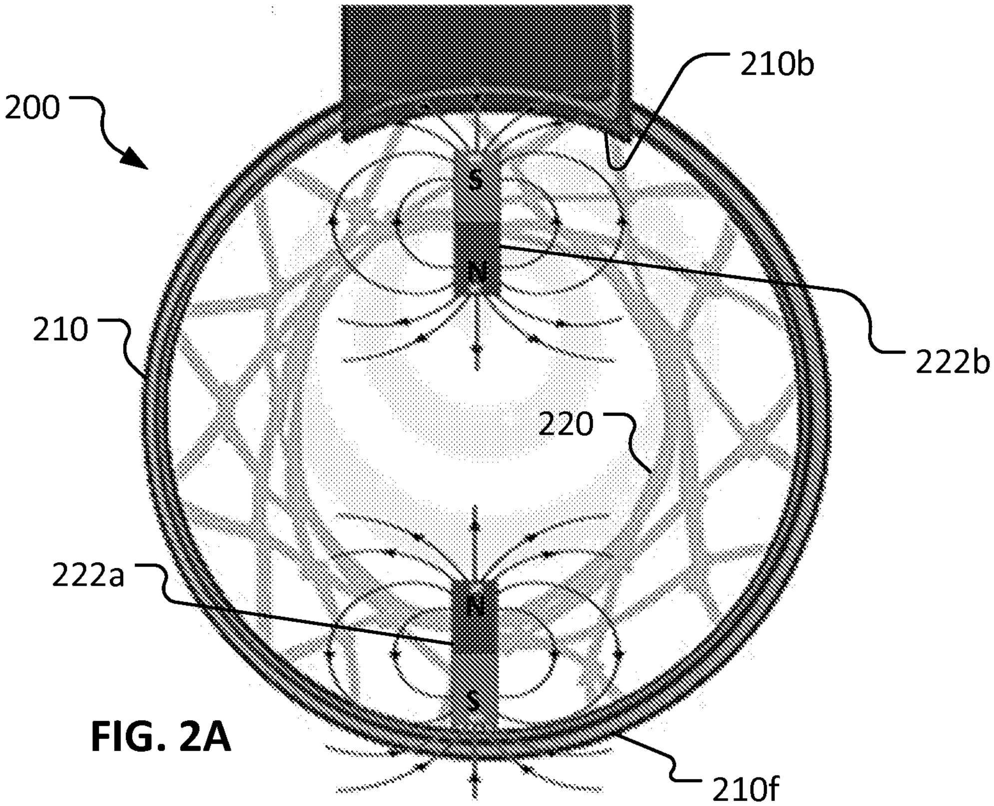
200
210b
S
N
222b
210
220
222a
N
S
210f

FIG. 2A

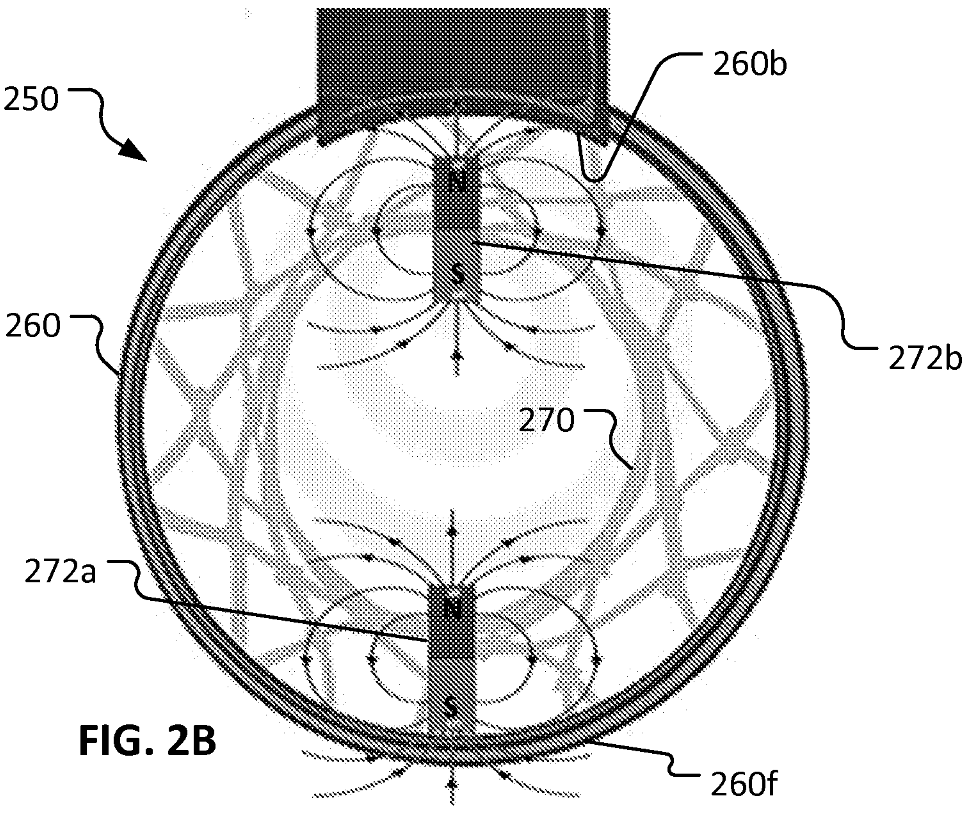
250
260b
N
S
272b
260
270
272a
N
S
260f

FIG. 2B

