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(56) Publications considered for the assessment of
patentability:

DE 197 17 399 C2

DE 196 05 218 C1

DE 195 07 957 C1

DE 101 14 362 C2

DE 101 62 668 B4

DE 197 57 849 A1

DE 101 46 692 A1

DE 101 11 826 A1

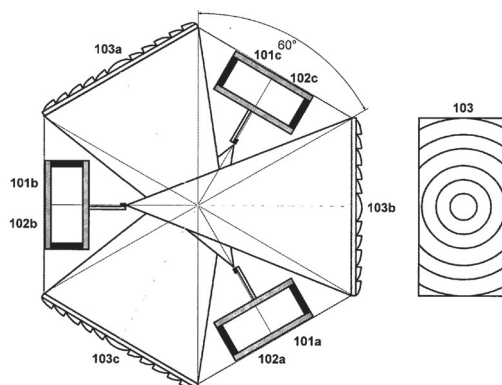
DE 41 27 168 A1

DE 38 25 081 A1

US 52 10 586 A

(54) Title: **Obstacles Detection Sensor**

(57) Main claim: Sensor for detecting obstacles for vehicles on the ground and aircraft having at least one multichannel distance measuring device operating according to the transit time method, which is accommodated in a rotating sensor head (1a) and comprises a plurality of components (101, 103, 104, 107), wherein the components are being displaceable in the axial direction such that different elevation angle ranges are scanned.



Description

Prior art

[0001] The following sensors for detecting obstacles for ground vehicles and aircraft are known:

Radar sensors with single or circumferential antenna.

[0002] Optical sensors according to the transit time method with mirror scanning, e. g.

- DE 197 57 849 A1
- DE 101 14 362 C2
- DE 101 11 826 A1
- DE 195 07 957 C1
- DE 196 05 218 C1
- DE 38 25 081 A1

[0003] DE 197 57 849 A1 describes an arrangement in which a rotating part contains a laser transmitter and a laser receiver in a coaxial arrangement. A sensor according to this description cannot be used in rain or haze, because backscatters from the close range falsify the signals. DE 38 25 081 A1 describes a scanner by means of a glass fiber brought to vibration.

[0004] There are also sensors that work on a transponder basis.

[0005] All of these sensors have the disadvantage that they do not detect small obstacles such as wires or gliders with a very small front surface.

Task

Object of the Invention

[0006] The object of the invention is to create a sensor that detects small obstacles via distance measurement according to, e. g. the pulse transit time method of electromagnetic radiation, and also a high angular resolution in all scanning ranges, e. g. 30° to 60° in elevation and 360° in azimuth, and generates a high energy density at the location of the obstacle and at the same time it can also be displayed with little volume and weight. This task is solved with a sensor according to claim 1 or claim 2.

Example of an embodiment

[0007] The invention is described with reference to [Fig. 1](#) to [Fig. 6](#).

[0008] According to [Fig. 1](#), the sensor comprises a sensor head **1a** that rotates around its axis **1b**. The sensor head contains, for example, a laser line with a plurality of individual lasers **101** for generating light pulses, which are controlled by the driver electronics **102**. The laser line is mapped on the environment via the optics **103**. The energy

backscattered by obstacles is received via the optics **107** and transferred to the receiver line **104**, e. g. consisting of a series of photodiodes. Further signal conditioning takes place in the electronics **105**. Through a beam splitter **106**, which is permeable to the wavelength of the laser **101** and simultaneously serves as a filter for the receiver **104**, the wavelength range of the light that is not assigned to the laser wavelength is guided onto the image or line sensor **108** and evaluated via the electronics **109**. The electronic boards **112a** and **112b** are used to evaluate the entire signal and power supply for all of the components in the sensor head **1a**.

