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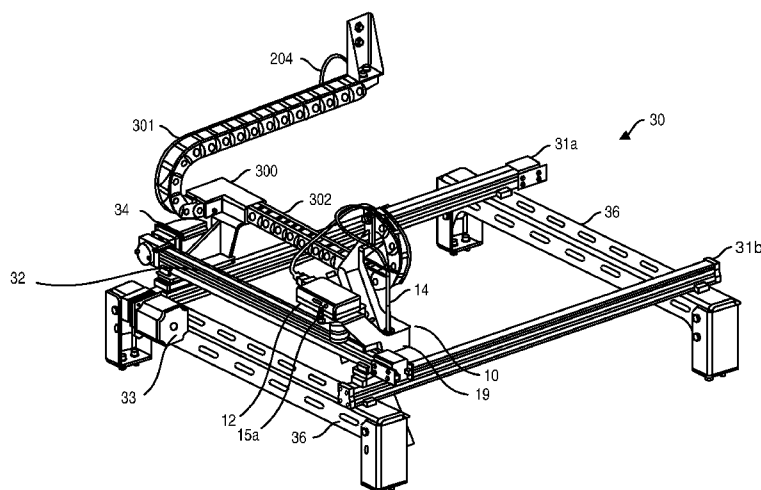


FIG. 10

(57) Abstract: A portable apparatus (1) for performing spectral analysis on material samples, for example mineral samples, comprising: a housing (100); a mobile analytical system (10) located within the housing (100), the mobile analytical system (10) comprising a camera (12), a spectrometer telescope (14), and at least one light source (15a, 15b); a sample tray (50) located within the housing (100); wherein during operation the mobile analytical system (10) is moveable on an x-y axis in a path over one or more of the mineral samples and wherein during operation the sample tray (50) is stationary. Also provided is a method for performing spectral analysis on material samples, for example mineral samples, in a portable apparatus (1).



PORTABLE APPARATUS AND METHOD FOR PERFORMING SPECTRAL SCANNING, IMAGING AND SAMPLE ANALYSIS

FIELD OF THE INVENTION

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The present invention relates to a system for scanning, imaging and analyzing material samples, such as mineral samples, and more particularly to portable systems for scanning, imaging and analyzing materials such as mineral samples on-site using spectral imaging, e.g. hyperspectral imaging.

10

BACKGROUND OF THE INVENTION

All materials (including e.g. minerals) reflect light in characteristic patterns. The manner in which light of different wavelengths is reflected or absorbed from each material is known as its reflectance spectrum (or spectra). By acquiring or collecting reflected light spectrum images can be created in order to differentiate and identify certain materials. Hyperspectral imaging generally refers to obtaining reflectance spectra for the region being imaged over a large number of discrete, contiguous spectral bands.

Historically, spectral imaging has been used in the mining and minerals industries (as well as in other industries such as e.g. the pharmaceutical and food industries) in order to e.g. identify possible exploration targets, environmental areas of concern and areas for potential mineral production and extraction. Existing spectral analysis systems have facilitated the collection of spectral data and continuous high-resolution color imagery of drill core, drill chips and drill powders from mineral samples.

Very large, non-portable, spectral analysis systems are currently utilized commercially. Such systems are typically set up in large rooms, where each of the elements of the systems is generally unprotected from dust, heat, vibration and ambient light. The presence of such elements can decrease the quality of the sample reading and also impact operator safety in that operators may be exposed to noise, dust or heat. Additionally, elements of the large spectral analysis systems, such as e.g. the lighting rigs or light source are typically

uncovered and very difficult to keep in place, and therefore may frequently require re-calibration which can take upwards of two hours per calibration and require special maintenance personnel.

5 The large spectral analysis systems are also heavy, e.g. several hundred kilograms, expensive and non-portable. Because of the non-portability of such systems, customer costs are further increased in that multiple units will be needed, one per site. Additionally, because of the non-portability of such systems, logistically it is very difficult and time consuming to use such systems. For example, at large mine sites, material samples may have to be transported
10 long distances to the room which contains large spectral analysis systems. Moreover, long transportation and handling of such samples can negatively affect the quality of such samples.

One of the reasons that large spectral analysis systems are so bulky, and have substantial footprint (typically 10 feet by 6 feet or more), is due to the fact
15 that such systems were designed in that the sample tray moves on a table under a stationary analytical system and lighting rig.

An alternative to using large spectral analysis systems is handheld spectral imaging devices. These devices are inefficient and expensive to operate in that they require substantial man hours. For example, one person using a
20 hand-held instrument can take up to 10 hours to manually process mineralogy of 400 meters of drill chips or material samples.

OBJECT OF THE INVENTION

25 It is an object of the invention to overcome or at least alleviate one or more of the above problems and/or provide the consumer with a useful commercially available choice.

SUMMARY OF THE INVENTION

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A portable apparatus for performing spectral analysis on material samples is provided. The portable apparatus may comprise a housing; a mobile analytical system located within the housing, the mobile analytical system comprising a

camera for collecting images of the material samples, a spectrometer telescope for collecting light reflected off of the material sample and for transmitting the light to a spectrometer for transforming the light into spectra, and at least one light source for providing illumination for the camera or the spectrometer telescope; a
5 sample tray located within the housing, the sample tray for holding material samples to be analyzed by the mobile analytical system; wherein during operation the mobile analytical system is moveable on an x-y axis in a path over one or more of the material samples and wherein during operation the sample tray is stationary.

10 In an exemplary embodiment of the portable apparatus, the portable apparatus may further comprise a sample drawer for introducing the sample tray into the housing, i.e. into the interior of the portable apparatus. In an exemplary embodiment the sample tray may further comprise one or more sample cartridges. In an exemplary embodiment, the one or more sample cartridges
15 may further comprise buckets for holding material samples.

In an exemplary embodiment of the portable apparatus comprising a sample drawer, the sample drawer may comprise a sample drawer locking device for locking the sample drawer containing the sample tray in the housing during operation of the portable apparatus. In an exemplary embodiment, the
20 sample drawer locking device may comprises a solenoid, a bracket, a latch, a draw detection switch, a magnet or a magnet adjustment bolt.

In an exemplary embodiment of the portable apparatus, the portable apparatus may further comprise a processing means for compiling and analyzing the collected images and spectra and for providing spectral or hyperspectral
25 analysis profiles of the material samples. In an exemplary embodiment, the spectrometer may be located outside of the housing. The spectrometer may be connected to the spectrometer telescope via a fiber optic cable.

In an exemplary embodiment of the portable apparatus, the portable apparatus may further comprise a calibration device for calibrating the position of
30 the mobile analytical system within the housing.

In an exemplary embodiment of the portable apparatus, the portable apparatus may comprise at least two light sources, a first light source for the camera and a second light source for the spectrometer telescope.

A method for performing spectral analysis on material samples in a portable apparatus is also provided. The method comprises: introducing material samples into the portable apparatus; moving a mobile analytical system having a camera, a spectrometer telescope and at least one light source on an x-y axis in a path above stationary material samples; collecting data from the stationary material samples; and manipulating the data in order to provide spectral or hyperspectral analysis of the material samples.

The method for performing spectral analysis on material samples in a portable apparatus may also comprise: introducing material samples into the portable apparatus; moving a mobile analytical system having a camera, a spectrometer telescope and at least one light source on an x-y axis in a path above stationary material samples; collecting images from the camera; collecting light reflected from the material samples from the spectrometer telescope; transmitting the light to a spectrometer; converting the light to spectral data; transmitting the images and the spectral data to a processing device; manipulating the images and the spectral data in order to provide spectral or hyperspectral analysis of the material samples.

In an exemplary embodiment of the method, the manipulating step may further comprise stitching or matching the collected images from a first material sample to the collected spectral data from the first material sample.

Other details, objects, and advantages of the invention will become apparent as the following description of certain present exemplary embodiments thereof and certain present exemplary methods of practicing the same proceeds.

BRIEF DESCRIPTION OF THE FIGURES

Embodiments of the invention, by way of example only, will be described with reference to the accompanying drawings in which:

Figure 1 shows an overview of an exemplary embodiment of the portable apparatus.

Figure 2 shows a front view of an exemplary embodiment of the portable apparatus.

Figure 3 shows a side view of an exemplary embodiment of the portable apparatus.

5 Figure 4 shows a side view of an exemplary embodiment of the portable apparatus with the spectrometer and support bracket attached.

Figure 5 shows a partial top overview of an exemplary embodiment of the portable apparatus with the viewing window and the mobile analytical system.

10 Figure 6 shows an exemplary embodiment of the sample tray and the sample cartridges containing buckets.

Figure 7 shows an exemplary embodiment of the sample drawer with the sample tray and sample cartridges containing buckets.

Figure 8 shows a front view of an exemplary embodiment of the sample drawer locking device.

15 Figure 9 shows a rear view of an exemplary embodiment of the sample drawer locking device.

Figure 10 shows an exemplary embodiment of the mobile analytical system and the linear slide system.

20 Figure 11 shows a sectional isometric view of the mobile analytical system and the linear slide system.

Figure 12 shows an exemplary embodiment of the spectrometer and the support bracket.

Figure 13 shows an overview of an exemplary embodiment of the calibration device.

25 Figure 14 shows a basic plan view of an exemplary embodiment of the cable layout for the portable apparatus and computer processing device.

Figure 15 is a picture of an exemplary embodiment of the mobile analytical system.

30 DETAILED DESCRIPTION OF THE INVENTION

Figures 1-2 and 5 depict an exemplary embodiment of a portable apparatus 1 for performing spectral analysis (e.g. scanning and imaging) of

material samples (e.g. mineral samples). In an exemplary embodiment, the portable apparatus 1 includes a housing 100. The housing 100 encloses the inner portions of the portable apparatus 1 in order to minimize the ingress of for example, dust, heat, vibration and ambient light into the portable apparatus 1.

