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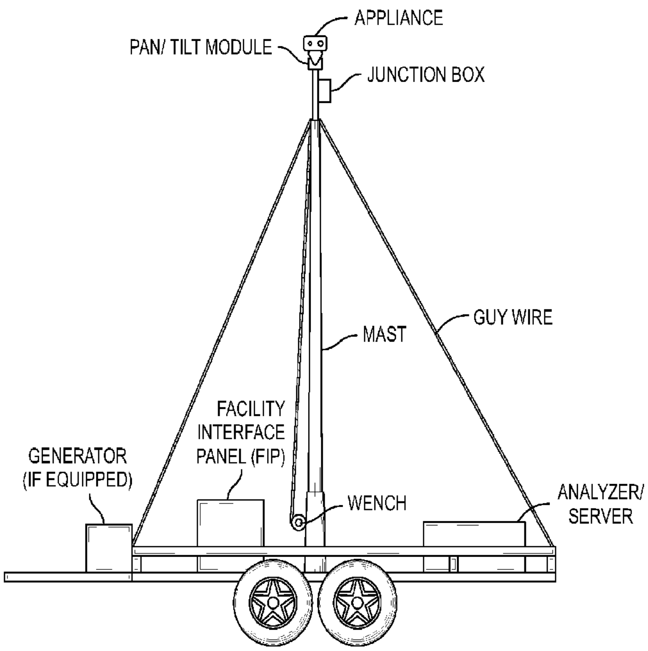

Figure 2

(57) Abstract: The present disclosure refers to a system for monitoring emissions. The system comprises an appliance with a mobile emission monitoring platform configured to identify and quantify a gas emission; an optional rangefinder configured to determine a size of a gas emission plume and a velocity of the gas emission plume; and an imaging device configured to provide an image. The appliance is mounted to an extendable mast on, for example, a trailer such that the system may provide mobile and continuous monitoring of emissions.

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Mobile Systems for Monitoring Emissions

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application is a continuation-in-part application of pending U.S. application with the Serial Number 17/485,762 filed September 27, 2021.

FIELD OF THE DISCLOSURE

[0002] The present disclosure relates to a mobile system for monitoring emissions such as, for example, methane.

BACKGROUND AND SUMMARY

[0003] Traditional emissions monitoring systems are stationary, complex apparatuses that either intermittently or continuously monitor emissions of gases from, for example, refineries, chemical plants, power plants, or other sources of gaseous emissions. Unfortunately, such traditional systems are immobile and therefore incapable of being moved to, for example, monitor a different location that may be more in need of monitoring. Moreover, such traditional systems are often capable of or configured to only detect one type of emission. In addition, traditional emissions monitoring systems were incapable of processing any data on-site. And traditional systems are often for detecting leaks as opposed to continuous monitoring of low levels of emissions. Thus, use of traditional systems often required transmitting or transporting acquired data to another location for processing and analyzing as to whether remedial action or intervention was required at the source of emission.

[0004] What is needed are more effective and cost-efficient systems for monitoring emissions. It would further be advantageous if such systems were mobile, capable of monitoring more than one type of emission, and/or could process data on-site. Advantageously, the system described herein may meet one or more up to all of the aforementioned needs.

[0005] The present application generally pertains to a system for monitoring emissions. The system may comprise a mobile emission monitoring platform configured to identify and quantify a gas emission. The system may also comprise a rangefinder configured to determine a size of a gas emission plume and a velocity of the gas emission plume and an imaging device configured to provide an image. One or more up to all of the emission monitoring platform, the optional rangefinder, and the imaging device may be operably connected to a processor. The emission monitoring platform, the optional rangefinder, and the imaging device may be mounted to an extendable mast which may be mounted to a trailer.

[0006] These and other objects, features and advantages of the exemplary embodiments of the present disclosure will become apparent upon reading the following detailed description of the exemplary embodiments of the present disclosure, when taken in conjunction with the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Various embodiments of the present disclosure, together with further objects and advantages, may best be understood by reference to the following description taken in conjunction with the accompanying drawings.

[0008] Figure 1 shows a trailer with a folded mast and other components of a system for monitoring emissions.

[0009] Figure 2 shows a trailer with an extended mast and other components of a system for monitoring emissions.

[0010] Figure 3 shows a truck with a folded extendable mast and other components of a system for monitoring emissions.

[0011] Figure 4 shows a truck with an extended mast and other components of a system for monitoring emissions.

[0012] Figure 5 is a front view of a skid mounted unit.

[0013] Figure 6 is a top view of a sked mounted unit.

DETAILED DESCRIPTION

[0014] The following description of embodiments provides a non-limiting representative examples referencing numerals to particularly describe features and teachings of different aspects of the invention. The embodiments described should be recognized as capable of implementation separately, or in combination, with other embodiments from the description of the embodiments. A person of ordinary skill in the art reviewing the description of embodiments should be able to learn and understand the different described aspects of the invention. The description of embodiments should facilitate understanding of the invention to such an extent that other implementations, not specifically covered but within the knowledge of a person of skill in the art having read the description of embodiments, would be understood to be consistent with an application of the invention.