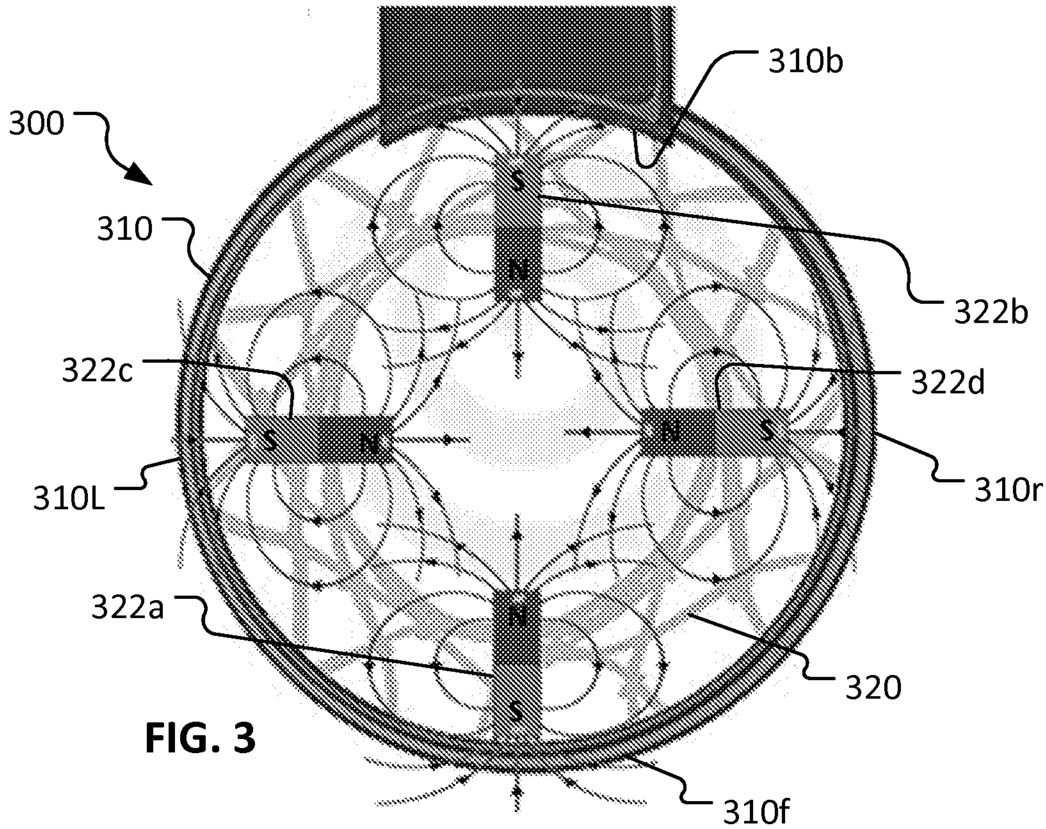
300
310b
310
322b
322c
322d
S
N
S
N
S
N
N
S
310L
310r
322a
320
310f

FIG. 3

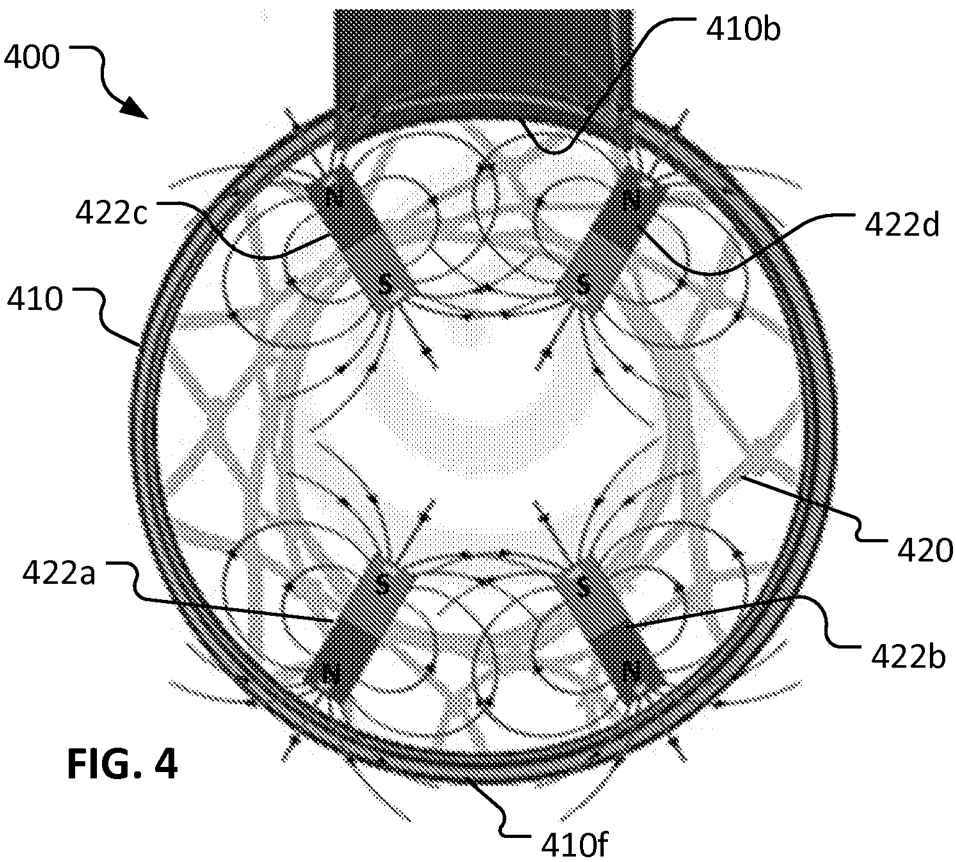
400
410b
422c
422d
410
N
S
N
S
S
N
S
N
420
422a
422b
410f