[0009] The distance is measured to the obstacle by determining the transit time, e. g. according to one of the methods known and described in the documents

- DE 197 17 399 C2
- DE 101 62 668 B4
- DE 41 27 168 A

[0010] The rotating part is supplied via inductive coupling with the energy transfer known from DE 101 14 362 C2. The data is transmitted into and out of the sensor head **1a** via the optical transmission and receiver groups **113** and **114**. The drive is carried out, e. g. via the sprocket **118** and the motor **120** via its pinion **119**. For example, the engine provides the angular increments directly via step control and these are thus determined and known by the motor control. The signal processing, the motor control, the power supply and interface to the vehicle or aircraft takes place in the electronics **117**. The system is protected against environmental influences by the transparent housing **121**. The remaining components are protected by the housing **122**. The system is attached to the device with the flange **123**. The lens systems **107** and **103** are fastened in a separate frame **110** and **111** and can be moved in axial direction with said frame via a hoist motor **124**. Thus, several angle ranges can be scanned or the elevation angle can be adjusted statically or dynamically to the planned flight or driving maneuver.

[0011] The environment is scanned according to [Fig. 2](#). Three scanning systems according to [Fig. 1](#) are accommodated in the sensor system **121**, each of which comprises the azimuth, for example to offset the scanning process by 120°, so that the areas **205**, **206** and **207** are scanned one after the other with one revolution. Each area is illuminated via the individual lasers **202**, which are combined in the laser line **201**. The information is assigned to the individual angular ranges by sequential control of the individual laser diodes or at least by sequential control of individual laser diode groups. The three recorded scanning ranges **205**, **206** and **207** as well as **208**, **209** and **210**, which are rotated

by 120°, can be scanned in parallel. After one revolution, the hoist motor **124** is actuated according to [Fig. 1](#) and the lens groups are moved so that the elevation ranges **208**, **209** and **210** are then scanned. This is only shown as an example. Multiple positions can be approached by the hoist motor **124**.

[0012] The respective elevation ranges **205** to **210** are divided on the transmitter side, e. g. according to **201** into 16 transmission beam regions **202** generated by the individual laser diodes. The receiver regions **203** contain receiver surfaces **204** in which the transmission beam regions **202** are depicted slightly smaller. This compensates for adjustment tolerances and runtime differences during scanning and the rotary movement. The individual distance ranges **202** are displayed sequentially or partially in parallel during the revolution.

[0013] The passive receiver part **108/109** consists, e. g. of a CMOS sensor with a high number of pixels for the visible area of the light. This is either mapped analogous to the receiver **104** as a line **204** with 10 to 3000 pixels or as a surface **211** with 100 to 10 million pixels that is adjusted in such a way that the transmitter images **202** are arranged approximately in the center. Instead of the visible range of the light, the infrared range can also be used, e. g. 8-12 µm to evaluate the thermal radiation of the obstacles.

[0014] In order to design the entire system as small and as easy as possible, the three scanning systems are nested in one another according to [Fig. 3](#). The transmitter unit thus consists of the optics **103a**, **103b** and **103c**, each of which is rotated by 120° and respectively map the laser groups **101a/102a**, **101b/102b**, and **101c/102c** onto the environment. Analogously, the mapping of the environment to the receivers is designed according to [Fig. 4](#). Here, the optics **107a**, **107b** and **107c** map the environment and the areas illuminated by the lasers respectively to the receiver groups **104a/105a**, **104b/105b**, and **104c/105c**. The beam paths are nested in one another according to [Fig. 4](#). In order not to impair the fast signal processing required for the runtime measurement by transmission paths, the entire distance is evaluated in the rotating sensor head.

[0015] The block diagram of the system according to the invention is shown in [Fig. 5](#). In addition to the components described in [Fig. 1](#) to [Fig. 4](#), the rotating part **501** also contains the video processing **502**, which controls the timing as a function of the laser scanning and is derived from the black-white or color contrast of relevant object outlines or light sources of the objects. The signal is acquired and the signal is processed for the distance measurement and for the pre-tracking, which already sorts the signals and assigns them to the

angular ranges and compares them with the video signal, that is likewise contained in the rotating part **501**. The hoist motor control is also located in the rotating part **501**. In addition to the components described in [Fig. 1](#), the overall control with the overall tracking and the data preparation **511** as well as the power supply and the interface to the overall system **512** are also located in the standing part **510**.

[0016] In the simplest case, the position of obstacles is evaluated by the obtained distance information, which is defined by the position of the scanning surfaces, the allocation to the respective system and by the angle of rotation and the elevation angle of the hoist motor. Due to the multiple scanning of obstacles with small surfaces made possible by the invention, the detection probability of obstacles such as wires and obstacles is very high. With the help of the respective camera system, which simultaneously scans the environment, both black-white and color contrasts of the obstacles can be determined and evaluated. Also active light sources such as position lights of aircraft and their strobes, as well as warning lights, e. g. of antennas can be evaluated. The correlation of this data with the distance measurement results in a very safe detection of obstacles.

