May 12, 2017

Linescan Projector and Camera Offset From Each Other Around Display for Creating Image that Appears to be Captured from Middle of Display

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Linescan Projector and Camera Offset From Each Other Around Display for Creating Image that Appears to be Captured from Middle of Display

Abstract:
A linescan projector and camera can be offset from each other around a display, such as the linescan projector being at the top of the display and the camera being at the side of the display. The linescan projector can sweep vertical lines horizontally, and the camera can capture horizontal images at different vertical locations. A processor can construct an image of a user's face that appears to have been taken from a middle of the screen, creating the appearance that the user is looking directly into the camera.

Webcams, or cameras included in or mounted on displays for the purpose of facilitating a video conference or chat over the Internet via a computer associated with the display, capture images of a user from a position outside the display, such as above the display. The user is typically looking at an image in the display, such as an image of another person with whom the person is engaging a video conference or chat. The position of the webcam above the display, which is above the image at which the user is looking, typically causes the user to appear to be looking down, rather than into the camera and at the other person.

A linescan projector and camera can be located and/or mounted on portions of the display or bevel that are offset from each other, such as the linescan projector on top (or bottom) of the display and the camera on one side of the display or the linescan projector on the side of the display and the camera on the top (or bottom) of the display. The linescan projector can project vertical lines, sweeping side-to-side horizontally. While the vertical lines are sweeping horizontally, the camera can capture horizontal pixels. A processor associated with the linescan projector and the camera can construct an image of the user's face that appears to have been taken from the middle of the display, or any other location, such as where an image of the other person is presented on the display, creating the appearance that the user is looking directly into the camera and/or at the other user.

FIG. 1A is a diagram of showing pixels 100 in a typical camera. The pixels 100 are square or circular, and form a grid. Each pixel 100 in the grid independently captures optical information, such as color and intensity of light received at the respective pixel 100. The pixels 100 pass the captured optical information to a processor, which can construct an image based on the optical information captured by all of the pixels 100.

FIG. 1B is a diagram showing horizontal pixels 150. The horizontal pixels 150 are rectangular or oval-shaped, and form a column. Each horizontal pixel 150 captures optical information, such as color and intensity of light received at the respective horizontal pixel 150. The information captured by each horizontal pixel 150 is the sum of all of the light received along the entire width of the horizontal pixel 150. The horizontal pixels 150 can capture multiple frames while the linescan projector is sweeping vertical lines in a horizontal direction across the subject. The multiple frames can form a composite image, with each frame capturing the reflected light from a different horizontal location of the object. The horizontal pixels 150 pass the captured frames to a processor, which can construct the composite image. The processor can construct a composite image from a perspective different from either the linescan projector or the camera, such as a location where a person's face is presented, causing a user to appear to be looking at the other person during a video conference or chat.

FIG. 2A is a diagram showing an artificial perspective from which to present an image. A point 202 can be a location from which a constructed image should appear to be capturing an image. A plane 210 can be a location of a scene being captured, such as the user's face. A point 208 can be a source of light, such as a point on a person's face that is being captured. Line 206 can be the path of light from the point 208 to the point 202, which is the perspective from which the constructed image will appear to be viewing the point 208 and/or plane 210. A plane 204 can represent an image plane through which the light represented by the line 206 appears to travel to arrive at the point 202.

FIG. 2B shows that a plane 212 can extend in a vertical direction above and below the line 206 and include the line 206. As described below, the plane 212 will extend through the actual linescan projector.

FIG. 2C shows that a plane 214 can extend in a horizontal direction, perpendicular to the plane 212 shown in FIG. 2B, to the sides of the line 206 and including the line 206.

FIG. 2D shows the intersection of the planes 212, 214 at the line 206, from the point 208 of the subject to the point 202.

FIG. 3 shows a plane 312 extending vertically. The line 206 extends through the plane 312. A point 302, which represents the location of the linescan projector that projects vertical lines that sweep horizontally across the plane 210, is included in the plane 312. The plane 312 can represent the projection of a vertical line by the linescan projector. A plane 304 represents an image plane of the linescan projector.

FIG. 4 shows a plane 414 extending horizontally. The plane 414 can extend from the plane 210 representing the subject to a point 402 representing a camera with horizontal pixels 150. The line 206 can originate from a point 208 on the plane captured by a horizontal pixel 150 in the camera. The plane 414 can extend through a plane 404 that represents an image plane of the camera.

FIG. 5 shows the intersection of the planes 312, 414 shown in FIGs. 3 and 4. As shown in FIG. 5, the planes 312, 414 intersect at the point 208 on the line 206 at the plane 210 representing the subject being captured (such as the user's face), with the point 202 representing the artificial camera from which the constructed image will appear to have been captured. The processor can, based on the optical information captured by the horizontal pixel of the camera via the plane 414 from the light reflected from the plane 210 that was projected by the linescan projector from the point 302 along the plane 312, construct the pixel at the point 208. The processor can construct pixels at other points on the plane 210 based on images reflected from light projected from the point 302 along other vertical planes and received by the camera by other horizontal pixels 150 via other horizontal planes extending from the point 402.

While the vertical lines projected by the linescan projector can sweep at a high rate so that they are directed toward the user for a small fraction of time, the intensity of light can be bothersome to a user. FIG. 6A shows the light projecting from the single point 402 along the vertical plane. FIG. 6B shows a linescan projector projecting light from the point 402 but scattered by an image plane 600 that maintains the vertical line and/or plane along which the light is projected. The image plane increases the number of points from which the light is projected, reducing the intensity of light experienced by the user.