FIG. 4

FIG. 5B

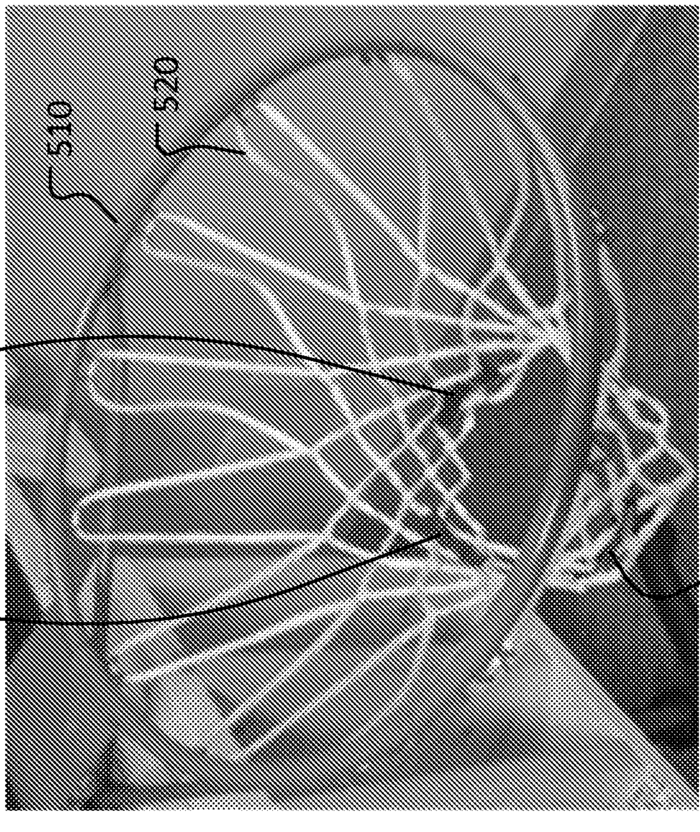

FIG. 5A