[0017] A further developed embodiment of the sensor system is shown in [Fig. 6](#).

[0018] Since different obstacles have good backscattering at different wavelengths and the environment has different attenuation values for different wavelengths, two transmitters **602** and **604** with their optics **601** and **603** are mapped to the environment according to [Fig. 2](#) in the further development of the invention. The transmitters have, for example, a wavelength of 905 nm for the transmitter **602** and e. g. 10 µm for transmitter **604**. The receiver unit uses the optic **107**, which is suitable for both wavelengths. The beam splitter **605** allows e. g. for transmittance of 905 nm wavelength and also for a selective filter for this wavelength. The backscattered energy is thus conducted from the transmitter with a wavelength of 905 nm to the detector **606**. The beam splitter can be designed in such a way that only energy with, e. g. a wavelength of 10 µm reaches the detector **607**.

[0019] Of course, the transmitters **602** and **604** and the receivers **606** and **607** and the beam splitters **605** can also be designed for other electromagnetic wavelengths.

[0020] With the arrangement according to [Fig. 6](#), however, it is also possible to design the density of the scanning points differently in different wavelengths that have otherwise approximately identical properties in order to increase the probability of detection or to take into account the optical resolution or the costs in the range of the longer wavelengths.

Claims

1. Sensor for detecting obstacles for vehicles on the ground and aircraft having at least one multichannel distance measuring device operating according to the transit time method, which is accommodated in a rotating sensor head (**1a**) and comprises a plurality of components (**101**, **103**, **104**, **107**), wherein the components are being displaceable in axial direction such that different elevation angle ranges are scanned.

2. Sensor for detecting obstacles for vehicles on the ground and aircraft with at least two multichannel distance measuring devices operating according to the transit time method, which are accommodated in a rotating sensor head (**1a**) and scan the azimuth offset in such a way that different elevation angle ranges (**205**, **206**, **207** or **208**, **209**, **210**) are scanned one after the other with one revolution.

3. Sensor according to any one of the preceding claims, in which the beam paths of the multichannel distance measuring devices are nested in one another for weight and space savings.

4. Sensor according to any of the preceding claims, in which all evaluations that require fast signal processing are accommodated in the rotating sensor head (**1a**) and only the preprocessed information is transmitted from the rotating sensor head (**1a**) to the stationary part.

5. Sensor according to any one of the preceding claims, in which the distance is measured in parallel in at least two wavelength ranges.

6. Sensor according to claim 5, in which the imaging optics are used simultaneously for at least two wavelength ranges.

7. Sensor according to any one of the preceding claims with an image sensor (**108**) that is arranged in the rotating sensor head (**1a**) and serves to record passive, planar images from which color contrasts and active light sources are determined and evaluated.

8. Sensor according to any one of the preceding claims with a transparent housing (**121**) that serves as a cylinder lens in the beam path of the individual optics (**103**, **107**).

9. Sensor according to any one of the preceding claims, in which the transmission beam regions (**202**) of the multichannel distance measuring devices are depicted slightly smaller than their reception ranges (**203**), so that transit time differences and adjustment tolerances are compensated.