5 The housing 100 may be comprised of a viewing window 101, side panels 102a / 102b, a front panel 108, feet 103 for supporting the portable apparatus 1, and a top cover 104. The viewing window 101 allows the operator to monitor the analysis process. In some embodiments, the viewing window 101 may be tinted in order to further reduce the ingress of ambient light into the portable apparatus
10 1. The top cover 104 may be locked during operation by way of e.g. a locking device 105. In an exemplary embodiment, the housing 100 includes a sample introduction means, e.g. a sample drawer 106 which may be disposed in e.g. the front panel 108 of the housing 100. In one embodiment, the portable apparatus 1 is approximately 1050 mm in width and 570 mm in height. The housing may
15 optionally include lifting handles (not shown) to assist in lifting the portable apparatus 1.

Figures 3-4 depict side views of an exemplary embodiment of the portable apparatus 1. It is envisioned that side panels 102a / 102b and the back panel may be removed for maintenance / cleaning / adjustments and access to the
20 electrical compartments. In particular, in some embodiments, removal of the side panel 102b provides access to the electrical component compartment. Alternatively, in some embodiments, the electrical components are housed in the side panel 102b. As further shown in Figure 4, a spectrometer 200 may be attached to the outside of the housing 100, e.g. via a support bracket 202 (e.g. to
25 the back side of the portable apparatus 1). While the spectrometer 200 is pictured outside of the housing 100, it is also envisaged that the spectrometer 200 could be inside of the housing 100. In one embodiment, the portable apparatus 1 is approximately 645 mm in depth without the support bracket 202 / spectrometer 200 and approximately 775 mm in depth with the support bracket
30 202 / spectrometer 200.

Figure 5 depicts a close-up view of the top cover 104 of the housing 100. The top cover 104 may be opened and closed manually; the top cover 104 may be supported by an internal gas strut on e.g. the left hand side of the portable

apparatus 1. During operation of the portable apparatus 1, the top cover 104 may be locked into place with e.g. a flat head screwdriver or a coin; both locks may be applied. A locking device 105 may be integrated into the top cover 104 to ensure that the top cover 104 is closed during operation. As shown in Figure 5, a mobile analytical system 10 is located within the housing 100.

Figure 7 depicts an exemplary embodiment of the sample drawer 106 for introducing mineral samples into the housing 100 of the portable apparatus 1. The sample drawer 106 is provided to accommodate a sample tray 50 (as further shown in Figure 6) with sample cartridges 51. In some embodiments, and as shown in Figures 6 and 7, the sample trays 50 may contain grooves or cutouts 56 for accepting the sample cartridges 51. The sample trays 50 may also contain sample tray handles 54 for lifting the sample tray 50 out of the sample drawer 106. In some embodiments, the sample tray 50 may include rubber feet to prevent the sample tray 50 from falling from a desk or other structure and to protect the surface the sample tray 50 is resting on. In some embodiments, the sample cartridges 51 contain buckets 58 for placing and separating mineral samples to be analyzed. In an exemplary embodiment the sample tray 50 may contain three grooves or cutouts 56 for accepting three sample cartridges 51, the sample cartridges 51 each containing twenty buckets 58. In operation, it is envisaged that after opening the sample drawer 106, the sample tray 50 may be manually removed from the sample drawer 106. The buckets 58 of the sample cartridges 51 may be loaded with material (mineral) samples to be analyzed and the sample cartridges 51 may be slid into e.g. the right hand side of the sample tray 50. The sample tray 50 may be placed in the sample drawer 106 while ensuring that the upstanding flange of the sample drawer on the right falls into the slot of the sample tray 50; this enables a correct position of the mineral samples and prevents the sample tray 50 from sliding sideways. The sample drawer 106 may then be closed in order to position the mineral samples within the sample tray 50 inside the housing 100. During operation the sample tray 50 remains stationary within the housing 100. Keeping the sample tray 50 stationary during operation, is especially advantageous in that the footprint, size and cost of the portable apparatus 1 is able to be significantly reduced by instead moving the mobile analytical system 10 rather than the sample tray 50.

In some embodiments, the sample drawer 106 may be supported by two or more heavy duty roller slides (not shown) on each of the lateral sides of the sample drawer 106. The heavy duty roller slides may be maintained by opening the sample drawer 106 fully and by applying bearing grease from underneath. Old grease and dirt may be removed and new bearing grease may be applied in a small amount twice (2x) a year.

Figures 8 and 9 depict a sample drawer locking device 70 for locking the sample drawer 106 in the open position during the loading phase and for locking the sample drawer 106 in the closed position during operation. In an exemplary embodiment, the sample drawer locking device 70 is comprised of a solenoid 76 (e.g. a 24V solenoid), a bracket 71, a latch 72, a draw detection switch 73, and a magnet adjustment bolt 74 / magnet 77. In some embodiments, the sample drawer locking device 70 may be mechanically opened by a spring device 75 located at the back of the sample drawer locking device 70; the solenoid 76 may pull the latch 72 and will lock the sample drawer 106 into position. The draw detection switch 73 may be mounted closer / further from the sample drawer 106 to adjust the locking moment. A magnet 77 (e.g. a button-type magnet) may keep the sample drawer in place and the holding strength can be adjusted by adjusting the distance to the sample draw using the magnet adjustment bolt 74.

Figure 10 and Figure 11 show isometric views of a linear slide system 30 located within the housing 100. The linear slide system 30 is designed to move the mobile analytical system 10 in a path (which can be predetermined) in the x-y direction. The x-direction is defined herein as the long travel direction and the y-direction is defined herein as the shorter travel direction. X-direction slide rails 31 comprise a driven x-direction slide rail 31a and a supporting idler slide rail 31b. The rails 31a, 31b may be substantially parallel to one another and may be located at the front end and back end of the housing 100. The driven x-direction slide rail 30a may have an attached x-direction motor 33 for moving the mobile analytical system 10 on the x-direction slide rails in the x-direction. In one embodiment, and as shown in Figure 10, there may be a single y-direction slide rail 32. The y-direction slide rail 32 may have an attached y-direction motor 34 for moving the mobile analytical system 10 on the y-direction slide rail 32 in the y-direction. In an exemplary embodiment, the x-direction slide rails 31 may be

attached to slide supports 36 which are mounted inside the housing 100 of the portable apparatus 1. The x-direction slide rails 31 may be attached directly to the top side of the slide supports 36. The y-direction slide rail 32 may be attached to the top side of the x-direction slide rails 31.

5 As shown for example in Figure 11, the linear slide system 30 may also comprise an x-direction encasement member 301 for protecting powering cables and data transmission cables to or from the x-direction motor 33, camera 12 or spectrometer telescope 14 and a y direction encasement member 302 for protecting powering cables and data transmission cables to or from the y-
10 direction motor 34, camera 12 or spectrometer telescope 14. Cables, e.g. the fiber optic cable 204 and camera power cable 13 which may run through the x or y direction encasement members 300, 301 may be accessed by removing a chain junction cover 300.

Figures 10-11 and 15 also depict the mobile analytical system 10. In some
15 embodiments, the mobile analytical system 10 is comprised of a camera 12 (e.g. a digital camera with a 0.2 nm resolution), a spectrometer telescope 14 and at least one light source 15a, 15b. The camera 12 is capable of taking pictures and collecting images of a mineral sample while the camera 12 is located above or over a mineral sample (e.g. one mineral sample in a bucket 58 which remains
20 stationary). The spectrometer telescope 14 is capable of collecting light which is reflected off of a mineral sample (e.g. one mineral sample in a bucket 58 which remains stationary). The at least one light source 15a, 15b provides illumination for the camera 12 and the spectrometer telescope 14. In some embodiments, there are at least two light sources, a first light source 15a (e.g. a LED with or
25 without an easily adjustable LED enclosure) for the camera and a second light source 15b for the spectrometer telescope (e.g. a standard ASD illuminator). The spectrometer telescope 14 may transmit the collected light to a spectrometer 200 via e.g. a fiber optic cable 204 which may be attached to the spectrometer telescope 14 and the spectrometer 200. In some embodiments, the camera 12
30 and the spectrometer telescope 14 are attached to a carriage 19, the carriage 19 being disposed on the top side of the y-direction slide rail 32. In some embodiments, the mobile analytical system 10 may be located at a consistent distance of approximately 1 cm above the stationary mineral samples. The ability

to maintain a consistent distance between the mobile analytical system 10 and the stationary mineral samples is advantageous in that more accurate analysis results may be obtained.

Figure 12 depicts a spectrometer 200 (e.g. an ASD TerraSpec 4 Spectrometer, an ASD LabSpec 4, or any standard or high resolution spectrometer) mounted to the rear panel of the housing 100 via a support bracket 202. The spectrometer 200 may be placed in the support bracket 202 and the support bracket 202 can be lifted into e.g. slots on the back panel of the housing 100 and lowered until e.g. mounting holes line up. Wing bolts or the like may be used to attach the support bracket 202 to the housing 100. A fiber optic cable 204 may be attached to the spectrometer 202 to transmit light that is collected from the spectrometer telescope 14 to the spectrometer 202 so that the spectrometer 202 may transform the collected light into spectra for each of the mineral samples. A power supply for the spectrometer 202 can be connected to the underside of the spectrometer 202 adjacent to its power switch. A data cable (e.g. an Ethernet cable) can also be plugged in to the underside of the spectrometer 202 and the opposite end of the cable may be attached to a data socket on the back of the housing 100.

Figure 13 depicts a calibration device 40 for calibrating the position of the mobile analytical system 10 within the housing 100. The calibration device 40 ensures that the mobile analytical system 10 is properly positioned directly above the mineral sample for which the camera 12 is collecting images of the mineral sample and the spectrometer telescope 14 is collecting light reflected off of the mineral sample. In some embodiments the calibration device 40 is mounted on a support bracket which can be laterally adjusted by loosening the bolts in the base of the support bracket and sliding the support bracket to the required position. The height of the calibration device 40 may also be adjusted by loosening bolts closest to the calibration device 40 and sliding the support bracket up to the required height.