As discussed above with respect to FIG. 1B, the camera can include a column of horizontal pixels. In an alternative implementation shown in FIG. 7, the camera can include a grid 702 of pixels and an array of processors 704 that cause the grid 702 of pixels to act like a column of horizontal pixels. Each processor 704 in the array is associated with a row of pixels in the grid 702, and adds and/or sums the optical information received by each of the pixels in the associated row. Each processor 704 then passes the sum to a processor that constructs the image from the point 202.

FIG. 8 shows a display 800. The display 800 presents an image 802 centered at the point 202 that forms the perspective from which the artificial image appears to be captured. The display 800 includes a linescan projector 804 centered on the point 302, and a camera 806 centered on the point 402. The linescan projector 804 can project vertical lines that sweep across the user's face who is facing the display 800. The camera 806 can capture images that are sums of optical information captured in horizontal planes at multiple times in association with the vertical lines projected by the linescan projector 804. A processor included in the display 800 or in communication with the display 800 can construct an image of the user that appears to have been captured at the point 202 that is the center of the image 802 at which the user is looking. The processor can send the constructed image to another computer being used by a person who is engaging in a video conference or chat with the user, and the constructed image will appear to show the user looking directly at the other person.

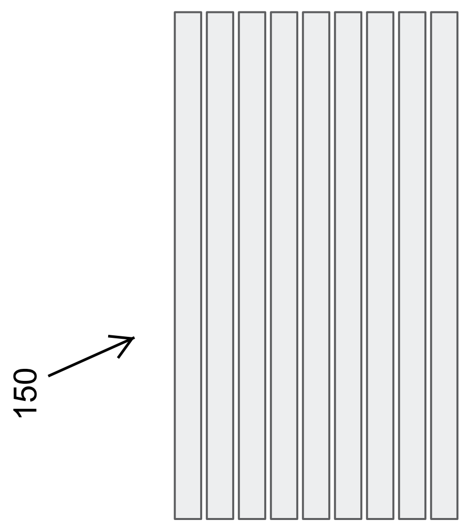

FIG. 1B

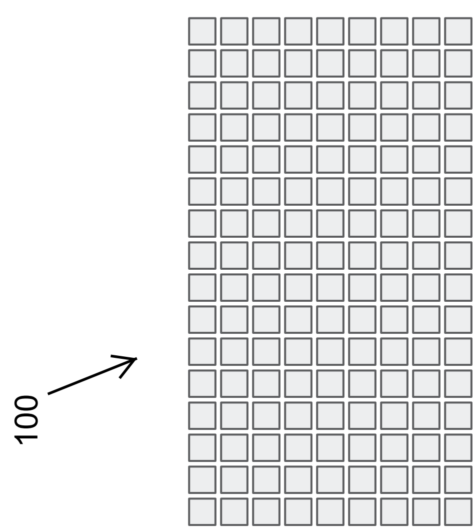

FIG. 1A

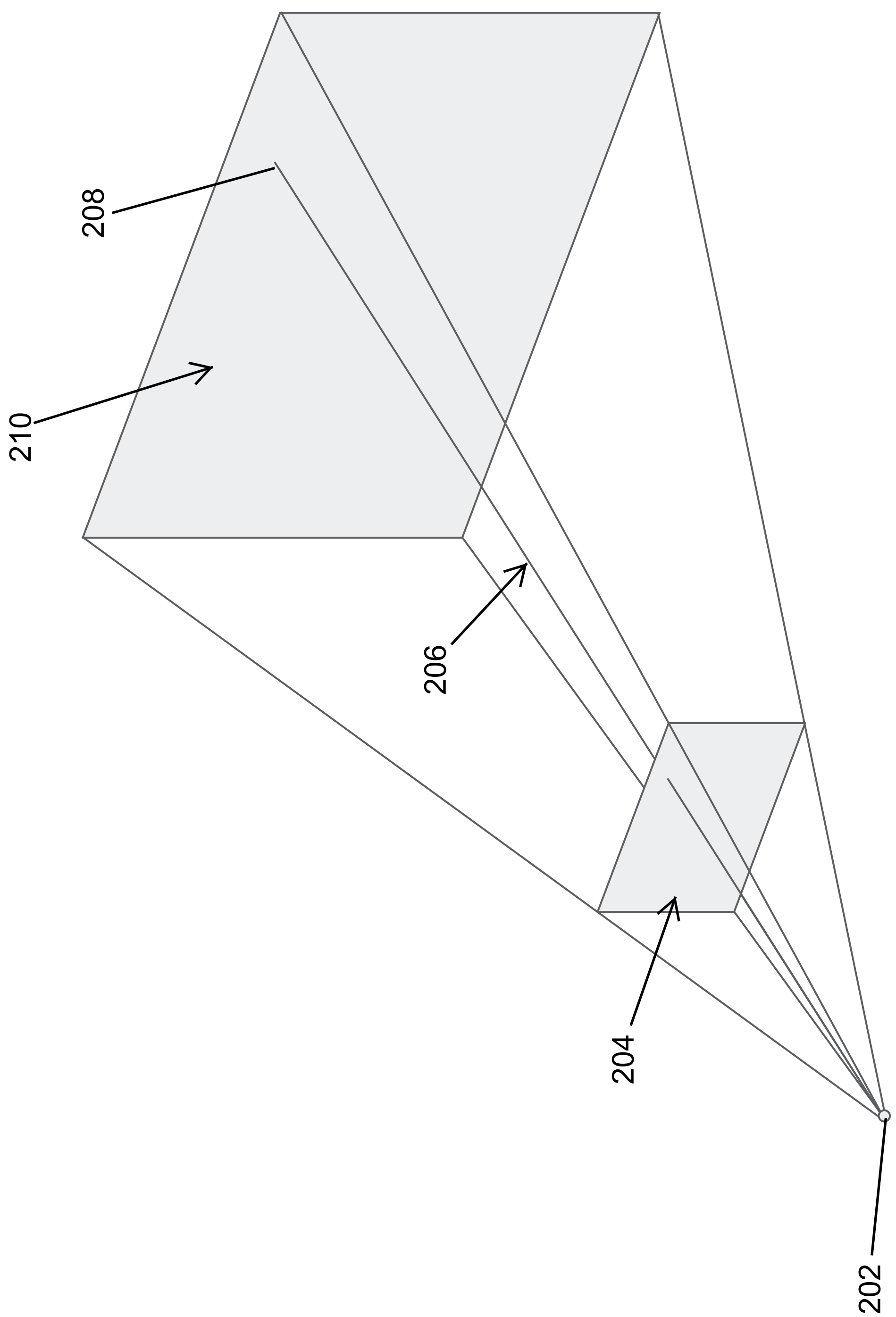

FIG. 2A

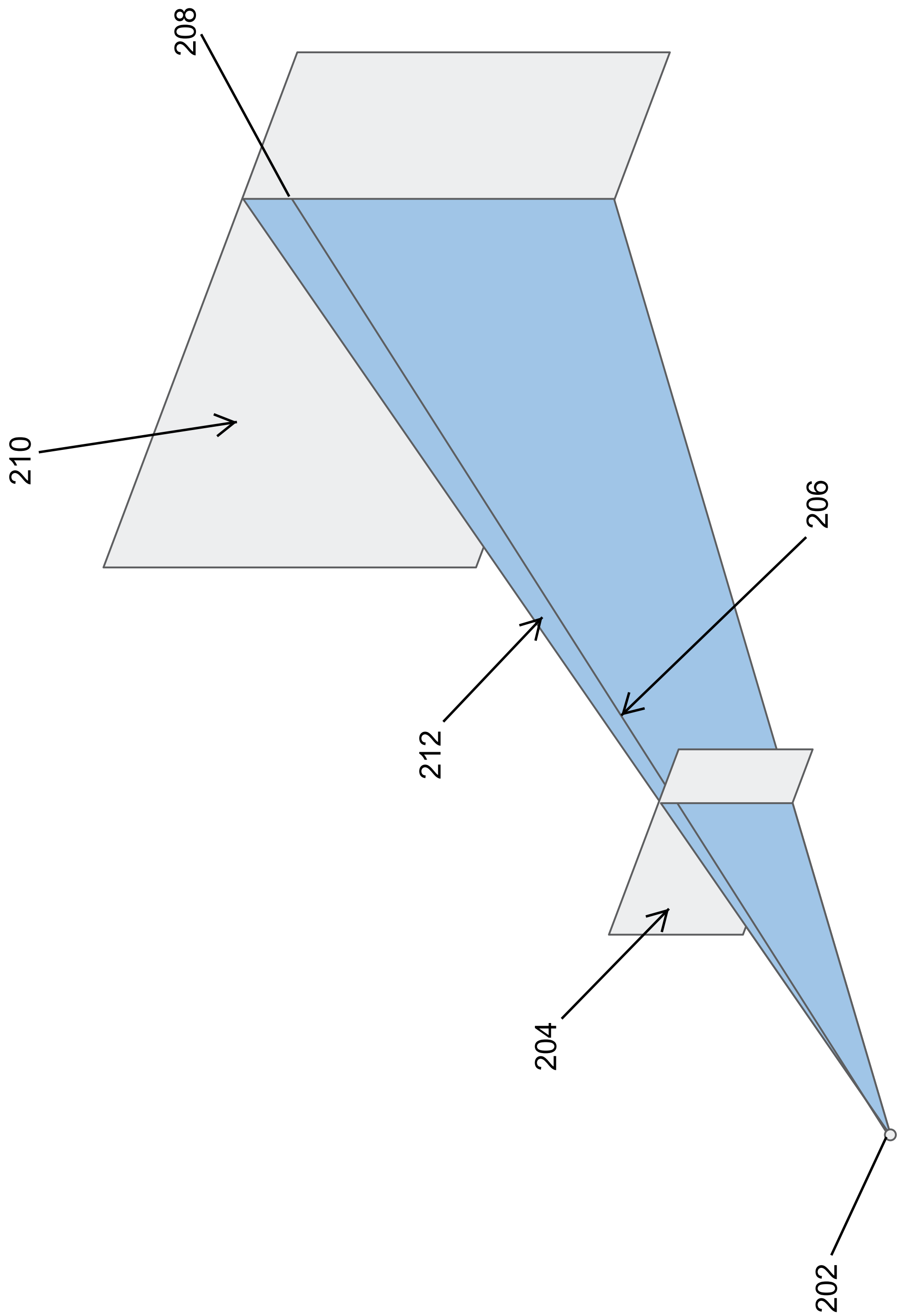

FIG. 2B

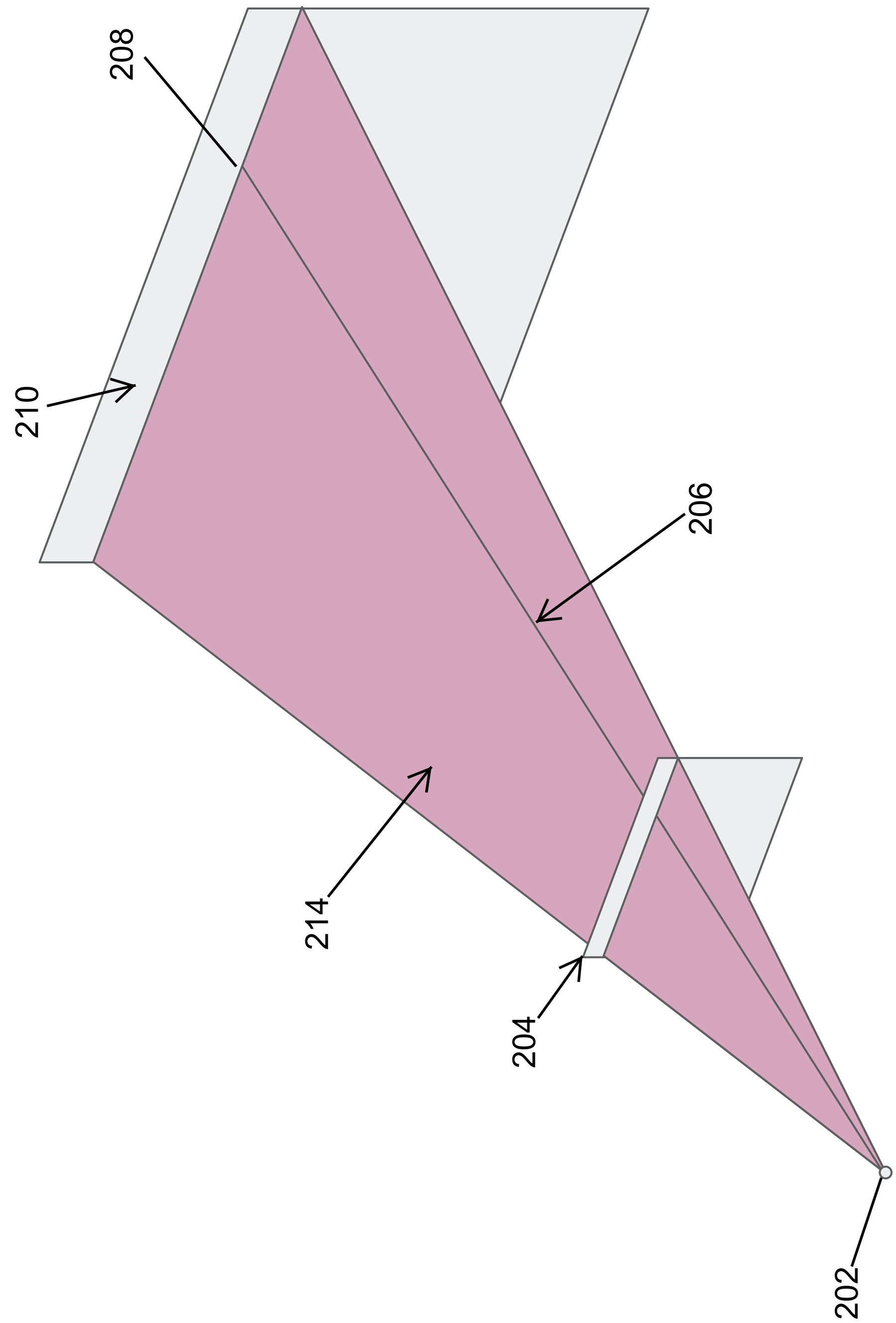

FIG. 2C

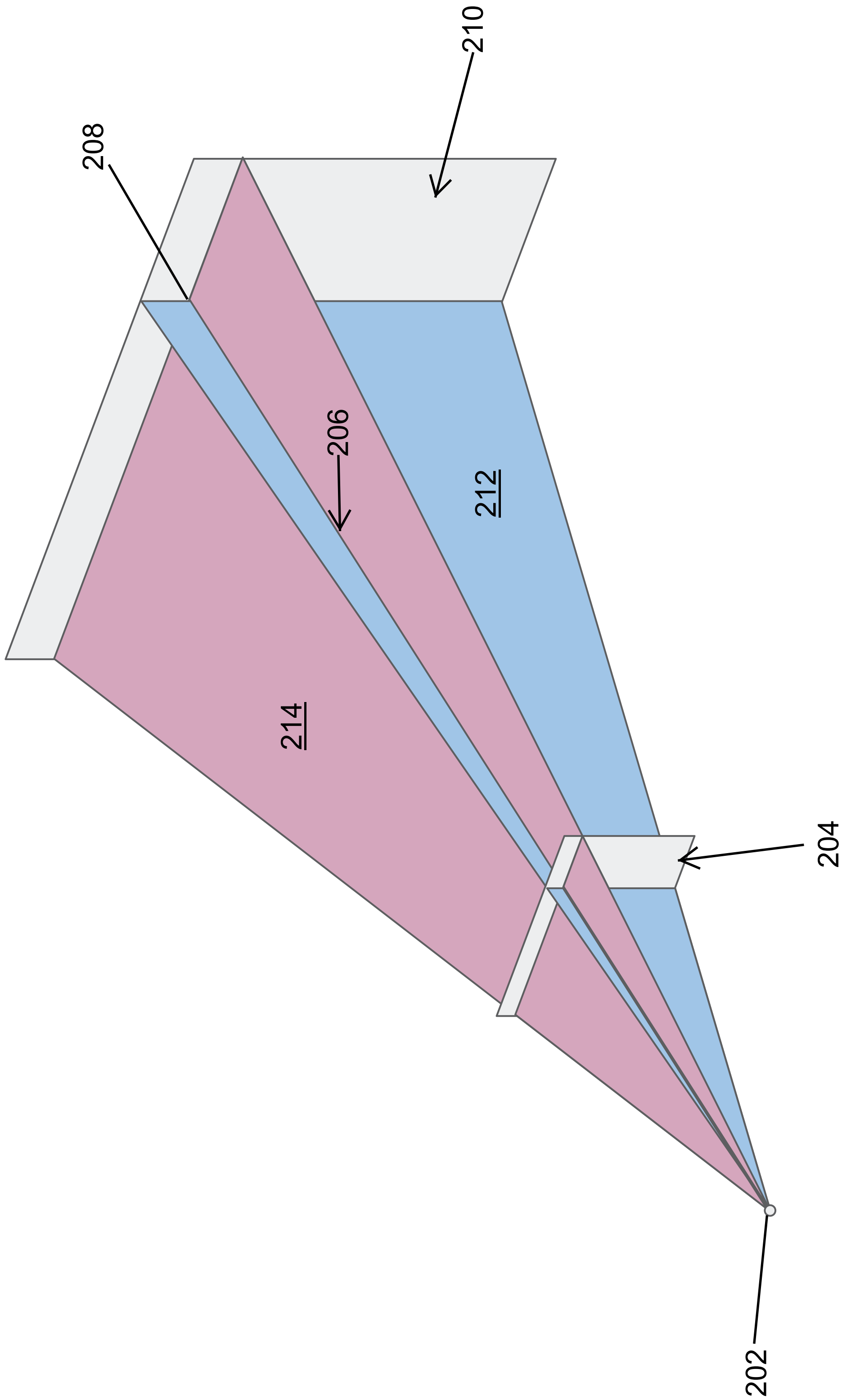

FIG. 2D