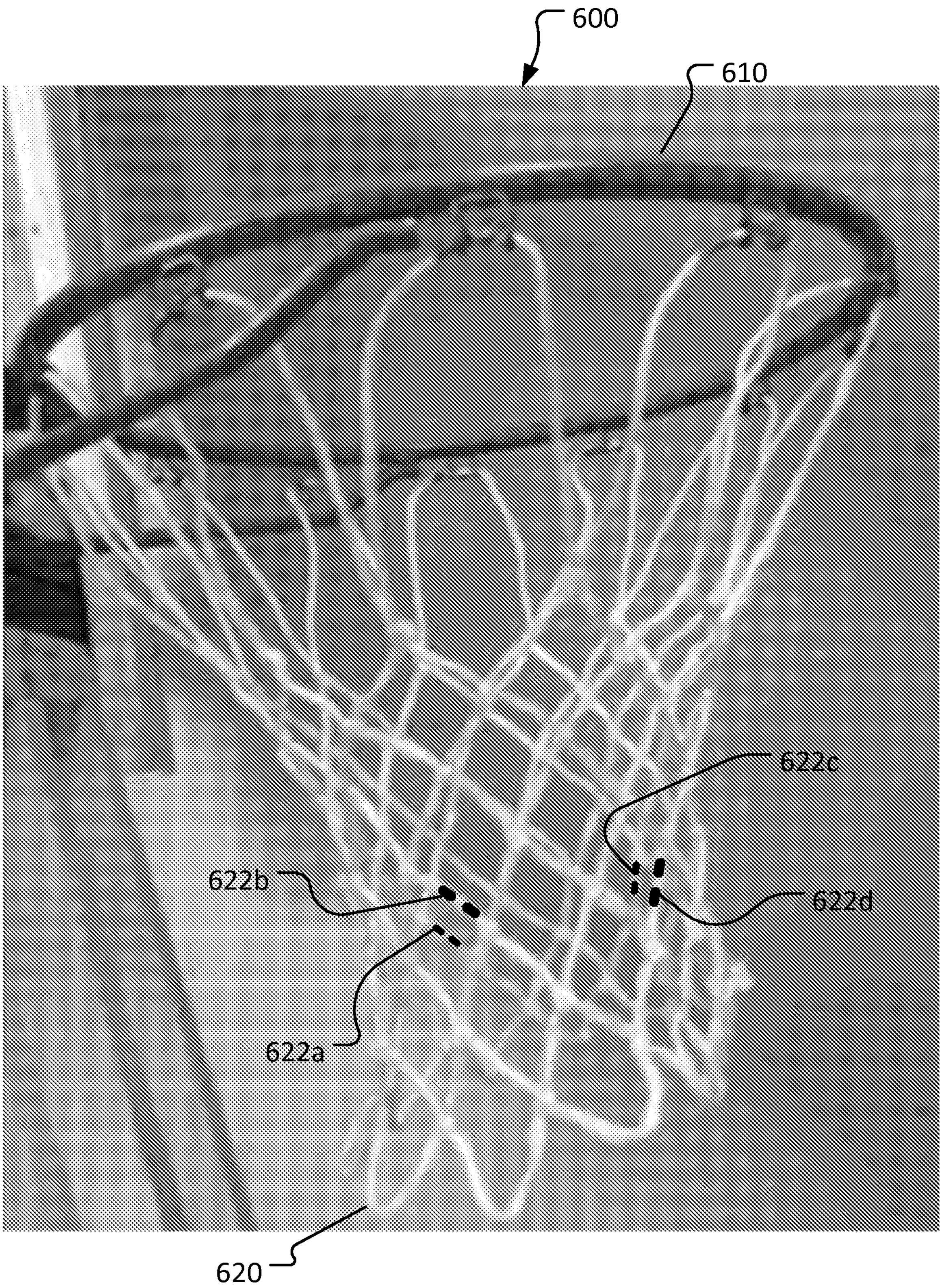

FIG. 6

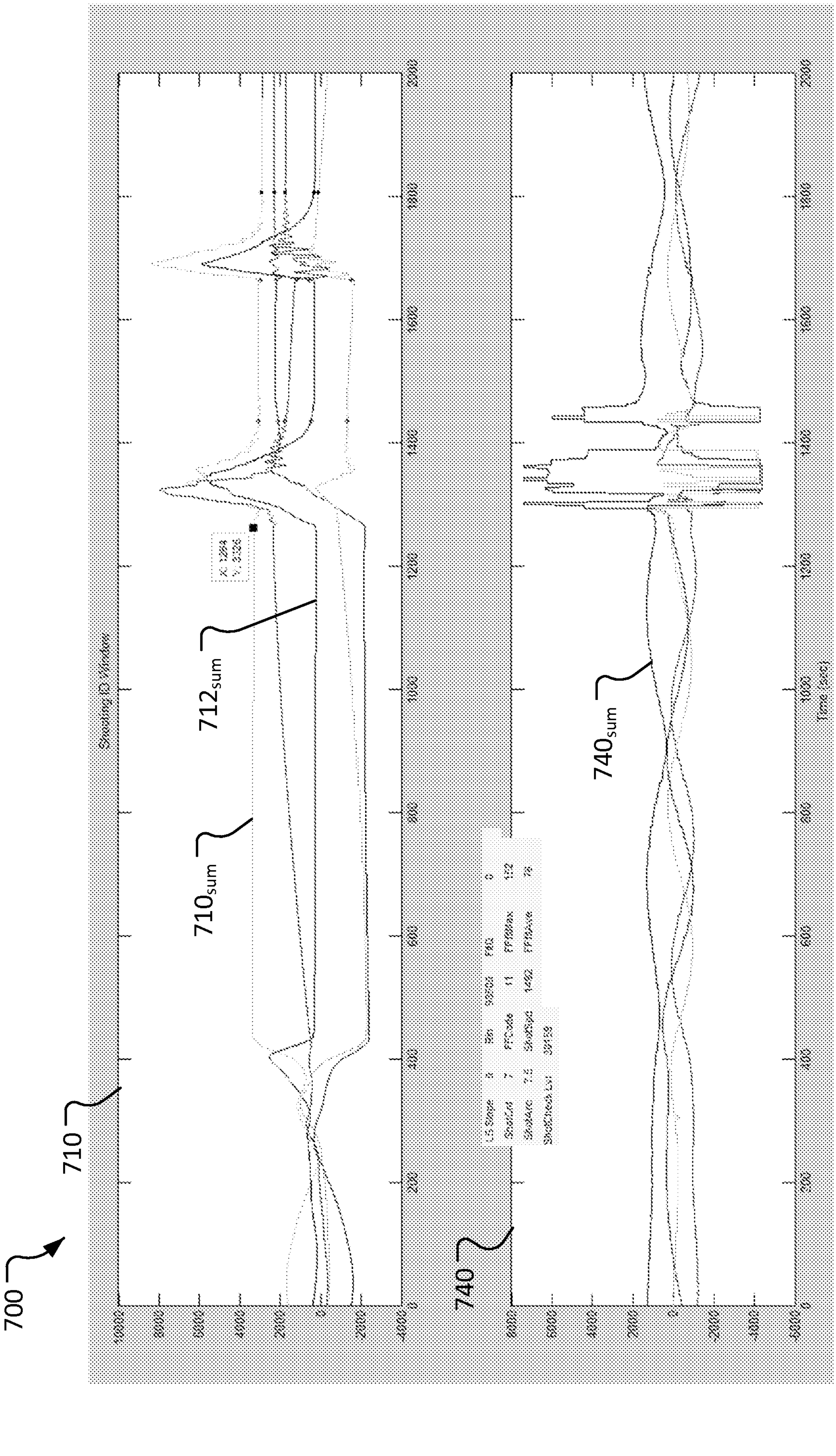