[0015] The systems for monitoring emissions typically comprise a mobile emission monitoring platform configured to identify and quantify a gas emission; an optional rangefinder configured to determine a size of a gas emission plume and a velocity of the gas emission plume; and an imaging device configured to provide an image. In this manner the system may be configured to continuously monitor a facility emitting an emission.

Mobile emission monitoring platform

[0016] The type of mobile emission monitoring platform is not particularly critical so long as it is capable of identifying and/or quantifying a volume or amount of gas emission of a specific gas or gases to be monitored. Such gases to be monitored by the systems described herein may include, for example, a hydrocarbon such as a C1-C6 hydrocarbon like methane or propane, carbon dioxide (CO_2), volatile organic compounds (VOCs), hydrogen sulfide (H_2S), and the like. In some embodiments the mobile emission monitoring platform may comprise a camera that may scan visible, ultraviolet, and/or near-infrared spectral ranges. Such cameras include, for example, hyperspectral cameras configured to identify and/or quantify a volume or amount of gas emission of a specific gas or gases to be monitored. Such cameras may capture a gas or mixture of gases unique infrared absorption to assist in identifying and quantifying an emission. In some embodiments a hyperspectral camera may be configured to identify and quantify two or more up to seven or more different gases. Similarly, in some embodiments the system may be configured to identify and quantify a gas emission wherein said gas emission comprises two or more gases or even a mixture of three or more gases.

[0017] The emission monitoring platform may be powered by any convenient source. In some embodiments the same power source may power the emission monitoring platform and other components of the system. Such power supplies may include, for example, uninterruptible power supplies. Suitable power supplies include, for example, facility power, a generator, a solar array, etc. In some embodiments, a solar array (as well as accompanying batteries and/or power inverters) may be integral to the unit itself. The emission monitoring platform and/or other components described herein may in some embodiments be operably connected to a processor.

Rangefinder

[0018] If desired, a rangefinder may also be included in the systems of the present application. Suitable rangefinders may vary depending upon the other components, the emission, and the desired capability or specificity. Typically, a suitable rangefinder is one configured to determine a size of a gas emission plume and a velocity of the gas emission plume. In some embodiments the rangefinder may facilitate a more accurate measurement of the size of the emission based on its proximity to the camera. As described above for the mobile emission monitoring platform any suitable power source may be employed and the rangefinder may also be operably connected to a processor.

Imaging device

[0019] An imaging device may also be included in the systems of the present application. Suitable imaging devices may vary depending upon what type of image is desired, e.g., photo, video, and/or combination thereof. The imaging device may also be powered by any suitable power source which source may be the same or different than that for the mobile emission monitoring platform and/or rangefinder. As with the other components described above, the imaging device may be operably connected to a processor.

Other components

[0020] The system may include other components which may vary depending upon the desired characteristics of the system. Such components include, for example, a facility interface panel (FIP). A facility interface panel may be configured to power and/or control the system. Components such as a photoionic or other cameras or sensor may be employed. A processor may also be employed and operably connected to the emission monitoring platform, the rangefinder, the imaging device, and/or a facility interface panel.

[0021] Incorporation of the FIP is an option for the utility and optimization of emissions performance analyses. The Mobile Emissions Platform may be an autonomous system which may operate independently from the system or process to be monitored. However, the FIP may be configured to allow the Mobile Emissions Platform to interface with process-level intelligence systems such as Supervisory Control and Data Acquisition (henceforth “SCADA”) systems and Programmable Logic Controllers (henceforth “PLC”) which may provide a secondary data layer for determining operational causes of emission activities downstream of each industrial process sensor (e.g., temperature monitor, pressure sensor, and/or flow meter, etc.).

[0022] The FIP may be configured to enable the end-user to extract operational insights relating to emissions performance and ultimately provide intelligent feedback which can be used for emissions mitigation and/or process optimization. That is, using the systems and methods described herein the remote sensing platform may be configured to have the ability to communicate with process-level intelligence systems (e.g., drone reconnaissance, manned aircraft reconnaissance, “Picaro” System, optical gas imaging (“OGI”) by way of operator/technician) and/or other systems.

[0023] The processor may assist in processing data from the various components and may be configured to provide a user with various data points, provide notices of certain conditions, and/or provide signals about corrective actions in regard to an emission. For example, the processor may be configured to provide a notice upon a gas emission above a threshold level or provide a user with an actual emission rate. Additionally or alternatively, a processor may be configured to provide a user with an actual emission rate per activity, an actual emission rate per a piece of equipment, or any combination thereof. In some embodiments the processor may be configured to provide a user with a summary image of an emissions event. Such a summary image may comprise, for example, a hyperspectral image of emission concentration on a visual image of a field of view. A processor may be configured to provide a user with a recorded video of an emissions event. Such a recorded video may comprise an emission concentration a visual image of a field of view. The processor may be configured to provide data such as one or more up to all of the following: hyperspectral data, system telemetry, emission data comprising an emission source, an emission volume, an emission frequency, and/or any combination thereof.