There are 6 pages of drawings

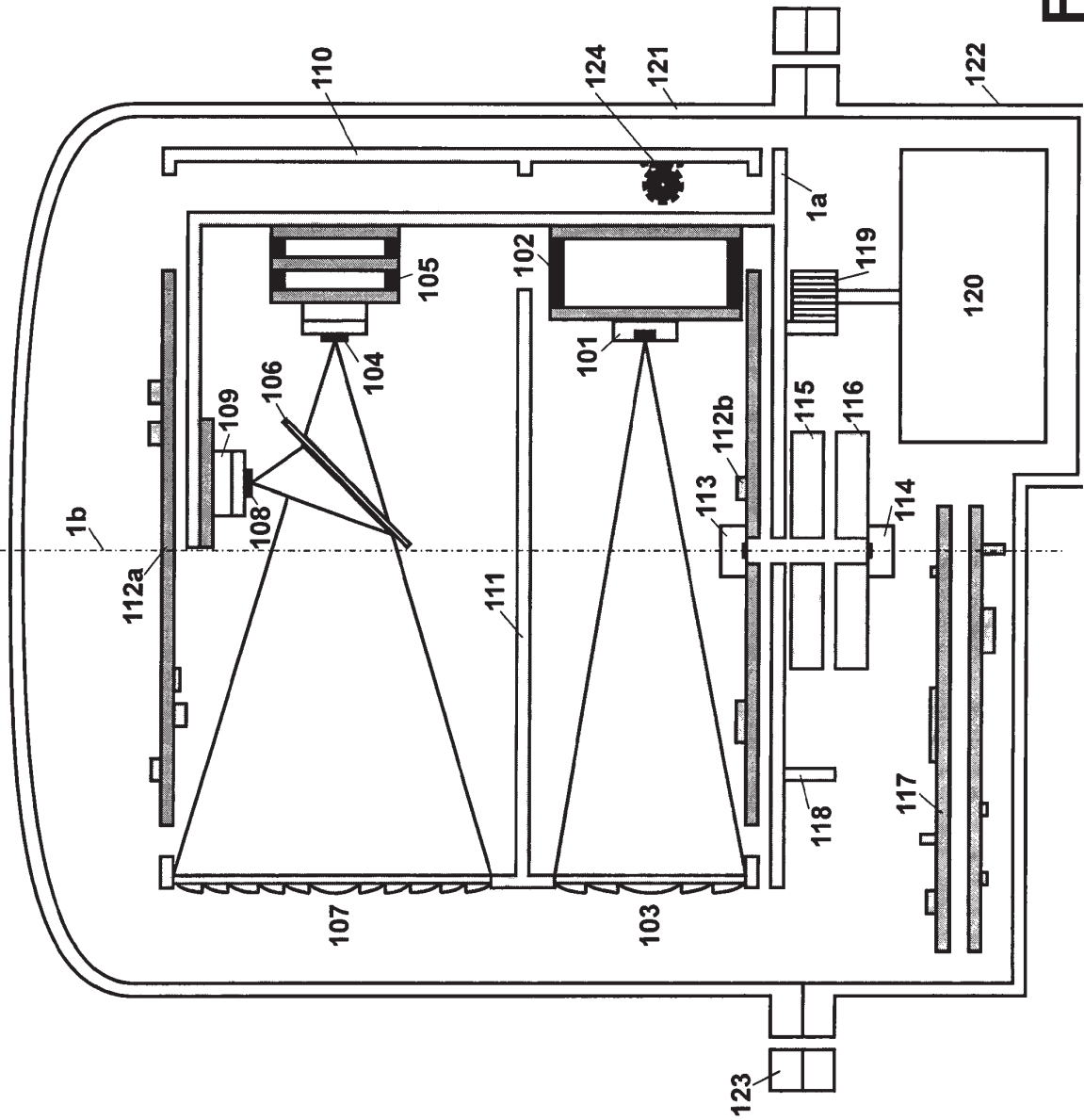


Figure 1

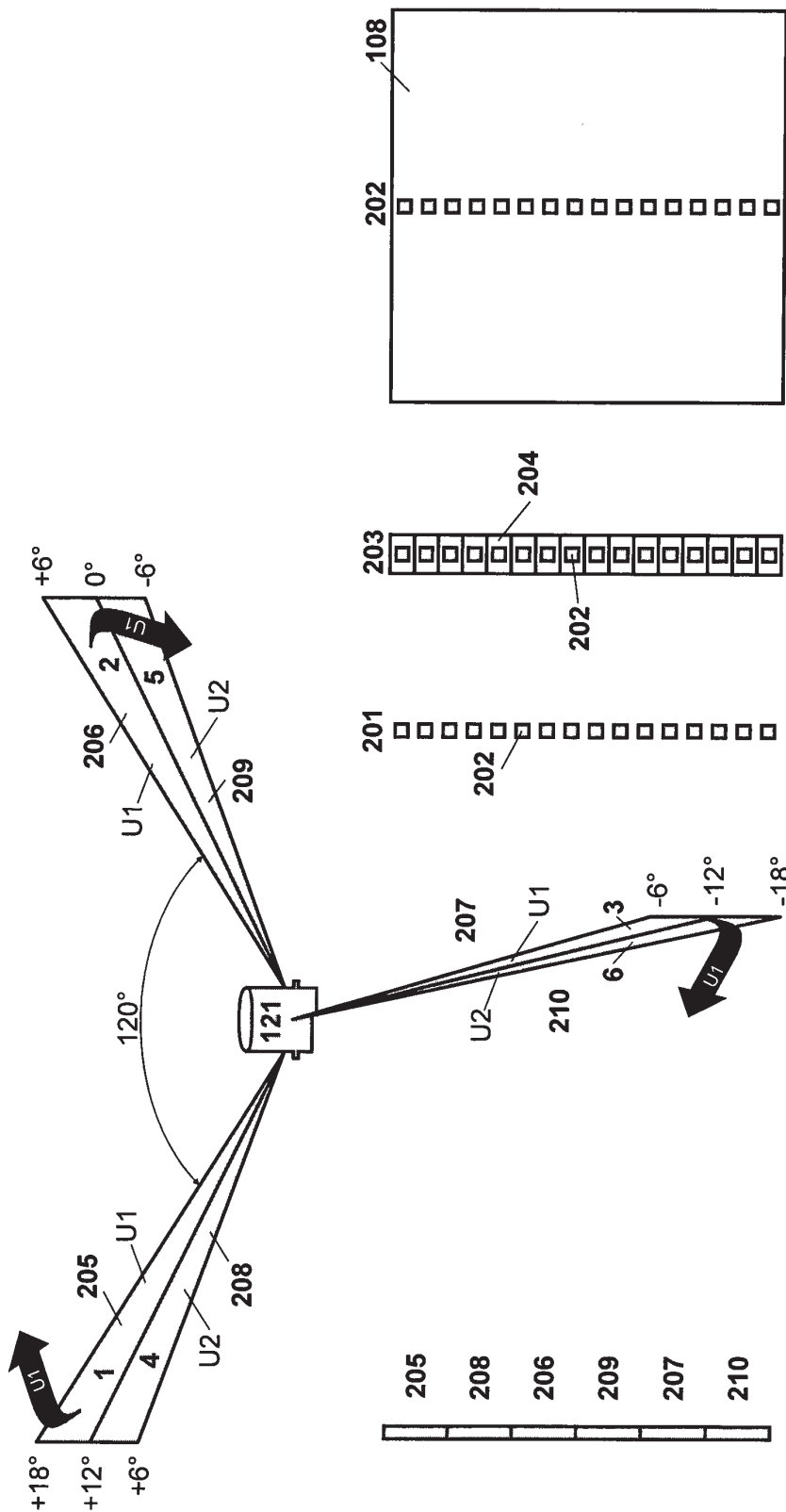