In some embodiments, as shown in e.g. Figure 14, the portable apparatus 1 is connected to a computer processing device (e.g. a laptop computer) with for example an RS232 cable and an Ethernet cable. The computer processing device may utilize software (e.g. CSIRO-created TSG software called The

Spectral Geologist) to e.g. control the mobile analytical system 10, compile and analyze the collected images and spectra and to provide spectral or hyperspectral analysis profiles of the mineral samples.

In operation the portable apparatus 1 may be removed from a transport case and placed on a solid surface, such as a rigid table or desk. The spectrometer 200 can be mounted or attached to the housing 100 of the portable apparatus 1, in some embodiments via a support bracket 202. The spectrometer 200 can be attached to the housing 100 of the portable apparatus 1 by plugging a first cable e.g. an Ethernet cable into the spectrometer 200 and into the back panel of the housing 100. The housing 100 and the portable apparatus 1 can be connected to a computer processing device, such as a laptop using a second cable, e.g. RS232 cable. The spectrometer 200 may be separately powered by a power supply, e.g. by plugging the spectrometer power supply into a power outlet. The portable apparatus 1 may also be powered by a power supply by e.g. connecting the portable apparatus power supply into a power outlet. The main power supply to the portable apparatus may be turned to the on position and if the sample drawer 106 and the top cover 104 are closed fans in the side panels 102a, 102b will turn on. A button e.g. a push button located on the front panel 108 will be illuminated to indicate that the sample drawer 106 may be opened to load sample cartridges 51 with mineral samples into the sample tray 50. The computer processing device can be powered on and software can be started on the computer processing device. The sample drawer 106 can then be opened, the sample tray 50 can be removed (e.g. by the sample tray handles 54) and sample cartridges 51 containing mineral samples can be loaded into the sample tray 50. The sample tray 50 can be placed back into the sample drawer 106 and then sample drawer 106 can be closed. The portable apparatus 1 is now ready to run a cycle. If the sample drawer 106 and top cover 104 are closed the following may occur:

The light source 15a, 15b will turn on and the sample drawer locking device 70 will be activated; the mobile analytical system 10 will move to a home position and then to the calibration device 40 for position calibration within the housing 100; the mobile analytical system 10 will move to a position over a first mineral sample (the mineral samples within the sample tray 50 will remain

stationary), the spectrometer telescope 14 will take a reading and the camera 12 will take a photo; the reading from the spectrometer telescope 14 will be sent to the spectrometer 200 ; the data from the spectrometer 200 and the photo from the camera 12 will be sent to the computer processing device. The mobile analytical system 10 may then move to a position over a second mineral sample and repeat the previous step. Such steps may repeat for all of the mineral samples. After the last mineral sample, the mobile analytical system 10 may move back to the home position and the light source 15a, 15b may turn off. The sample drawer locking device 70 may be turned off and allow the sample drawer 106 to open and the sample tray 50 / sample cartridges 51 to be removed.

There are numerous advantages of the portable apparatus 1 described and claimed herein. Such a portable apparatus 1 increases productivity. Testing has shown that such an apparatus 1 has the ability to accurately scan over 4000 samples in one 10-hour shift which is approximately 10 times faster than one person using a hand-held instrument to manually process scanning of mineral samples. Additionally, due to portability, preliminary data can be assessed by geologists and operators on site, with the faster results assisting further decisions on drilling and targets. One embodiment of the portable apparatus 1 has a total mass of approximately 66 kg making it very easy and safe to transport by road or air, including between several sites in the same day. Because of its small size and low weight such an apparatus is easy to unpack and initialize, enabling flexible use at several sites in short periods — even in the same day. The small footprint of the portable apparatus 1 is also very advantageous — primarily due to the innovation of the mobile analytical system 10 (e.g. on the linear slide system 30) and stationary sample tray 50. Because of the small footprint and compact structure manufacturing costs for the portable apparatus as compared to large spectral analysis systems may be reduced.

It is to be understood that the form of this invention as shown is merely a preferred embodiment. Various changes may be made in the function and arrangement of parts; equivalent means may be substituted for those illustrated and described; and certain features may be used independently from others without departing from the spirit and scope of the invention as defined in the following claims.

LIST OF COMPONENTS

	1	portable apparatus
	10	mobile analytical system
5	12	camera
	13	camera power cable
	14	spectrometer telescope
	15a	light source for camera
	15b	light source for spectrometer telescope
10	19	carriage
	30	linear slide system
	31	x-direction slide rails
	31a	driven x-slide rail
	31b	supporting idler x-slide rail
15	32	y-direction slide rail
	33	x-direction motor
	34	y-direction motor
	36	slide supports
	40	calibration device
20	50	sample tray
	51	sample cartridges
	54	sample tray handles
	56	sample tray accepting grooves
	58	buckets
25	70	sample drawer locking arrangement
	71	bracket
	72	latch
	73	draw detection switch
	74	magnet adjustment bolt
30	75	spring
	76	solenoid
	77	magnet
	100	housing

- 101 viewing window
- 102a first side panel
- 102b second side panel
- 103 feet
- 5 104 top cover
- 105 locking device
- 106 sample drawer
- 108 front panel
- 200 spectrometer
- 10 202 support bracket
- 204 fiber optic cable
- 300 chain junction cover
- 301 x-direction energy chain
- 302 y-direction energy chain

CLAIMS:

1. A portable apparatus (1) for performing spectral analysis on material samples, for example mineral samples, the portable apparatus comprising:

5 a housing (100);

a mobile analytical system (10) located within the housing (100), the mobile analytical system (10) comprising a camera (12) for collecting images of the material samples, a spectrometer telescope (14) for collecting light reflected off of the material samples and for transmitting the light to a spectrometer (200)
10 located apart from the mobile analytical system (10) for transforming the light into spectra, and at least one light source (15a, 15b) for providing illumination for the camera (12) and a spectrometer telescope (14);

a sample tray (50) located within the housing (100), the sample tray (50) for holding the material samples to be analyzed by the mobile analytical system
15 (10);

wherein during operation of the portable apparatus (1), the mobile analytical system (10) is moveable on an x-y axis in a path over one or more of the material samples and wherein during operation the sample tray (50) is stationary.

20

2. The portable apparatus (1) of claim 1, further comprising a sample drawer (106) for introducing the sample tray (50) into the housing (100).

3. The portable apparatus of claim 1, wherein the sample tray (50) further
25 comprises sample tray accepting grooves (56) for holding one or more sample cartridges (51).

4. The portable apparatus (1) of claim 3, wherein the one or more sample cartridges (51) further comprise buckets (58) for holding the material samples.

30

5. The portable apparatus (1) of claim 2, wherein the sample drawer (106) comprises a sample drawer locking device (70) for locking the sample drawer

(106) containing the sample tray (50) inside the housing (100) during operation of the portable apparatus (1).

6. The portable apparatus (1) of claim 5, wherein the sample drawer locking device (70) comprises a solenoid (76), a bracket (71), a latch (72), a draw detection switch (73), a magnet (74).

7. The portable apparatus (1) of claim 1, further comprising a computer processing means for compiling and analyzing the collected images and spectra and for providing spectral or hyperspectral analysis profiles of the material samples.

8. The portable apparatus of claim 1, further comprising a calibration device (40) located within the housing (100) for calibrating the position of the mobile analytical system (10) within the housing (100).

9. The portable apparatus (1) of claim 1, wherein the spectrometer (200) is located outside of the housing (100) and wherein the spectrometer (200) is connected to the spectrometer telescope (14) via a fiber optic cable (204).

10. The portable apparatus (1) of claim 1, wherein there are at least two light sources (15a, 15b), a first light source (15a) for the camera (12) and a second light source (15b) for the spectrometer telescope (14).

11. A method for performing spectral analysis on material samples, for example mineral samples, in a portable apparatus (1) comprising:

introducing material samples into the interior of the portable apparatus (1);
moving a mobile analytical system (10) comprising a camera (12), a spectrometer telescope (14) and at least one light source (15a, 15b) on an x-y axis in a path above the material samples while the material samples remain stationary; and

collecting spectral data from the stationary material samples.

12. A method for performing spectral analysis on material samples, for example mineral samples, in a portable apparatus (1) comprising:

introducing material samples into the interior of the portable apparatus (1);

5 moving a mobile analytical system (10) comprising a camera (12), a spectrometer telescope (14) and at least one light source (15a, 15b) on an x-y axis in a path above the material samples while the material samples remain stationary;

collecting images from the camera (12);

10 collecting light reflected from the material samples from the spectrometer telescope (14);

transmitting the collected light to a spectrometer (200);

converting the light to spectral data;

transmitting the images and the spectral data to a computer processing device; and

15 manipulating the images and the spectral data in order to provide spectral or hyperspectral analysis of the material samples.

13. The method of claim 12, wherein the manipulating step further comprises stitching or synchronizing the images from a first material sample to the spectral
20 data from the first material sample.