Remote Sensors

[0024] The mobile emissions platform used herein may be configured to accommodate a number of different instruments and technologies. For example, one or more of the following may be incorporated depending upon the needs of the system:

[0025] Ultrasonic gas detection (All Gas Species (sans O_2)); uses acoustic sensors to identify fluctuations in noise that is imperceptible to the human ear within a process environment. Typically, these sensors have the ability to detect ultrasonic frequencies (25 to 100 KHz), while excluding audible frequencies (0 to 25 KHz). Unlike traditional gas detectors that measure the accumulated gas, ultrasonic gas detectors "hear" the leak, triggering an early warning system.

[0026] Ultrasonic technology may be used to detect and measure a gas species where two (2) Mobile Emissions Platforms are utilized; one (1) Mobile Emissions Platform houses an ultrasonic emitter while the second (2) Mobile Emissions Platform houses an ultrasonic transducer (receiver). Gas (target pollutant) is measured through an adiabatic process known as *Time of Flight* ("TOF") where the concentration of the pollutant is determined by the frequency of sound as it travels through an environmental medium (e.g., air).

[0027] Metal Oxide Sensors ("MOS") (Hydrocarbons); detect concentrations of a gas species by measuring the resistance variation of the metal oxide due to the adsorption gases. Atmospheric oxygen residing on the MOS surface is reduced by target gases, allowing more electrons in the conduction band of the metal oxide material. This resistance (drop) is reversible and varies depending on the reactivity of the sensing materials, presence of catalyst materials, and working temperature of the sensor.

[0028] Non-Dispersive Infrared ("NDIR") through Extractive Interface (Hydrocarbons); a spectroscopic sensor used in gas detection; is "non-dispersive" in the fact that no dispersive elements (e.g., prism, diffraction gradient; normally present in other types of spectrometers) are used to separate or parse out the broadband light into a narrow spectrum suitable for gas sensing.

[0029] The majority of NDIR sensors use a broadband lamp source and an optical filter to select a narrow band spectral region that overlaps with the absorption region of the target gas. Primary components may include:

- Infrared ("IR") source (lamp);
- Sample Chamber or light tube;
- Light filter; and
- IR detector.

[0030] Fourier-Transform Infrared ("FTIR") through Extractive Interface (All Gas Species (sans O_2)); a technique used to obtain an IR spectrum of absorption or emission of a solid, liquid, or gas. An FTIR spectrometer may simultaneously collect high-resolution spectral data over a wide spectral range. In some cases this may confer a significant advantage over dispersive technology (spectrometer) which measures intensity over a narrow range of wavelengths at a time.

[0031] The primary goal of an FTIR system is often to measure how much light a sample absorbs at each wavelength. Rather than introducing a monochromatic beam of light (beam composed of only a single wavelength) to a sample, this technique focuses a beam containing many frequencies of light at once and measures how much of that beam is absorbed by the sample. Next, the beam is modified to contain a different combination of frequencies, providing a second data point. This process is repeated (rapidly) over a short period of time. Afterwards, Fourier Transform (mathematical process) is applied to the raw data set which "reverse analyzes" the spectrum to infer absorption patterns at each wavelength.

[0032] The beam is generated with a broadband light source – one (1) containing the full spectrum of wavelengths to be measured. The light is directed through a Michelson interferometer; a certain configuration of mirrors, one (1) of which is moved by a motor. As this mirror moves, each wavelength of light in the beam is periodically blocked, transmitted, blocked, transmitted, by the interferometer, due to wave interference. Different wavelengths are modulated at different rates – so that at each moment or mirror position the beam emitted from the interferometer captures a different spectrum.

[0033] Catalytic Gas Sensor through Extractive Interface (Hydrocarbons); consisting of a detector element (D) which contains catalytic material and is sensitive to gases, and a compensator element (C) which is inert. Combustible gases will burn only on the detector element, causing a rise in its temperature and, as a consequence, as rise in its resistance. Combustible gases will not burn on the compensator – its temperature and resistance remain unchanged in the presence of combustible gases.

[0034] Normally a Wheatstone bridge circuit is formed with both elements. A variable resistor (VR) is adjusted to maintain a state of balance of the bridge circuit in clean-air, free of combustible gases. When combustible gases are present, only the resistance of the detector element will rise, causing an imbalance in the bridge circuit, thus producing an output voltage signal (V_{out}). The output voltage signal is proportional to the concentration of combustible gases; gas concentration can be determined by measuring the output voltage.

[0035] Light Detection and Ranging (“LiDAR”) (Hydrocarbons); a method for determining gas concentrations of target species through the use of a tunable laser diode (“TLD”). A TLD utilizes a laser whose wavelength of operation cab be altered in a controlled manner. Since no real laser is truly monochromatic, all lasers can emit light over some range of frequencies, known as linewidth of the laser transition. In most lasers, this linewidth is quite narrow (1,064 nm wavelength transition of a Nd: YAG Laser has a linewidth of approximately 120 GHz or 0.45 nm). Tuning of the laser output across this range can be achieved by placing wavelength-selective optical elements (such as an etalon) into the laser’s optical cavity to provide selection of a particular longitudinal mode of the cavity.