Figure 2

48-channel transmitter unit

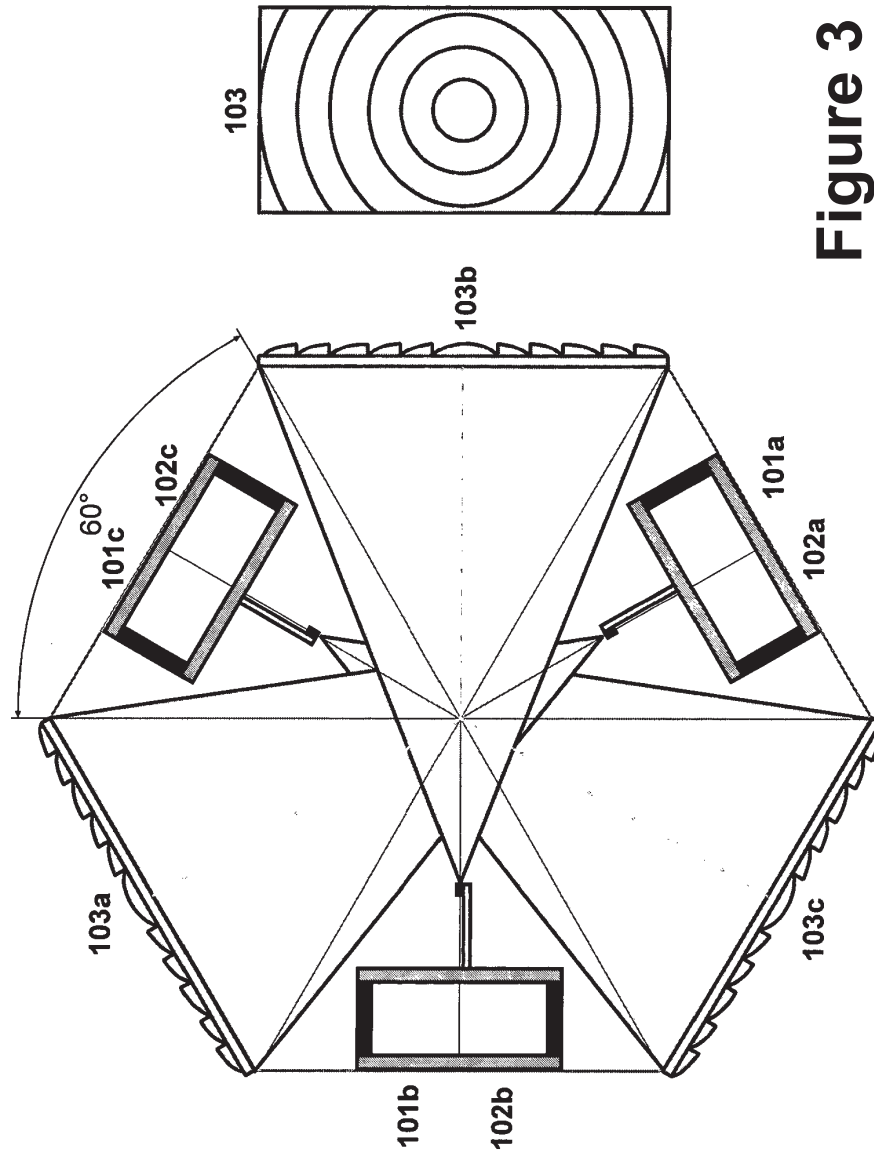


Figure 3