FIG. 7

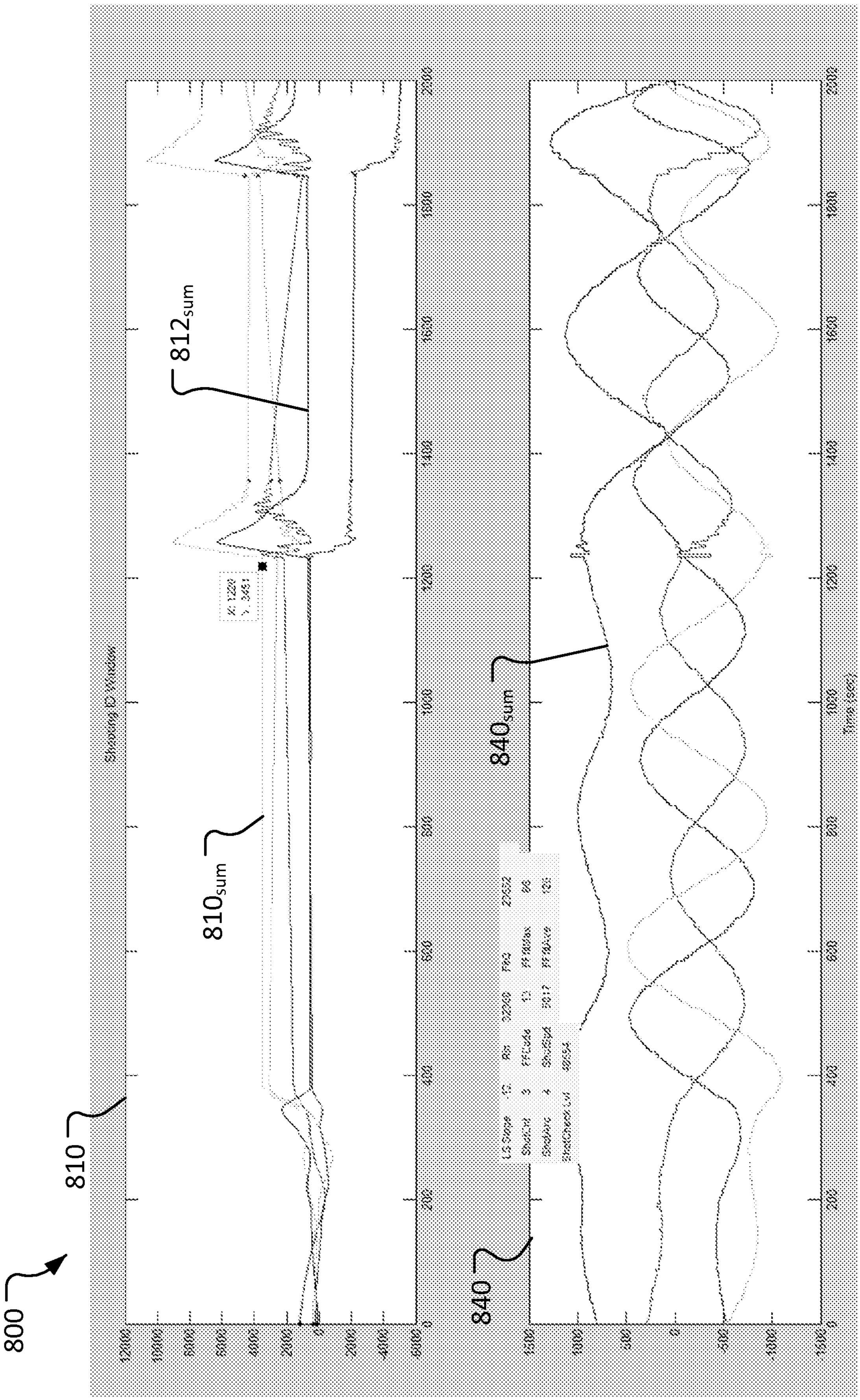

FIG. 8