[0036] The range of applications of tunable lasers is extremely wide. When coupled with the right filter, a tunable source can be configured over a few hundred nanometers with a spectral resolution from 4 nm to 0.3 nm depending on the wavelength range. With proper isolation (>OD4) tunable source can be used for basic absorption and photoluminescence study.

[0037] Photoionization Detection through Extractive Interface (C3+ Hydrocarbons); measure volatile organic compounds (henceforth “VOC”) and other gases in concentrations from sub-parts per billion (ppb) to ten thousand parts per million (10,000 ppm). The photoionization (henceforth “PID”) detector is an efficient and inexpensive detector for many gas and vapor analytes.

[0038] In a PID, high-energy photons, typically in the vacuum ultraviolet (VUV) range, break molecules into positively-charged ions. As compounds enter the detector they are bombarded by high-energy ultraviolet (UV) photons and are ionized when they absorb the UV light, resulting in ejection of electrons and the formation of positively-charged ions. The ions undergo numerous reactions including reaction with oxygen and/or water vapor, rearrangement, and fragmentation. A few of them may recapture an electron within the detector to reform their original molecules; however, only a small portion of the airborne analytes are ionized (to begin with) so the practical impact of this (if it occurs) is usually negligible. Thus, PIDs are non-destructive and can be used before other sensors in multiple-detector configurations.

[0039] The PID will only respond to components that have ionization energies similar to or lower than the energy of the photons produced by the PID lamp. As stand-alone detectors, PIDs are broad band and non-selective, as these may ionize everything with an ionization energy less than or equal to the lamp photon energy. The more common commercial lamps have photons energy upper limits of approximately 8.4 eV, 10.0 eV, 10.6 eV, and 11.7 eV. The major and minor components of clean air all have ionization energies above 12.0 eV and thus do not interfere significantly in the measurement of VOCs, which typically have ionization energies below 12.0 eV.

[0040] Flame-ionization Detection through Extractive Interface (Hydrocarbons); flame ionization detection ("FID") is a standard instrument used in industry for measuring hydrocarbon gas concentrations; its response is either poor or nil to compounds such as hydrogen sulfide (H_2S), carbon tetrachloride (CCL_4), or ammonia (NH_3). It is mass-sensitive, not concentration sensitive; hence, changes in carrier gas flow rates have little effect on the detector response. It is preferred for general hydrocarbon gas analysis with varying ranges of detection.

[0041] The optimum sample gas is introduced into an FID through column input. Any hydrocarbon gas sample will produce ions when burned in the hydrogen flame (located inside the instrument). To detect the ions, two (2) electrodes are used to provide a potential difference. The positive electrode doubles as the nozzle head where the flame is produced. The other electrode is negative, which is positioned above the flame. Thus, the ions are attracted to the negative collector plate – striking a plate which induces a current. This current is proportional to the rate of ionization, which in turn depends upon the 11concentration of hydrocarbon gas in the sample.

[0042] Electrochemical Gas Detection through Extractive Interface (Combustion Gases); gas detection systems which measure the concentration of a target gas by oxidizing or reducing the target gas at an electrode and measuring the resulting current.

[0043] The gas is extracted and diffuses into a sensor through the back of a porous membrane – directed toward the working electrode where it is oxidized or reduced. The electrochemical reaction results in an electric current that passes through the external circuit. Additionally, the sample is amplified while performing other signal processing functions (from the circuit) while maintaining the voltage across the sensor between the working counter electrodes for a two (2) electrode sensor or between the working and reference electrodes for a three (3) electrode cell.

An opposite and equal reaction occurs at the counter electrode, such that if the working electrode results in oxidation, the counter electrode is a reduction.

[0044] Chemiluminescence Gas Analysis through Extractive Interface (Nitrogen Compounds); operates on the principle that nitric oxide (NO), nitrogen dioxide (NO_2) need to be converted into NO in order to be measured. NO_2 is converted to NO using a molybdenum ("Moly Converter") or stainless-steel converter. Total nitrogen compounds (NOx) is equal to the sum of NO_2 and NO.

[0045] Stainless steel is the most popular choice for converter material; however, Moly Converters have been used for years. The stainless-steel converter is heated to six hundred and twenty-five degrees Celsius (625°C) – the Moly Converter is heated to three-hundred and twenty-five degrees Celsius (325°C). The oxide layer of the stainless steel removes one (1) of the oxygen atoms from the NO_2 – resulting in the formation of NO.

[0046] The sample flows into the analyzer via a three-way (3-way) solenoid valve. The solenoid typically switches every ten to fifteen seconds (10 sec – 15 sec); the sample is routed either directly into the reaction chamber where only NO is measured or through an N_2O – NO converter where NOx is measured (NO_2 that has been converted to NO and the NO in the sample).

[0047] Dry air is pumped in from the ambient environment through a flow switch into an ozone (O_3) generator. The generator creates the O_3 needed for the chemiluminescent reaction. A flow sensor located upstream of the reaction chamber measures the sample flow rate.

[0048] In the reaction chamber, the 1-part O_3 reacts with the 2-parts NO in the sample and luminesces. A photomultiplier tube ("PMT") located within a thermoelectric cooler (set a negative three degrees Celsius (-3°C)) – used to eliminate background noise, detects the luminescence generated during the reaction. The sample exhaust exits the reaction chamber through the O_3 converter and is vented to atmosphere.