48-channel receiver unit

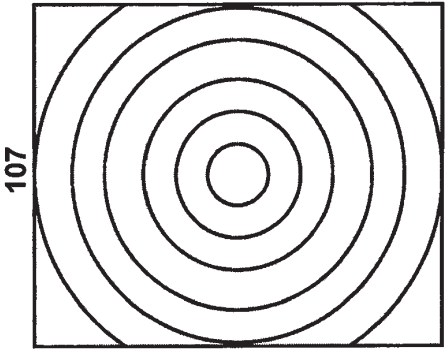
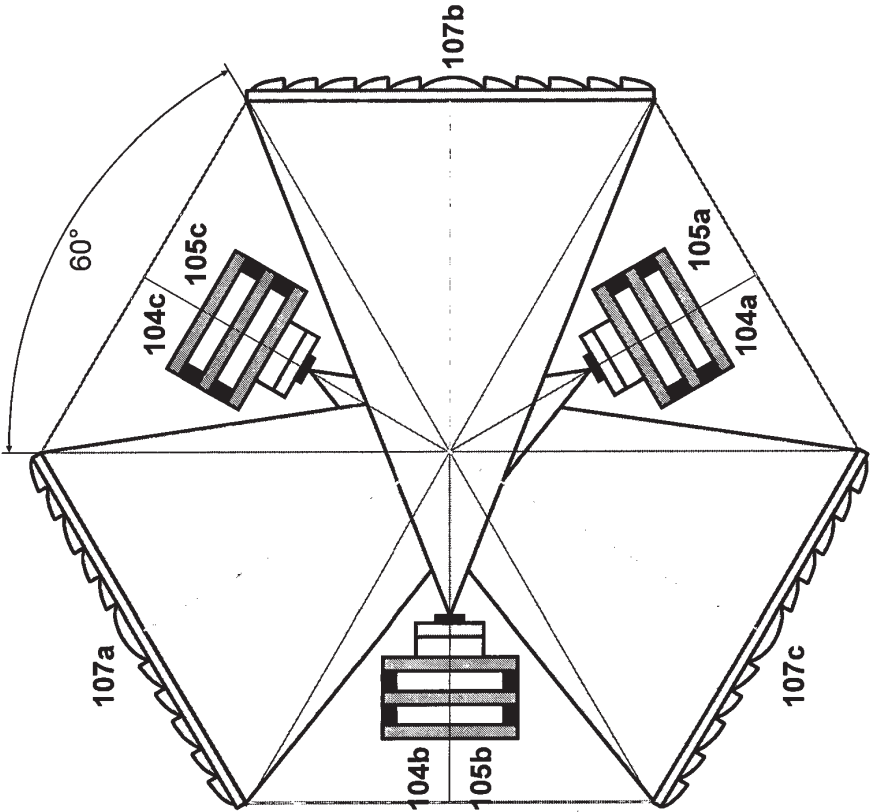