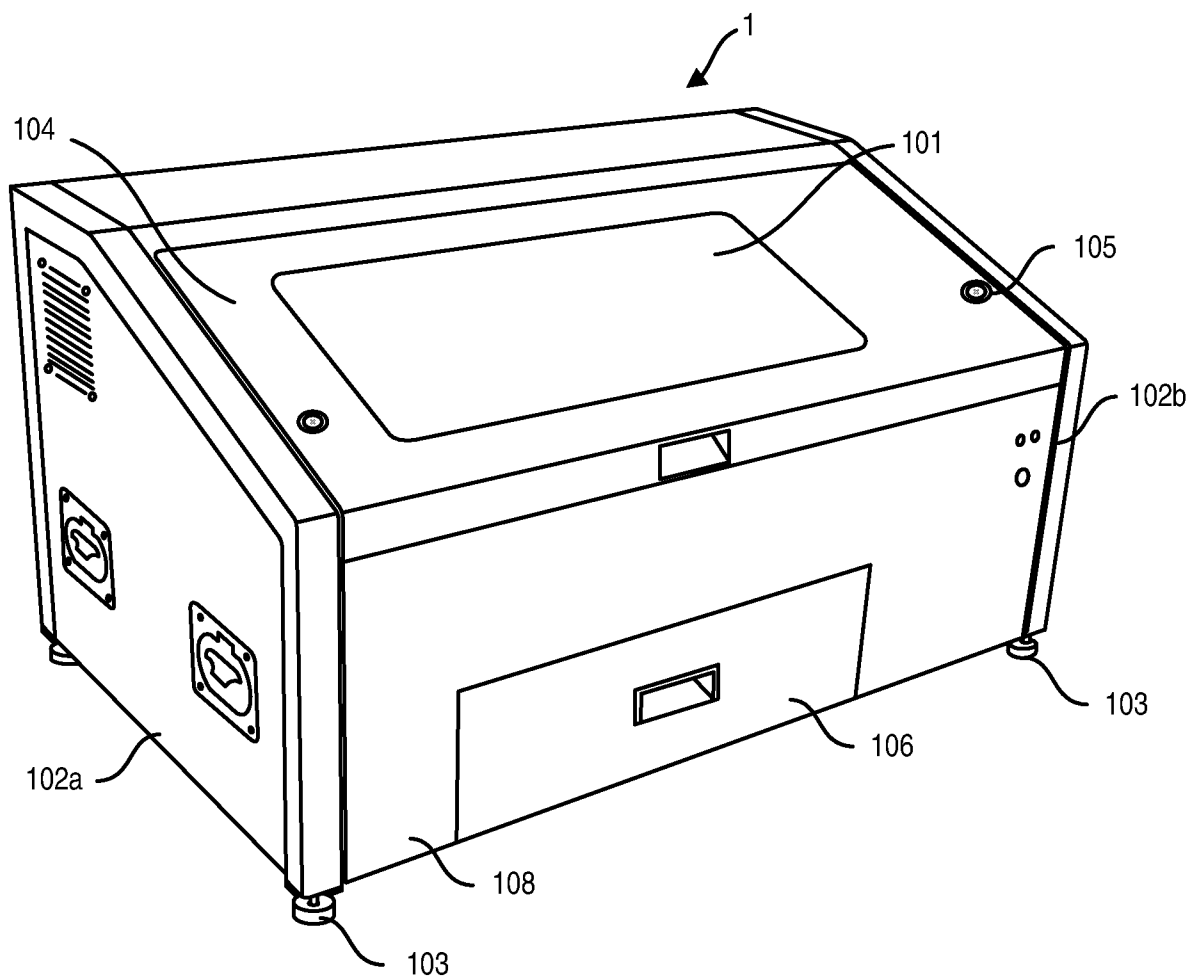


FIG. 1

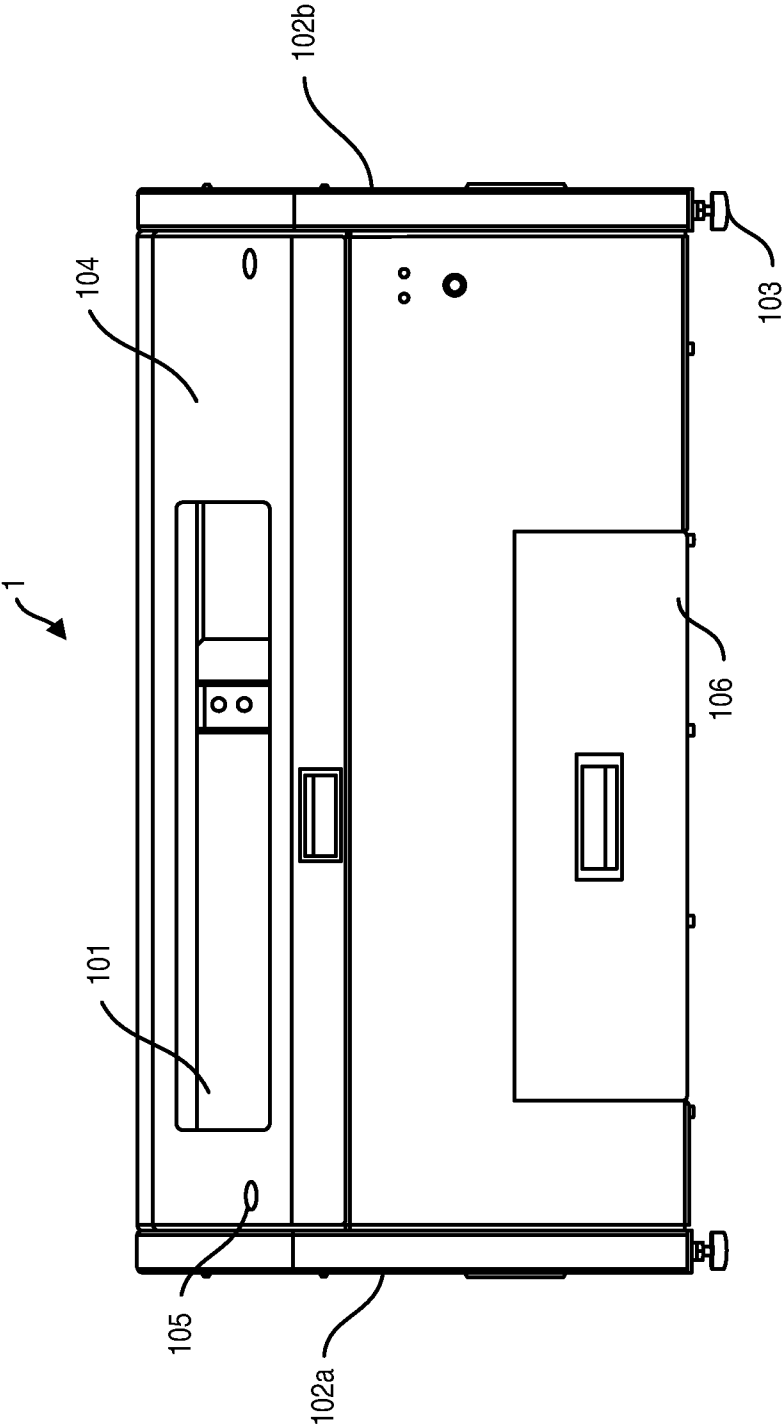


FIG. 2

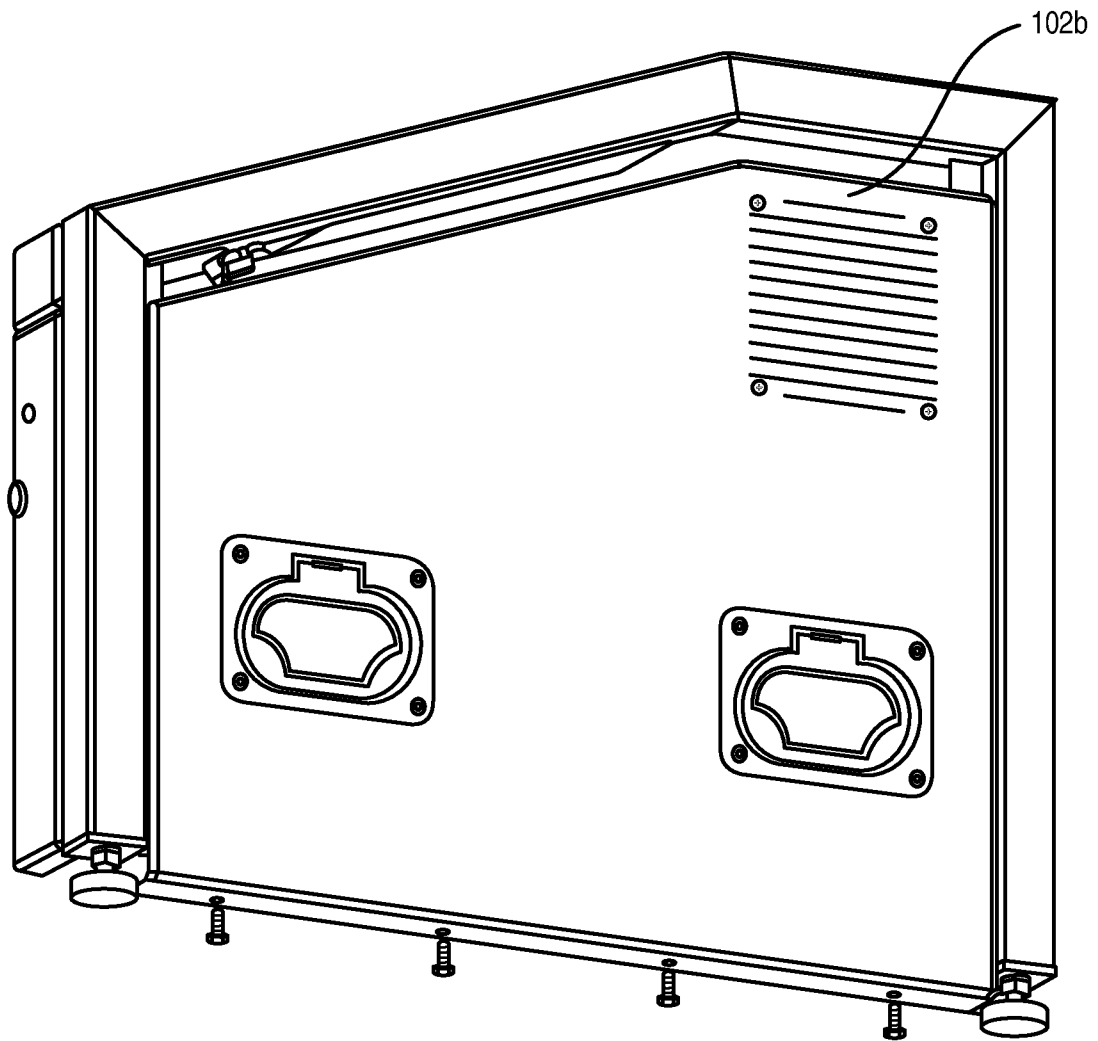


FIG. 3

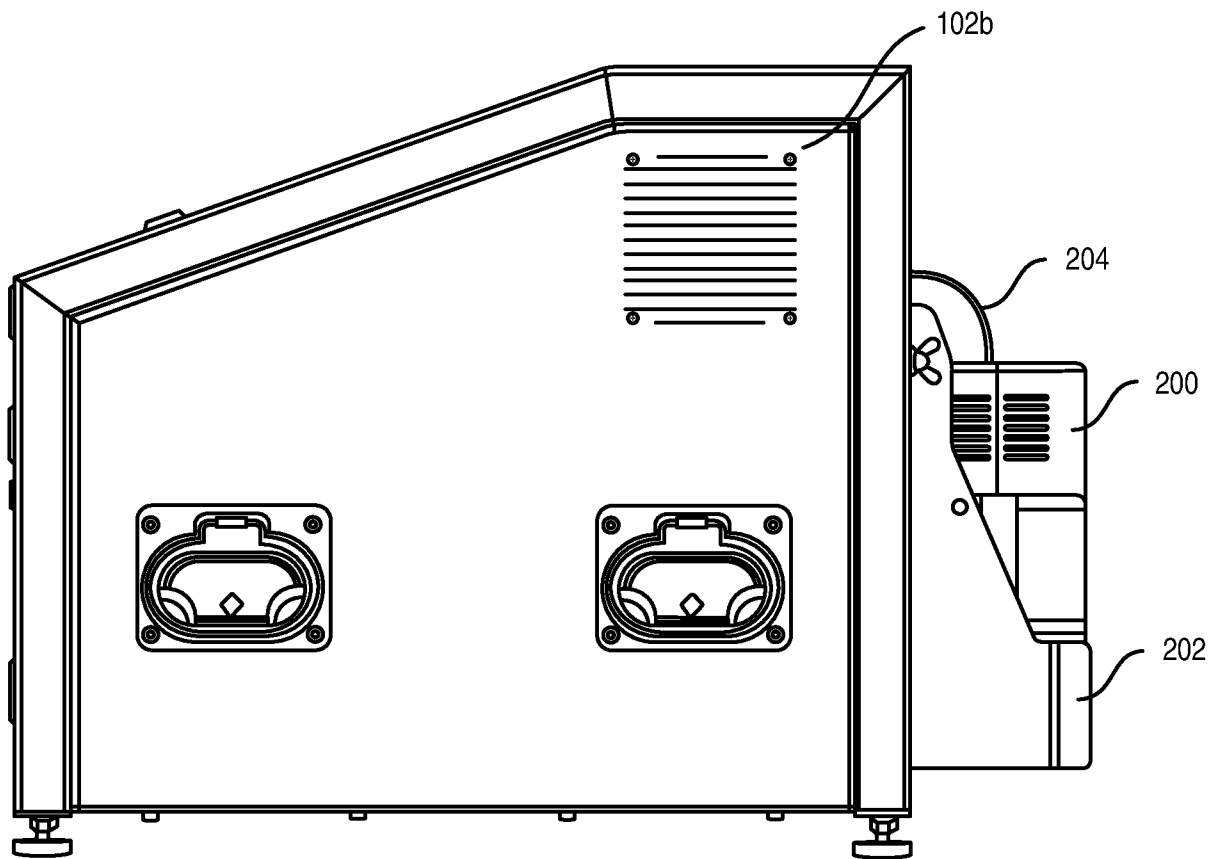


FIG. 4

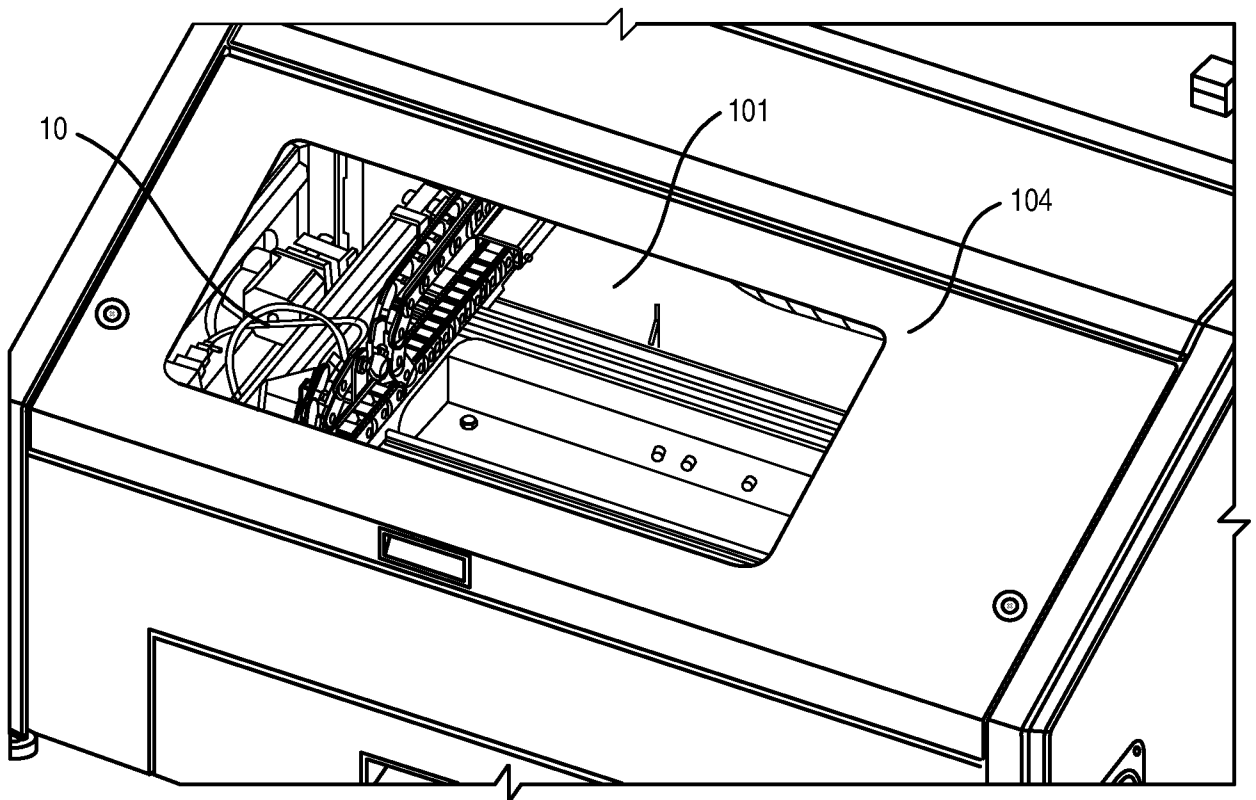


FIG. 5

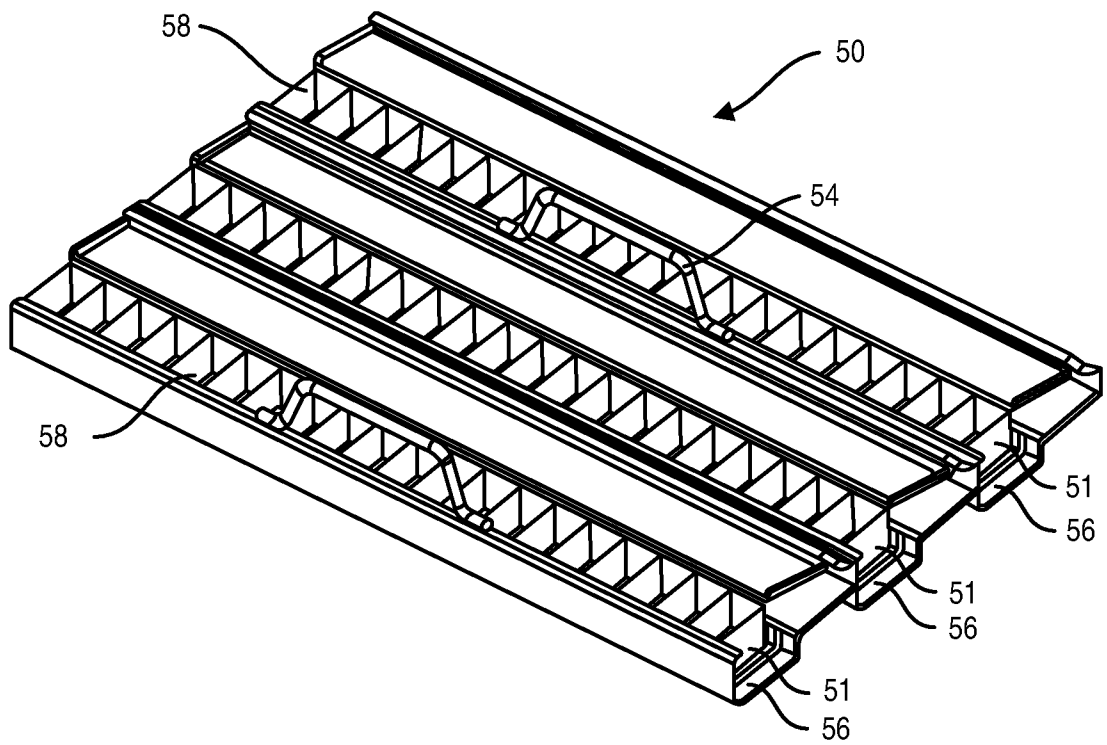


FIG. 6

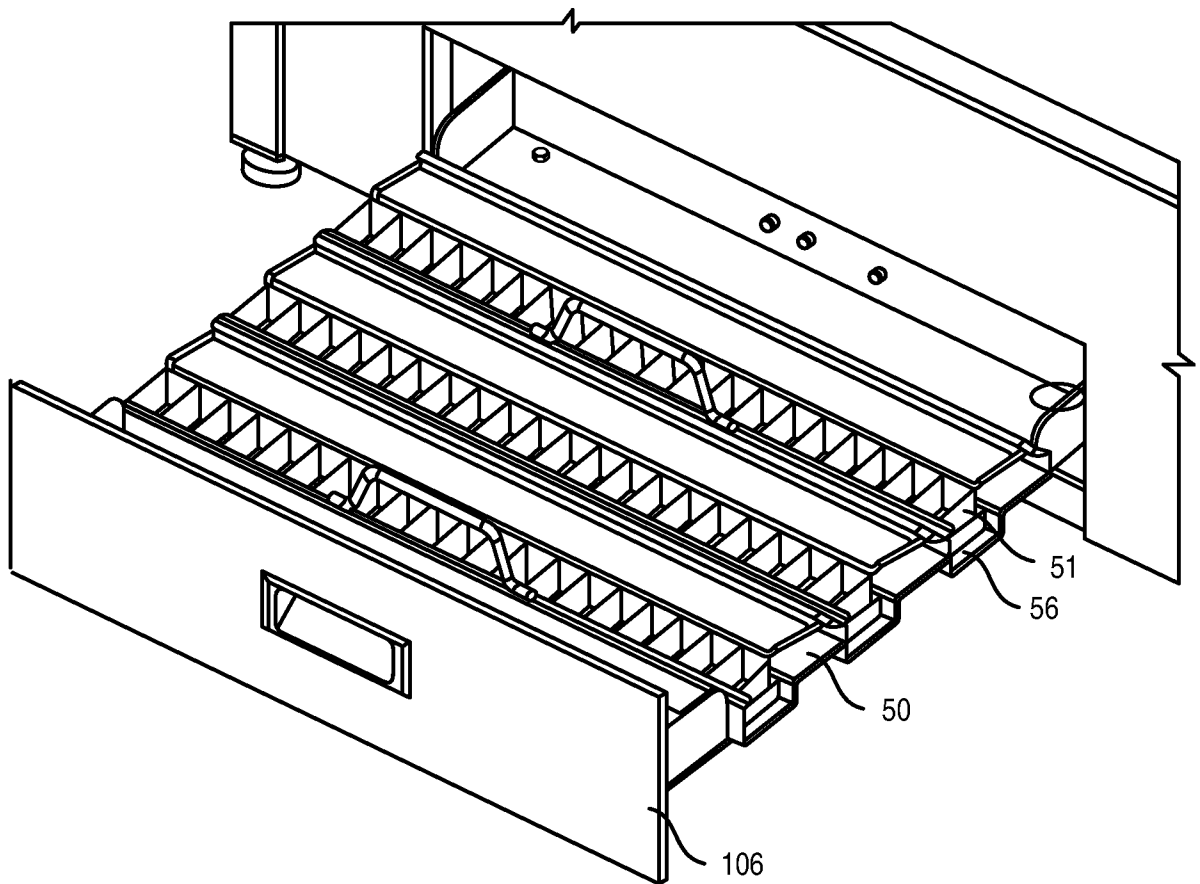


FIG. 7