[0049] Meteorological Station (Contextual Data); a facility or equipment with instruments used for measuring atmospheric conditions to provide information for weather characteristics and behavior. The measurements include (not limited to):

- Temperature;
- Atmospheric pressure;
- Humidity;
- Wind speed;
- Wind direction; and
- Precipitation.

[0050] Wind measurements are taken with as few other obstructions as possible, while temperature and humidity measurements are shielded from direct solar radiation, or insolation. Manual observations are taken periodically; automated measurements are taken at prescribed intervals.

Extendable mast

[0051] In some embodiments the emission monitoring platform, the rangefinder, and/or the imaging device and other components are each mounted to an extendable mast. In its extended position in a substantially vertical direction an extendable mast may allow for each component to have a more unobstructed aerial view or line of sight of an emission source. Each of the aforementioned components may be mounted to a separate extendable mast but in most embodiments it may be suitable to mount the components to the same extendable mast. In some embodiments at least two up to all of the emission monitoring platform, the rangefinder, and the imaging device are housed within an appliance which appliance is mounted to the extendable mast. Such an appliance protects the individual components from damage due to wind, rain, snow, etc. and in addition substantially aligns the line of sight of the individual components to the emission source or sources of interest. Furthermore, housing the individual components in the appliance facilitates the mounting to the extendable mast.

[0052] The extendable mast may be configured to be mounted to a vehicle or a trailer for mobility. Such vehicles are not particularly limited and may be a car, truck, semitrailer, boat, or other convenient vehicle depending upon the desired operation. The height of the extendable mast and the location of the appliance on the extendable mast may vary depending upon, for example, the distance and location of the emission source or sources to be monitored. In some embodiments the location of the appliance on the extendable mast be moved up or down via a convenient means such as a winch or an actuator (hydraulic or mechanical). In some embodiments the system is configured such that emissions may be observed from a lateral distance of from about 25 meters up to about 150 meters. In some embodiments the extendable mast may be a telescoping mast that extends up to about 40 feet or more in a substantially vertical direction relative to the ground.

[0053] Figure 1 shows a trailer with a folded mast and other components of a system for monitoring emissions. A generator on the trailer may supply power to a facility interface panel that controls the system. A folded mast which may or may not be telescoping may be extended with a winch or other suitable mechanism to a desired height for monitoring emissions. A processor and/or server may analyze and process data locally and be configured to transmit signals to an operator and/or to the emission source being monitored. The appliance with the emission monitoring platform, the rangefinder, and/or the imaging device may be conveniently stored for security when not in operation.

[0054] Figure 2 shows the trailer with the attached appliance in an extended position. A remotely operated pan/tilt module provides for precise positioning of the appliance for emission monitoring. A tilt feature advantageously allows the camera to cover a desired area from, or example, the base of the trailer to, for example, the boundary of the camera’s detection range.

[0055] Figure 3 shows a truck with a folded extendable mast and other components of a system for monitoring emissions.

[0056] Figure 4 shows a truck with an extended mast and other components of a system for monitoring emissions.

[0057] In some embodiments the extended mast may include an optional guy wire while in other embodiments a guy wire may not be necessary or desirable. That is, in some embodiments a telescopic mast can be operated without one or more guy-wires. A telescoping or telescopic mast is generally an upright pole or tower that consists of tubular sections that may slide within one another while being extended and/or retracted. Telescopic masts can be made from a variety of materials including, for example, steel, aluminum, other metals, plastics, and combinations thereof depending upon the application, project requirements, or other factors. In some embodiments, the extending mast (which may be a telescopic mast) may be mounted to or laid adjacent the mobile emissions platform, building, freestanding tripod, skid, or other type of modular device. The telescopic mast may be in addition to or in lieu of the lay-down mast depending upon the desired configuration, requirements, detector types, and/or detector heights employed.

[0058] The telescoping mast may be utilized in instances where emissions detection capabilities of the instrument are not particularly dependent upon horizontal stability. Alternatively or additionally, the telescoping mast may be reinforced in some convenient manner such that it is horizontally stable. That is, it may be made more rigid and/or stabilized at its base or other mechanism. A telescopic mast may often be appropriate for point-source instruments such as metal oxide detectors, ultrasonic transducers, non-dispersive infrared (NDIR) with extractive interface, and multi-spectral imagers. Telescoping masts may also be useful in areas where overhead electrical hazards are present (and/or piping and industrial process equipment); to avoid contact by limiting the radial divergence from the center of the mast's inflection point (i.e., lay-down mast).

[0059] Adapting the Mobile Emissions Platform to accommodate other Modular Industrial Platforms.

[0060] Advantageously, the systems and methods described herein may be used in lieu of, in addition to, or in partial combination with other modular industrial platforms that may or may not be designed and custom fabricated to operate within specific parameters and/or constraints. Such other modular industrial platforms that may be used with the components and methods described herein include, for example, the following:

[0061] (1) Enclosed utility trailer; also referred to as a "Cargo Trailer" – a trailer whose cargo area is protected from the elements. Any on-road transportable container sufficiently durable for repeated use which, by virtue of its own particular design, permits the temporary (or permanent) storage and protection of bulk commodities, goods, and other cargo, and which may be transported in various modes without intermediate loading or unloading.