Figure 4

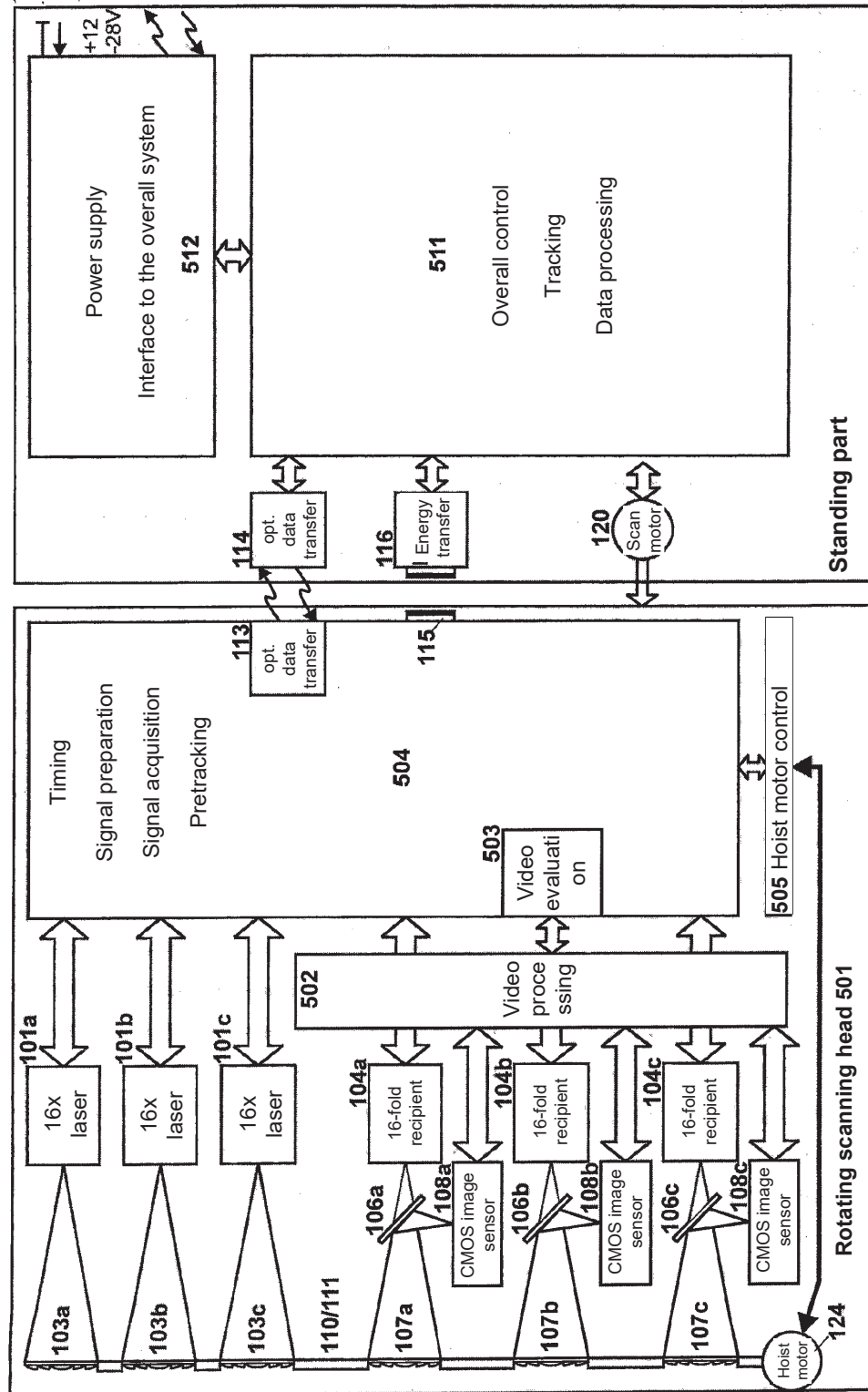