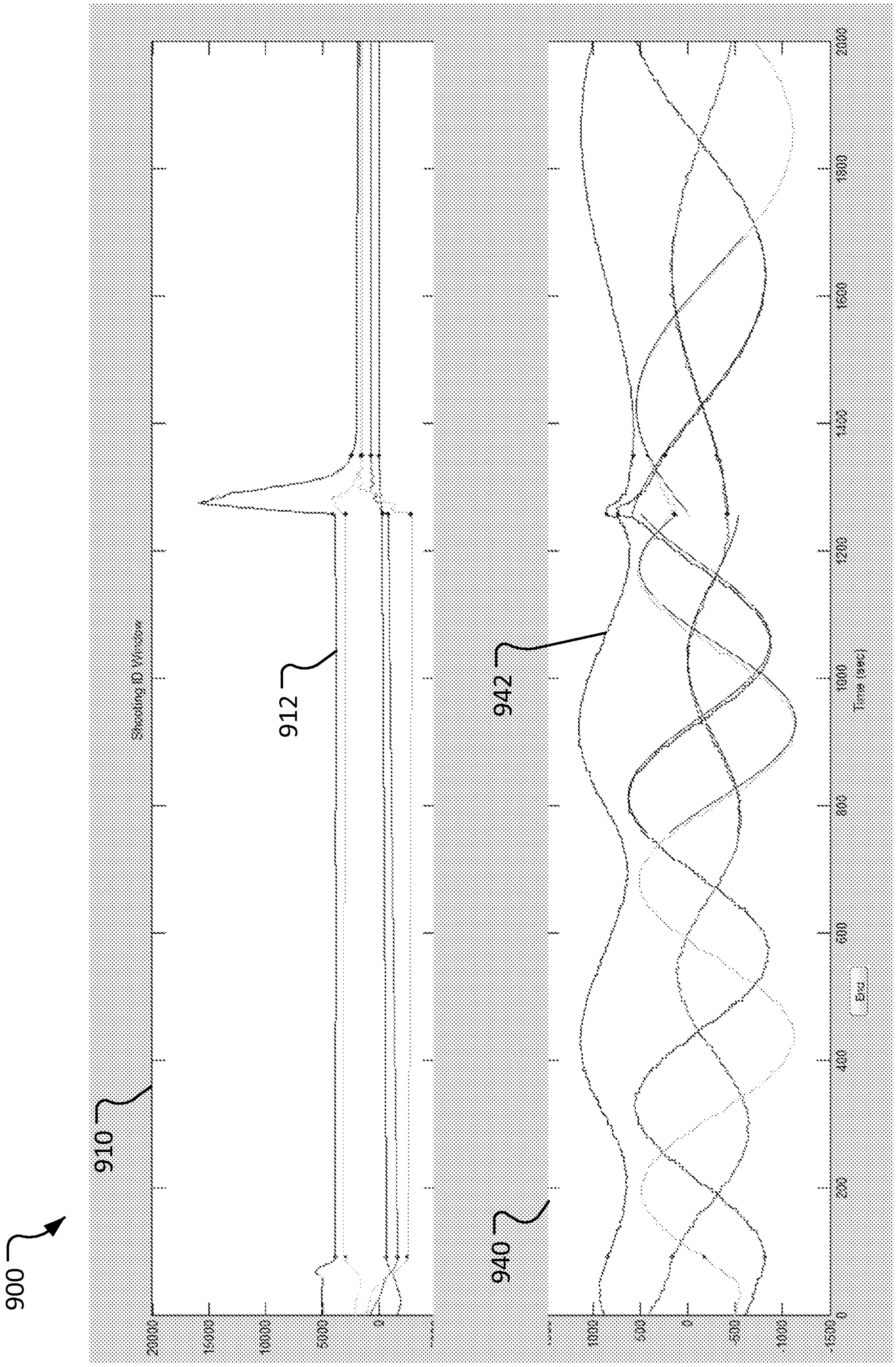

FIG. 9

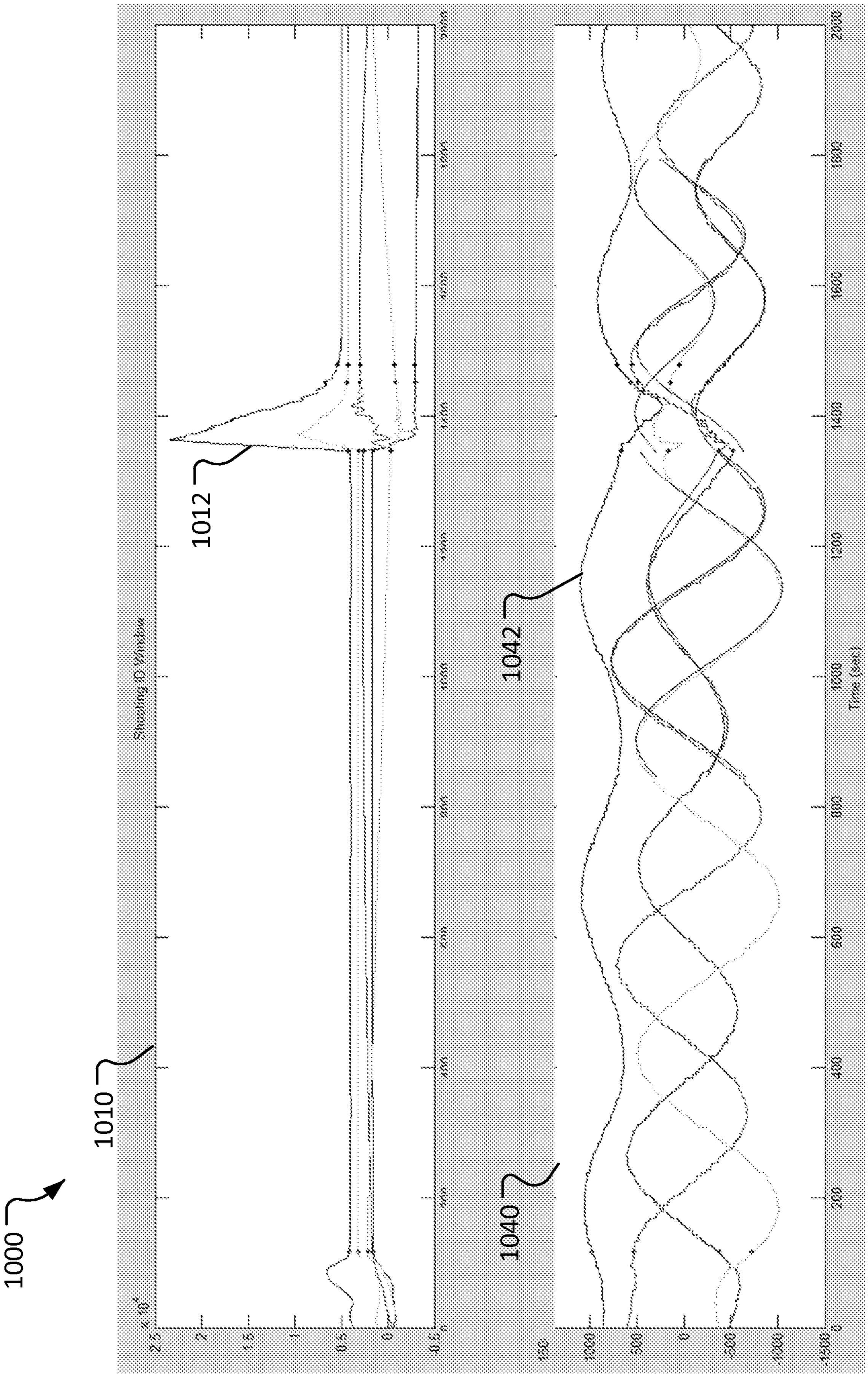