[0062] (2) Self-Contained Cargo Container; an industrial container or chassis that is rigid, reusable, and capable of being mounted or dismounted/handled by standard container lifting equipment and used by ocean carriers for transportation of goods on board ships; includes any container that is insulated, refrigerated or dry cargo, or described as flat rack, vehicle rack, liquid tank, or open top.

[0063] (3) Skid Mount Unit; a method of distributing, deploying, and storing machinery and hosting equipment – usually stationary equipment for industrial and scientific purposes; on its own or with other units as part of a modular system. The equipment at the point of manufacture is permanently mounted to a frame, rails, or metal pallet. This equipment can then be easily and readily secured and transported; skid mounted appliances may be temporarily placed within a facility, observation area, warehouse, or onto a vehicle, trailer, or truck. These units often have standard lifting points for maneuverability with a forklift or other lifting device.

[0064] In the preceding specification, various embodiments have been described with references to the accompanying drawings. It will, however, be evident that various modifications and changes may be made thereto, and additional embodiments may be implemented, without departing from the broader scope of the invention as set forth in the claims that follow. The specification and drawings are accordingly to be regarded as an illustrative rather than restrictive sense.

WE CLAIM:

1. A system for monitoring emissions comprising:

a mobile emission monitoring platform configured to identify and quantify a gas emission wherein the gas emission comprises a hydrocarbon, volatile organic compound, hydrogen sulfide, carbon dioxide, or a mixture thereof ;

and

an imaging device configured to provide an image;

wherein the emission monitoring platform and the imaging device are each operably connected to a processor; and

wherein the emission monitoring platform and the imaging device are each mounted to an extendable mast configured to be mounted to a car, a truck, skid, cargo container, or a trailer;

wherein the system further comprises a facility interface panel configured to power and control the system; and

wherein the extendable mast is a telescoping mast.

2. The system of claim 1 further comprising a rangefinder configured to determine a size of a gas emission plume and a velocity of the gas emission plume.

3. The system of claim 2 further comprising an appliance mounted to the extendable mast and wherein the appliance houses at least two or more of the emission monitoring platform, the rangefinder, and the imaging device.

4. The system of claim 1 wherein the gas emission comprises a C1-C6 hydrocarbon.

5. The system of claim 1 wherein the gas emission comprises methane and the emission monitoring platform comprises a hyperspectral imaging device.

6. The system of claim 1 wherein the facility interface panel is configured to be powered by facility power, a generator, a solar array, or any combination thereof.

7. The system of claim 1 wherein the processor is configured to provide a notice upon a gas emission above a threshold level.

8. The system of claim 1 wherein the processor is configured to provide a user with an actual emission rate.

9. The system of claim 1 wherein the processor is configured to provide a user with an actual emission rate per activity, an actual emission rate per a piece of equipment, or any combination thereof.

10. The system of claim 1 wherein the processor is configured to provide a user with a summary image of an emissions event wherein said summary image comprises a hyperspectral image of emission concentration on a visual image of a field of view.

11. The system of claim 1 wherein the processor is configured to provide a user with a recorded video of an emissions event wherein said recorded video comprises an emission concentration.

12. The system of claim 1 wherein the processor is configured to provide a user with hyperspectral data and system telemetry.

13. The system of claim 1 wherein the processor is configured to provide a user with emission data comprising an emission source, an emission volume, an emission frequency, or any combination thereof.

14. The system of claim 3 wherein the appliance is configured to allow for 360 degree monitoring of a facility emitting an emission.

15. The system of claim 3 wherein the appliance is configured to observe emissions at from about 25 meters up to about 150 meters.

16. The system of claim 1 wherein the system is configured to continuously monitor a facility emitting an emission.

17. The system of claim 1 wherein the extendable mast is mounted on a trailer and wherein the extendable mast is configured to extend substantially vertical relative to the ground.

18. The system of claim 1 wherein the extendable mast is a telescoping mast that extends up to about 40 feet in a substantially vertical direction relative to the ground.

19. The system of claim 1 wherein the emission monitoring platform is configured to identify and quantify a gas emission wherein said gas emission comprises two or more gases.