Figure 5

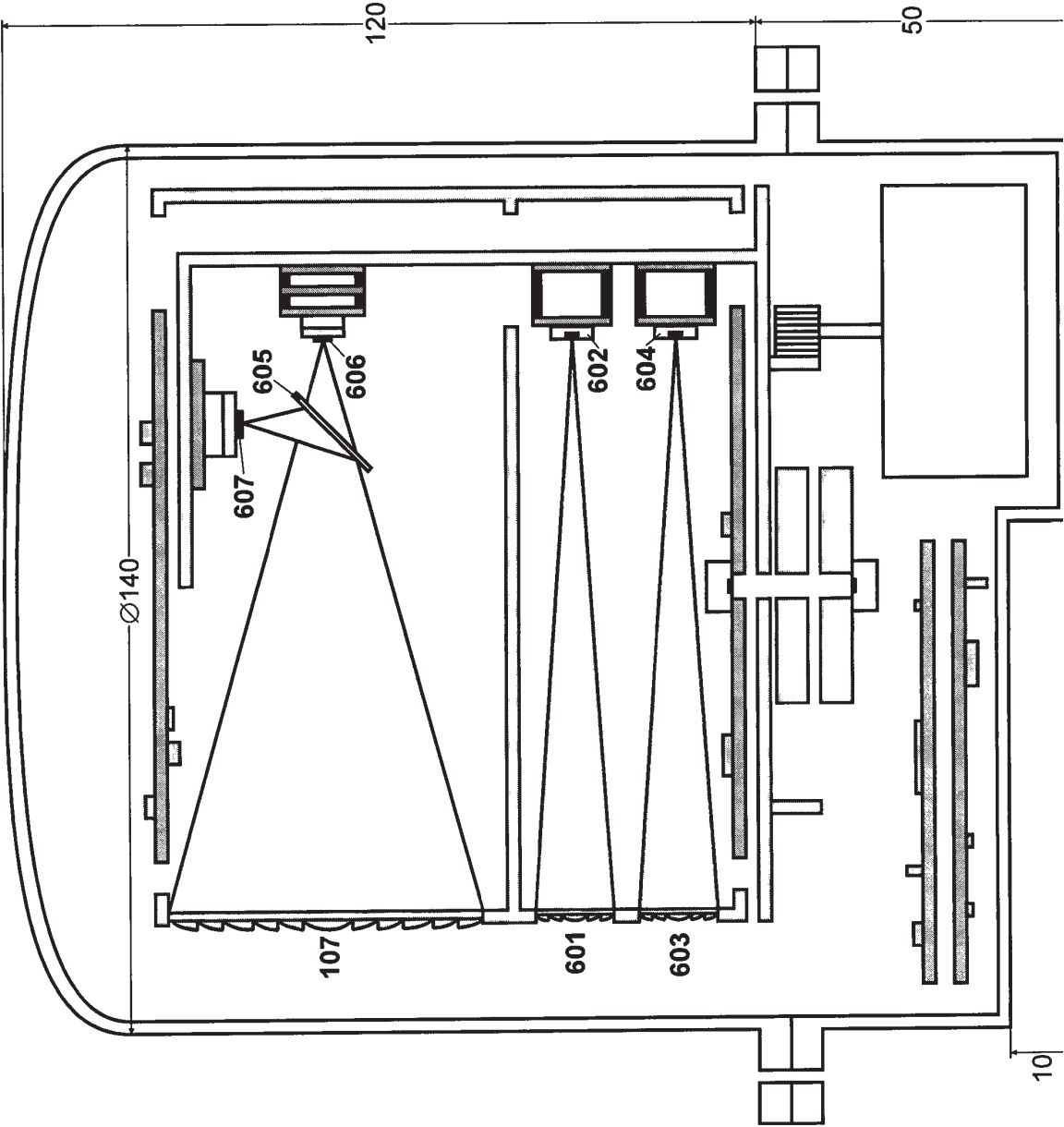


Figure 6