FIG. 10

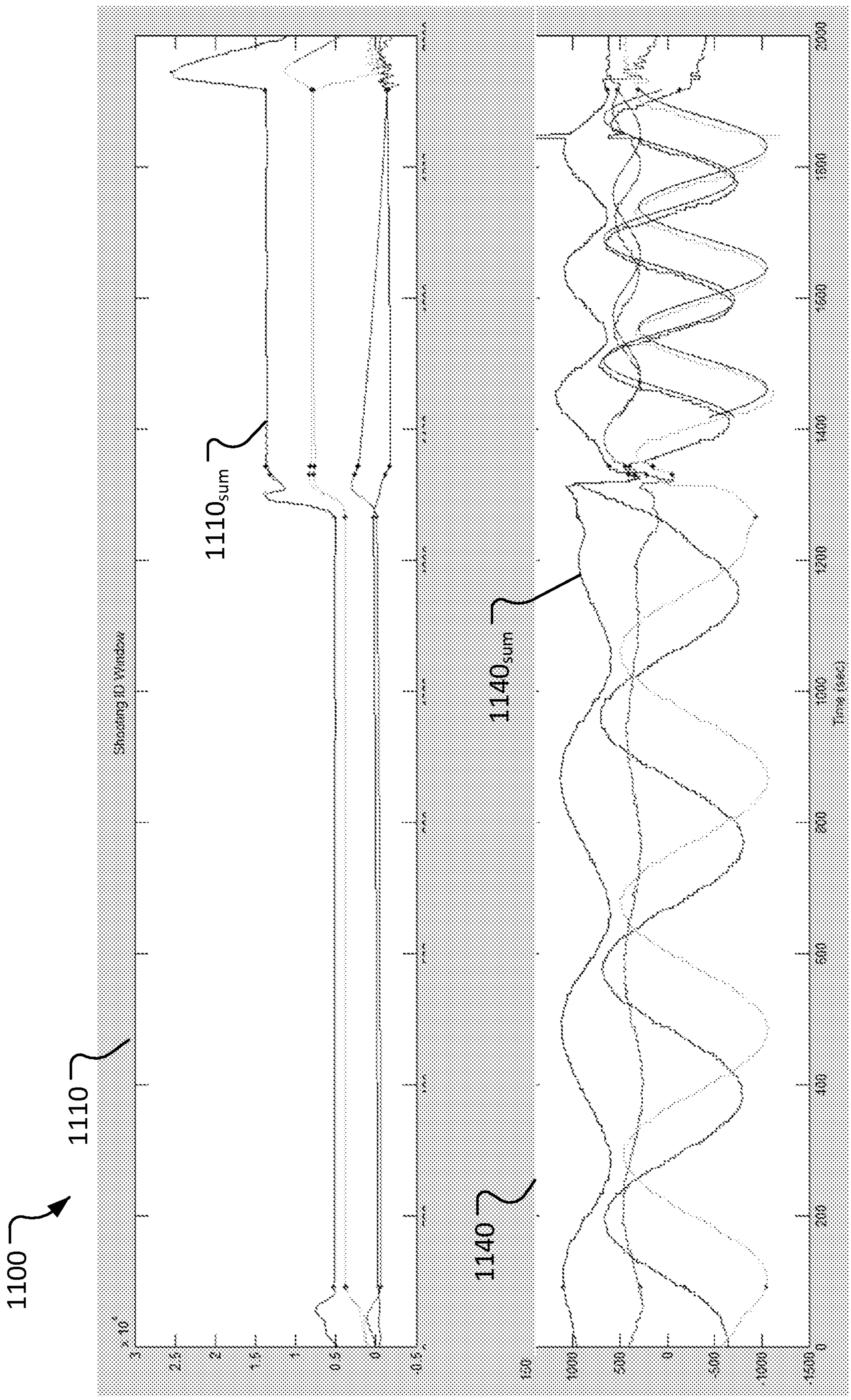

FIG. 11

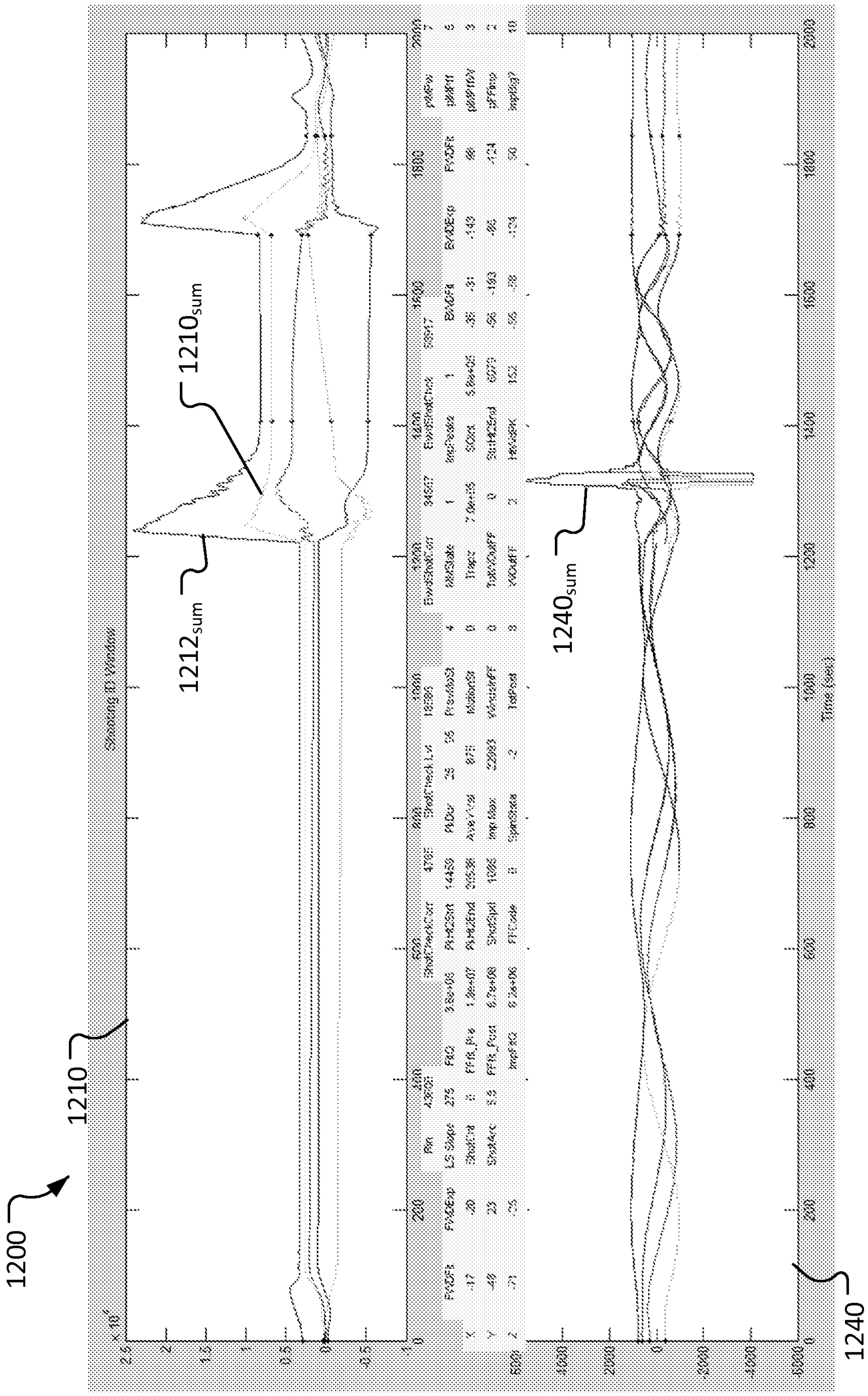