20. The system of claim 1 wherein the system further comprises a winch for moving the extendable mast up or down.

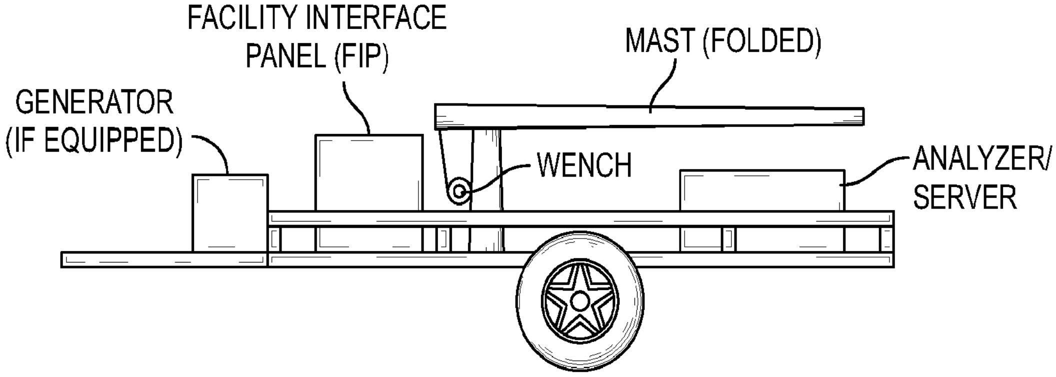