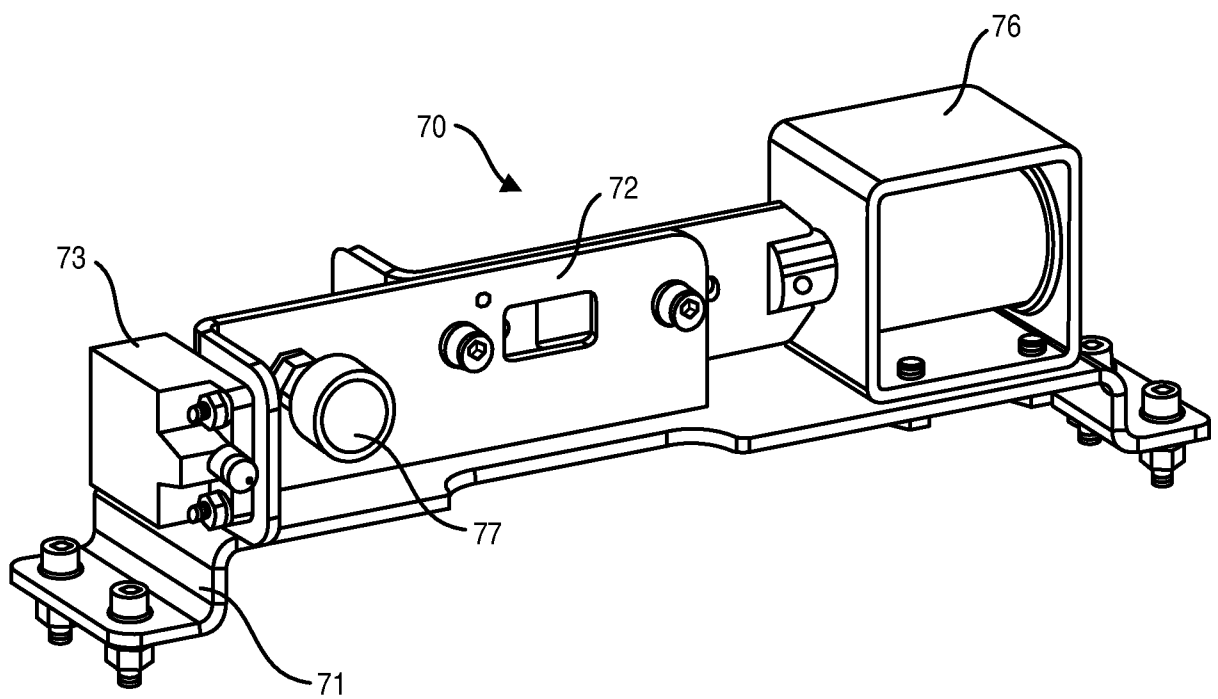


FIG. 8

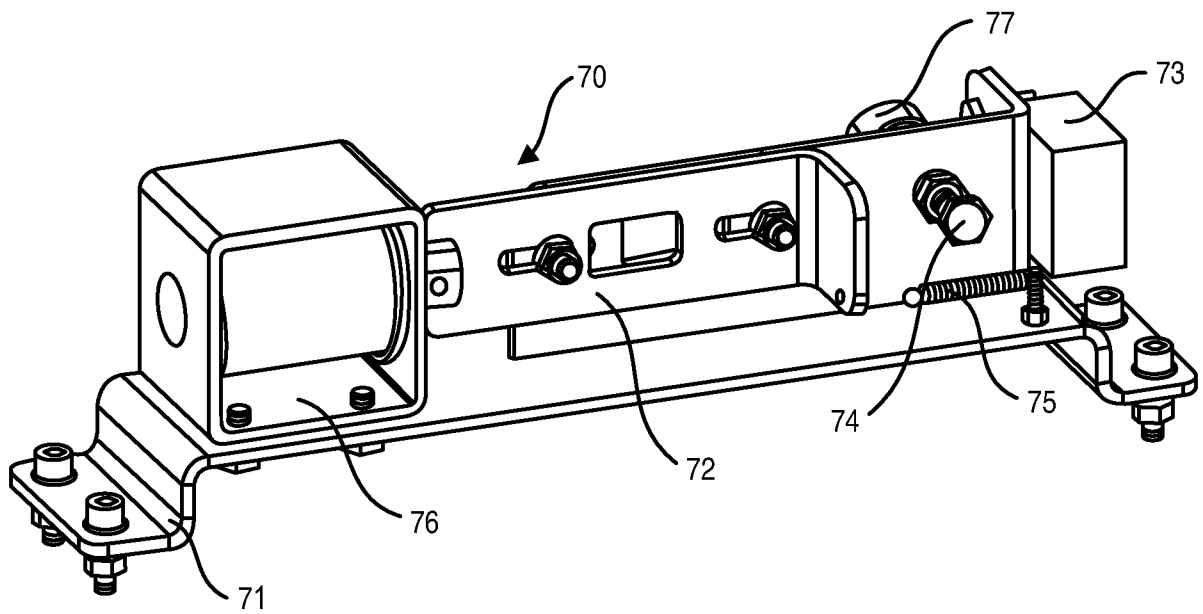


FIG. 9

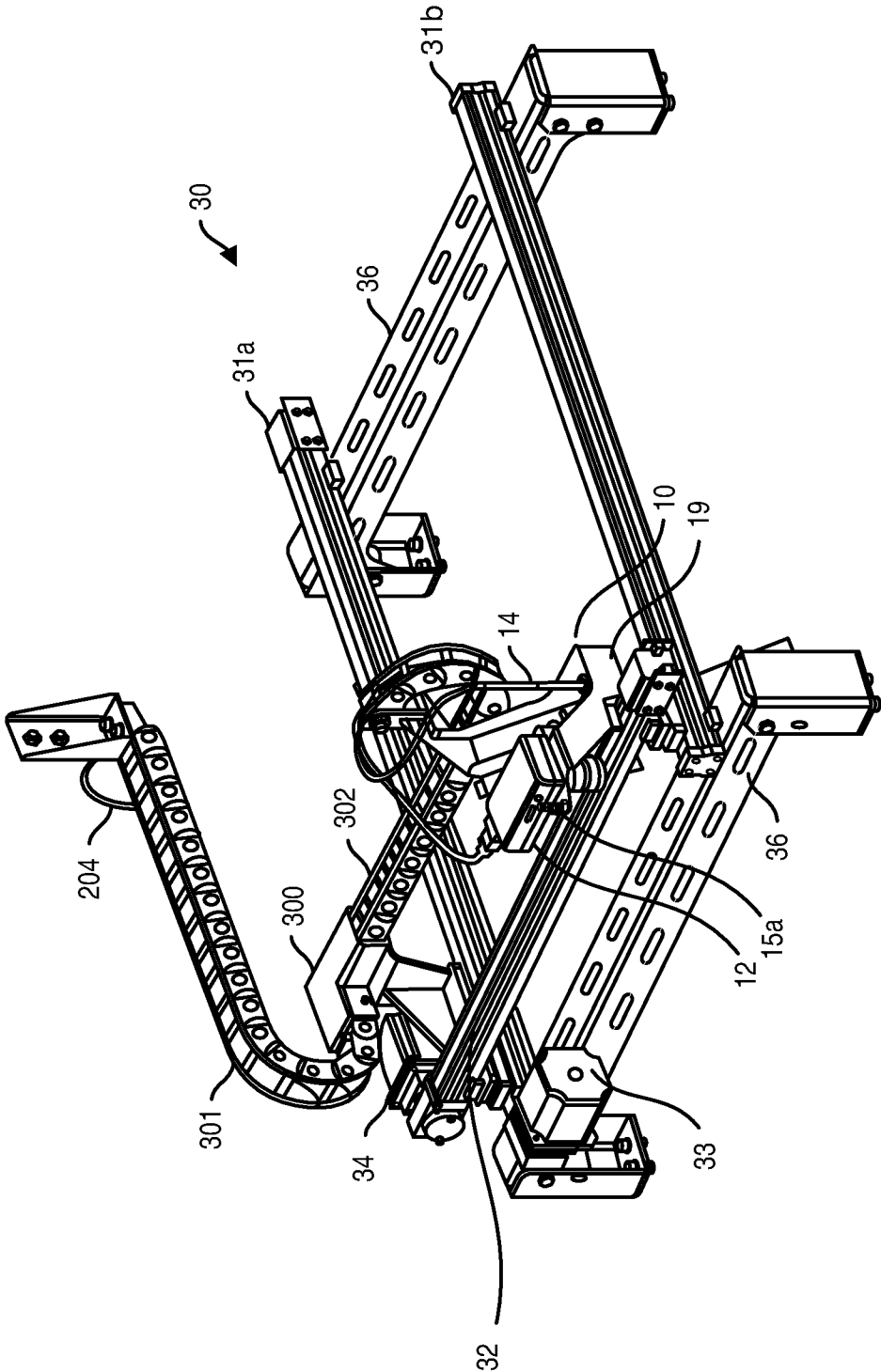


FIG. 10

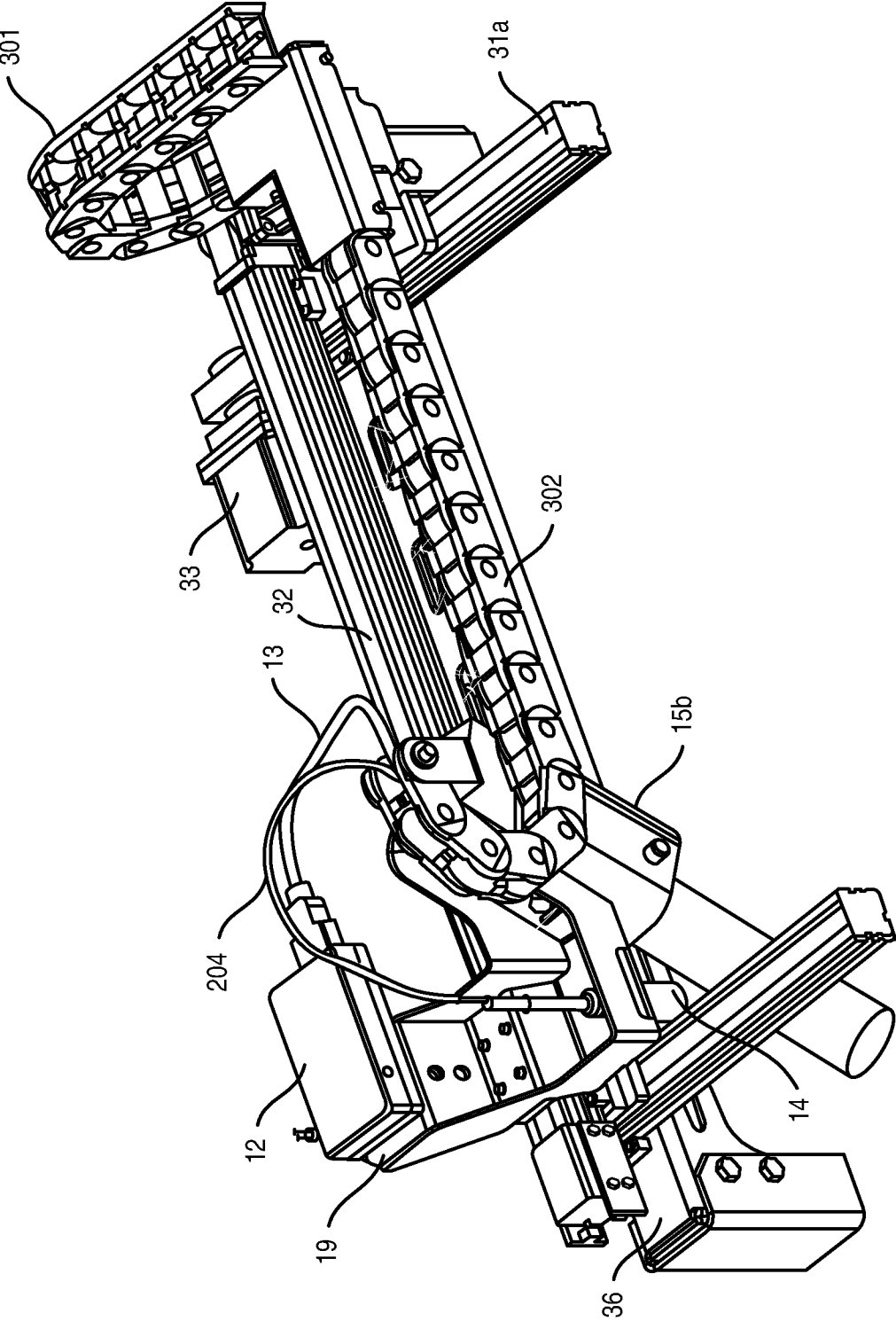


FIG. 11

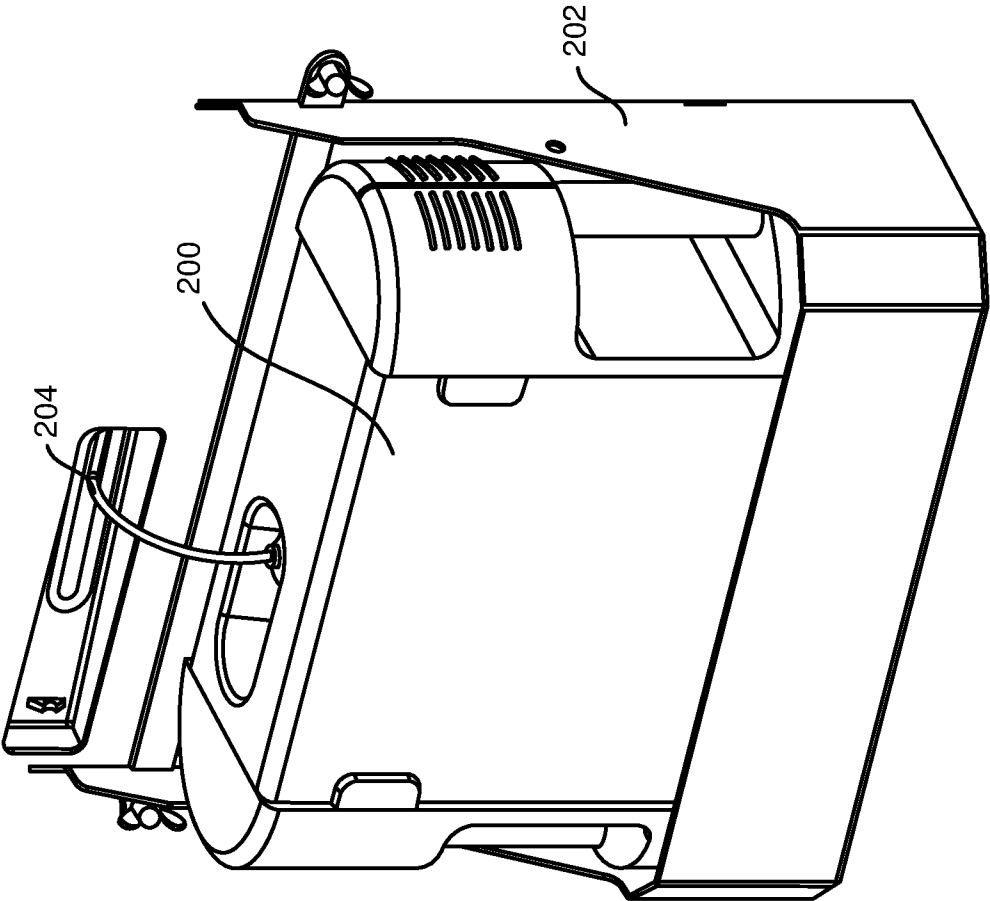


FIG. 12

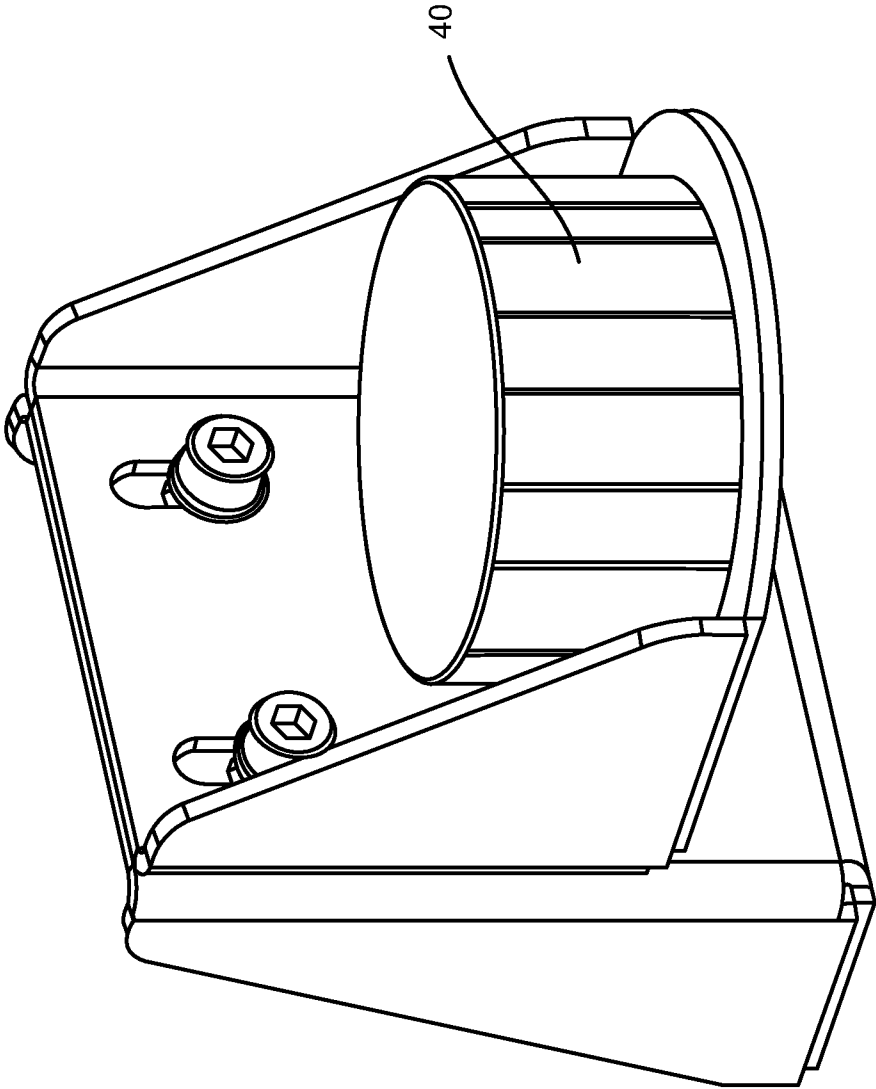
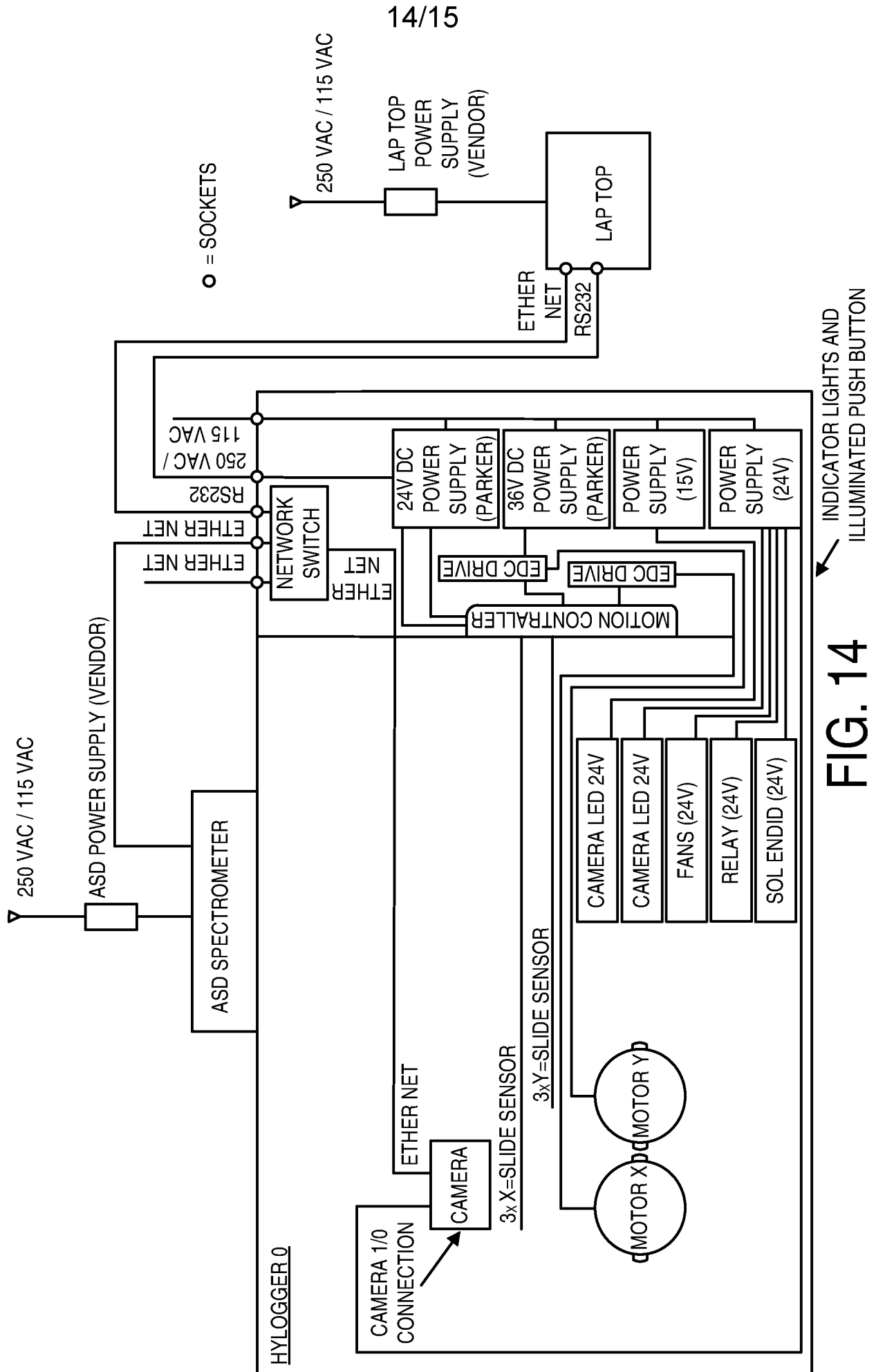


FIG. 13



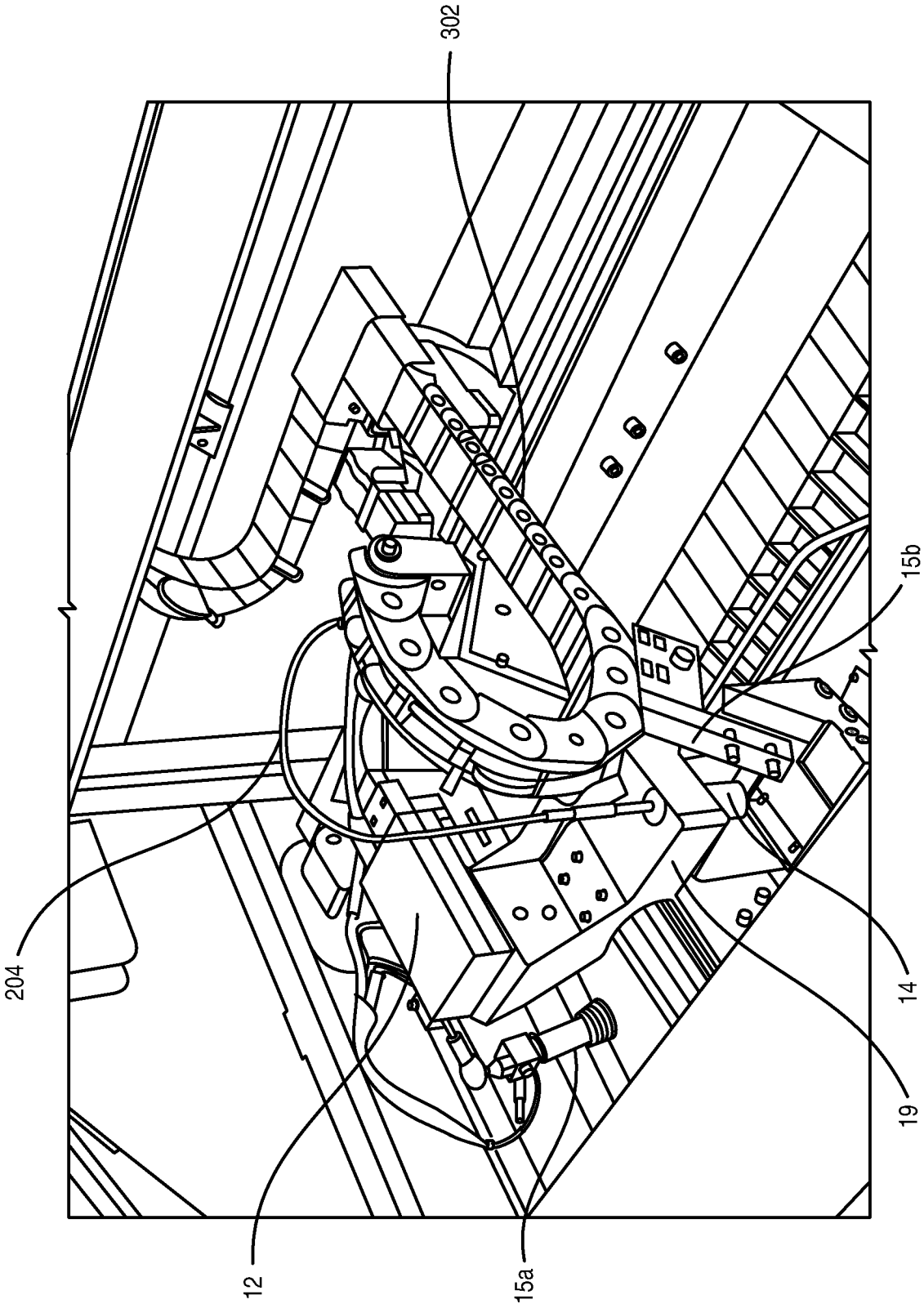


FIG. 15

INTERNATIONAL SEARCH REPORT

International application No
PCT/DK2017/050061

A. CLASSIFICATION OF SUBJECT MATTER
INV. G01N21/25 G01J3/28 G01N21/31 G01N21/55
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G01N G01J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

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Y	CN 103 925 999 B (UNIV SUN YAT SEN) 30 December 2015 (2015-12-30) paragraph [0032]; figure -----	1-13
Y	CN 204 903 384 U (NANJING CT CHINA GEOL SURVEY) 23 December 2015 (2015-12-23) paragraph [0017]; figures -----	1-13
Y	EP 2 916 158 A1 (EUROPEAN MOLECULAR BIOLOGY LAB EMBL [DE]) 9 September 2015 (2015-09-09) the whole document -----	1-13
	-/--	



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

15 May 2017

Date of mailing of the international search report

26/05/2017

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Authorized officer

Riblet, Philippe

INTERNATIONAL SEARCH REPORT

International application No
PCT/DK2017/050061

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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