FIG. 12

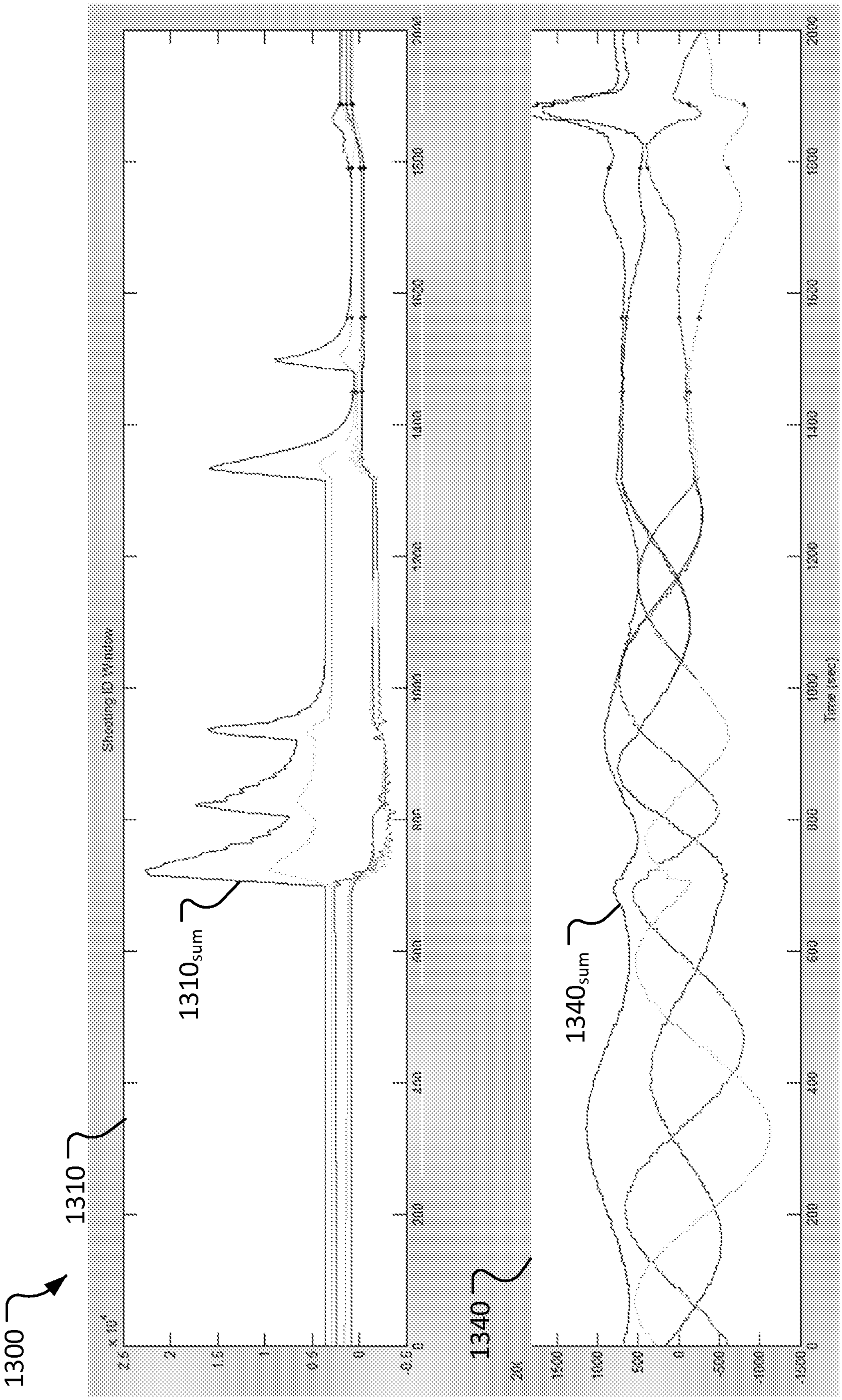

FIG. 13