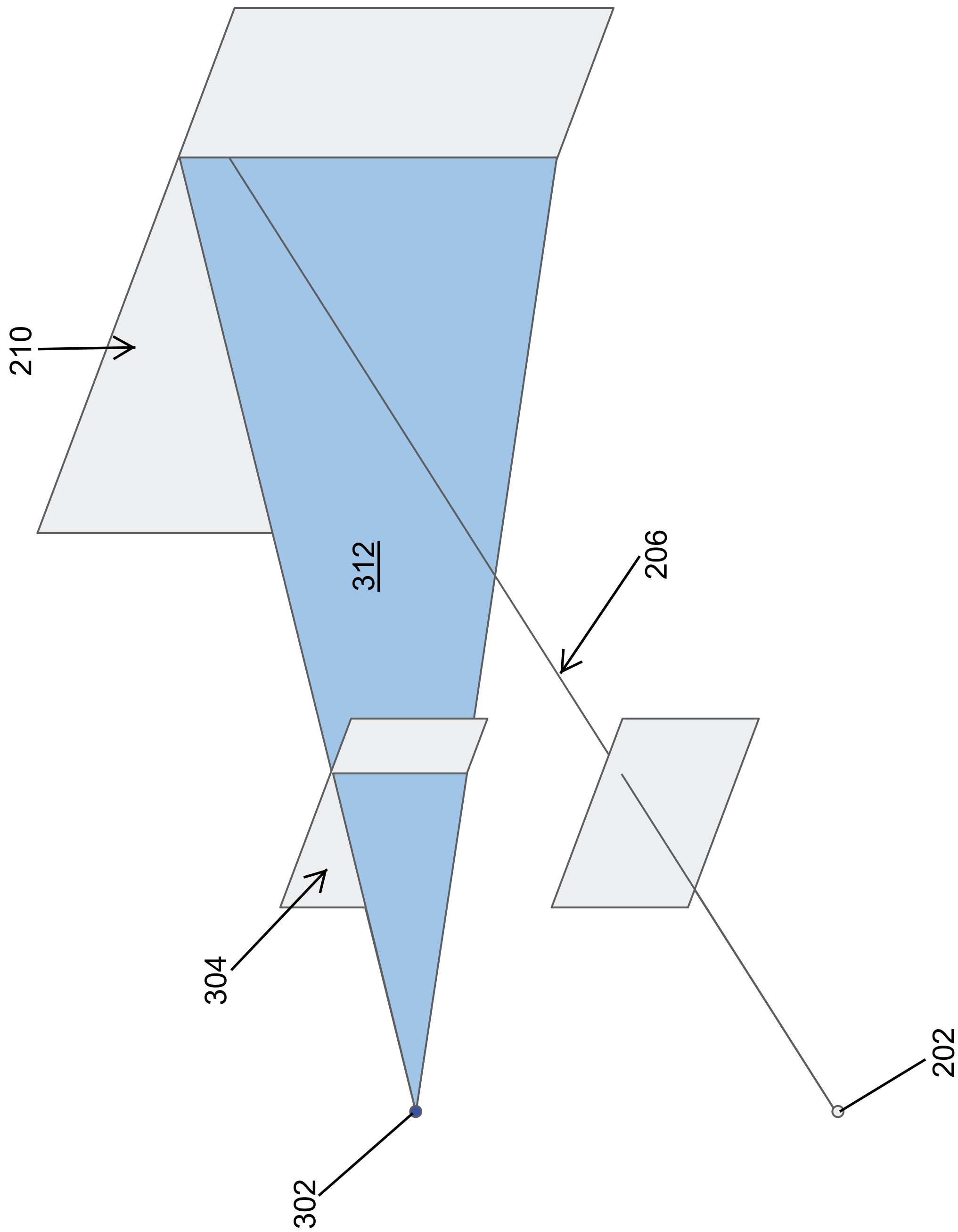

FIG. 3

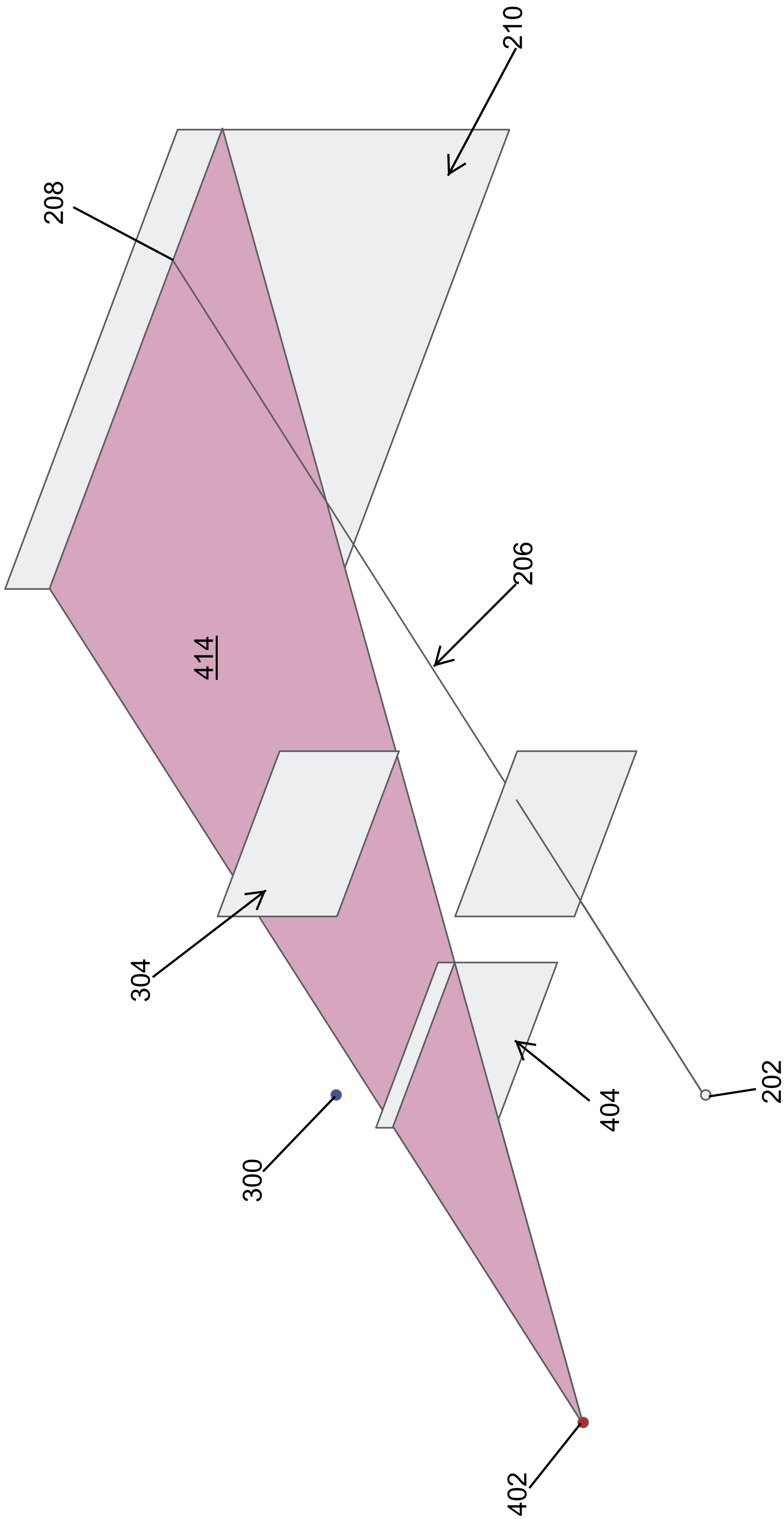

FIG. 4

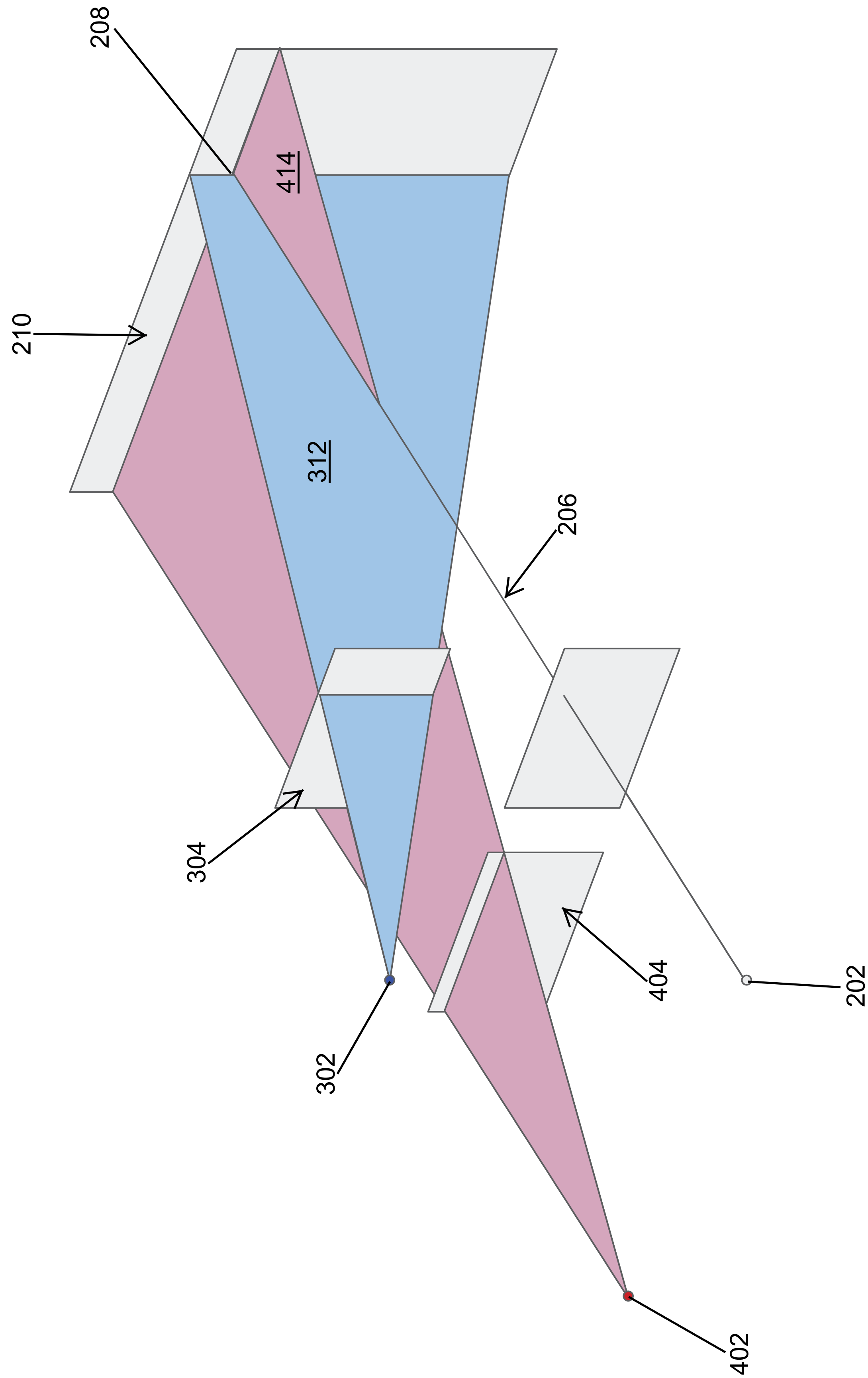

FIG. 5

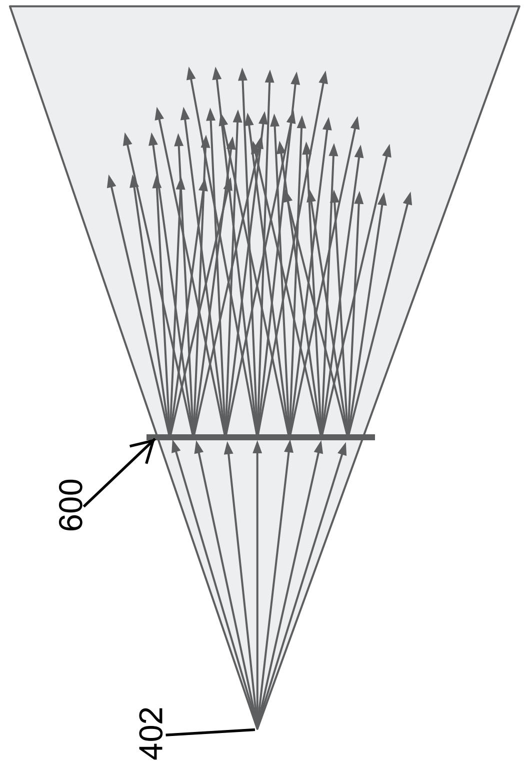

FIG. 6B

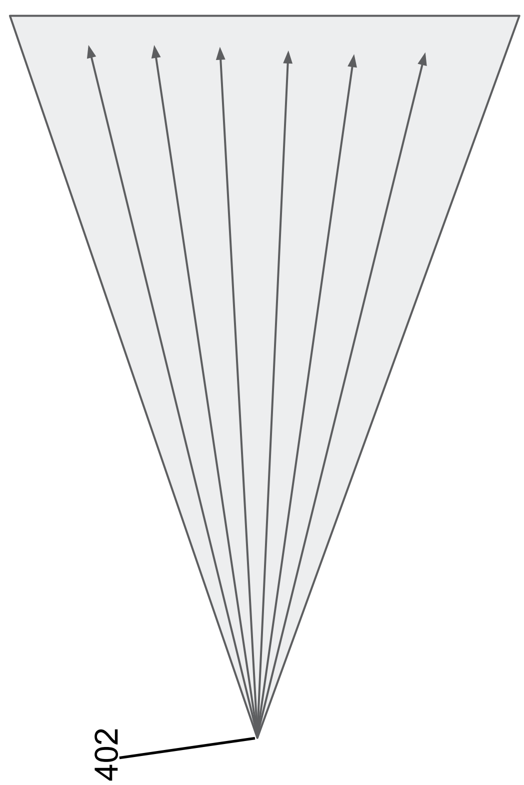

FIG. 6A

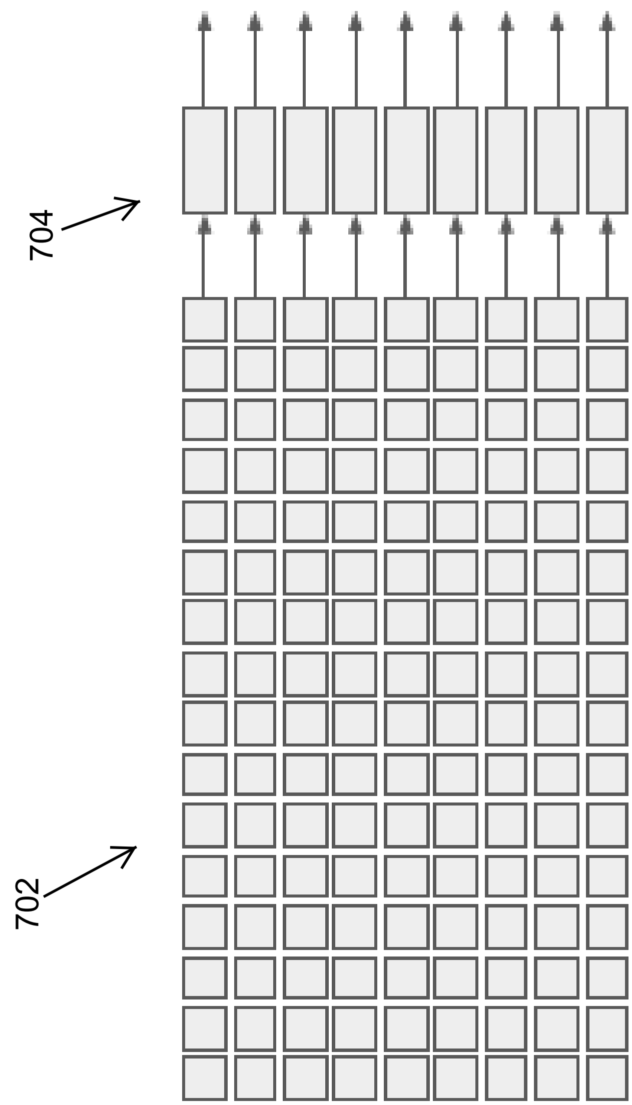

FIG. 7

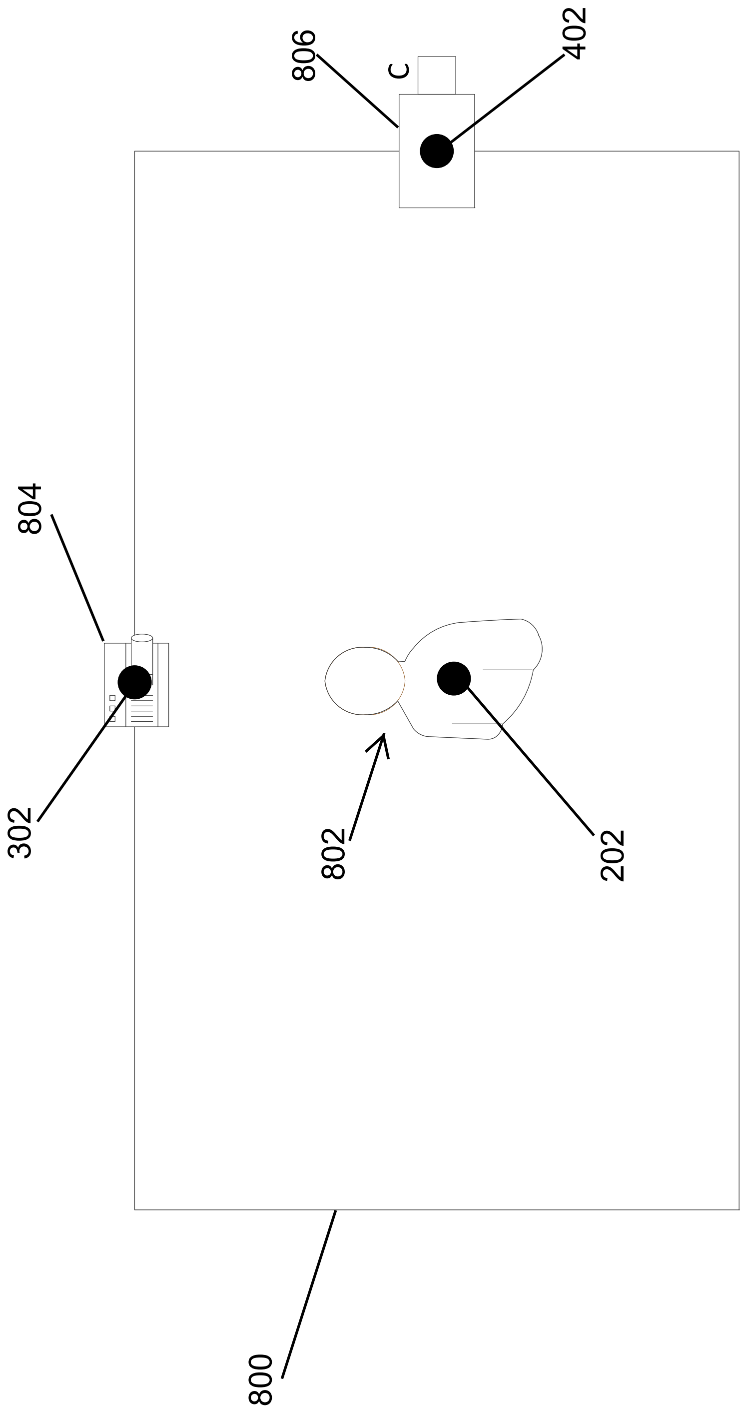

FIG. 8