Figure 1

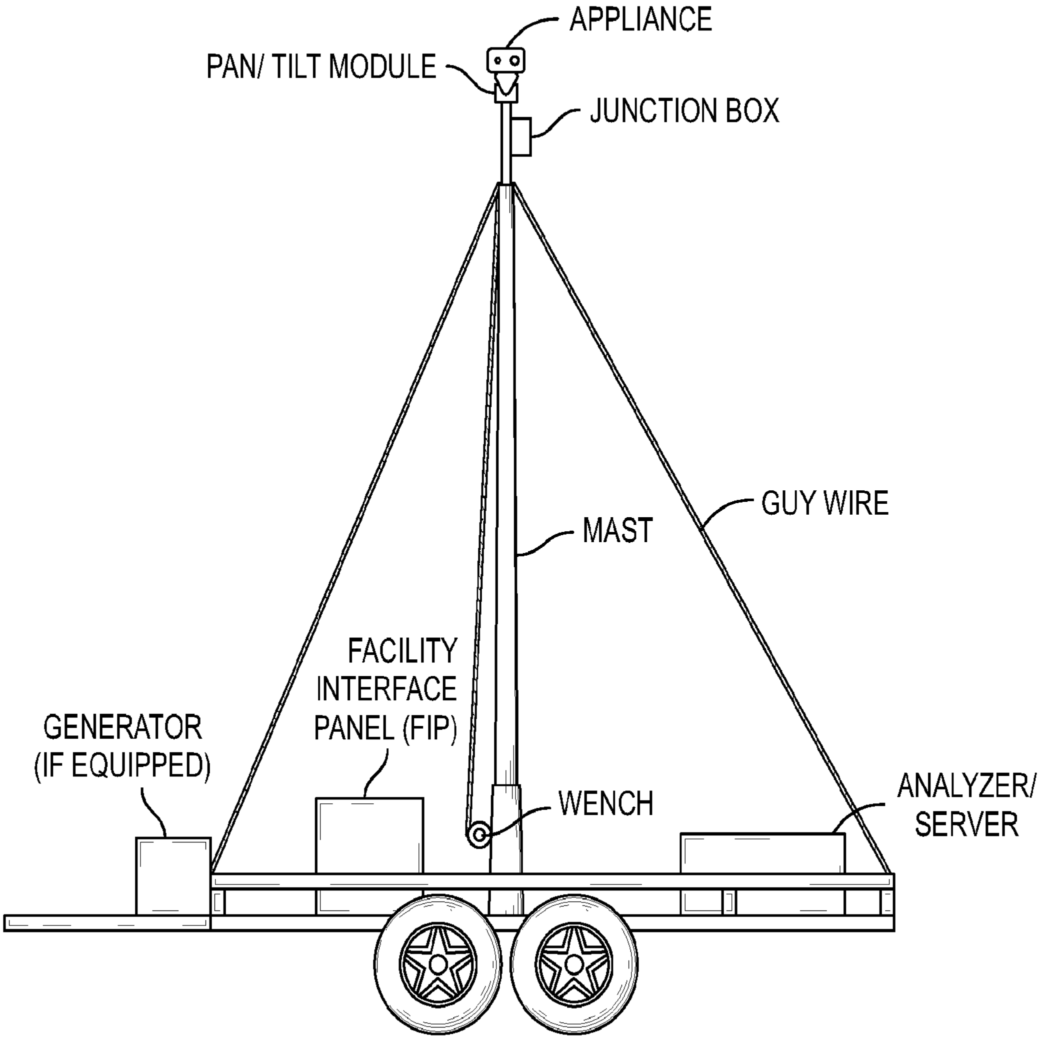

Figure 2

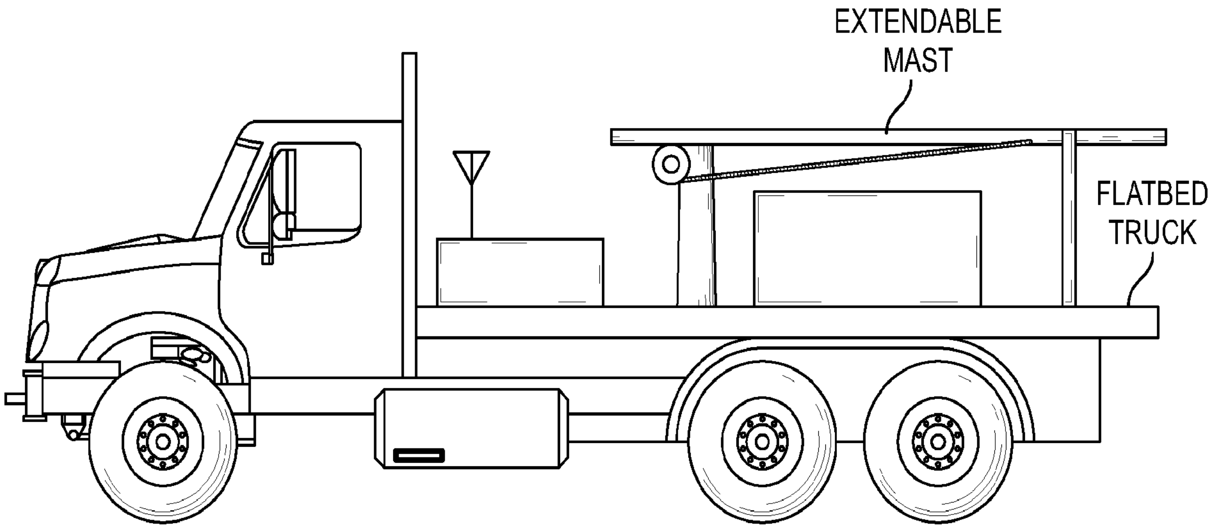

Figure 3

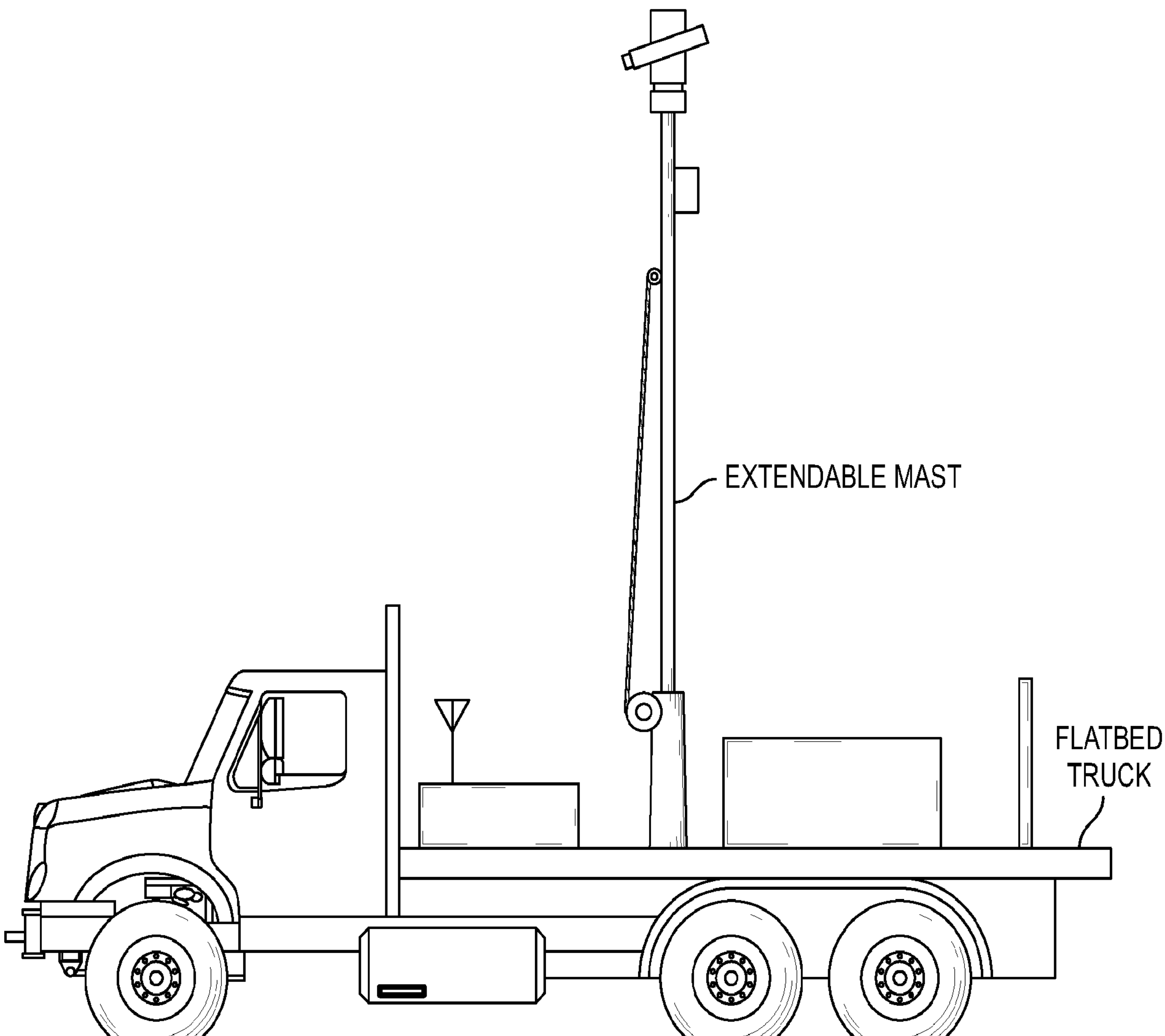

Figure 4

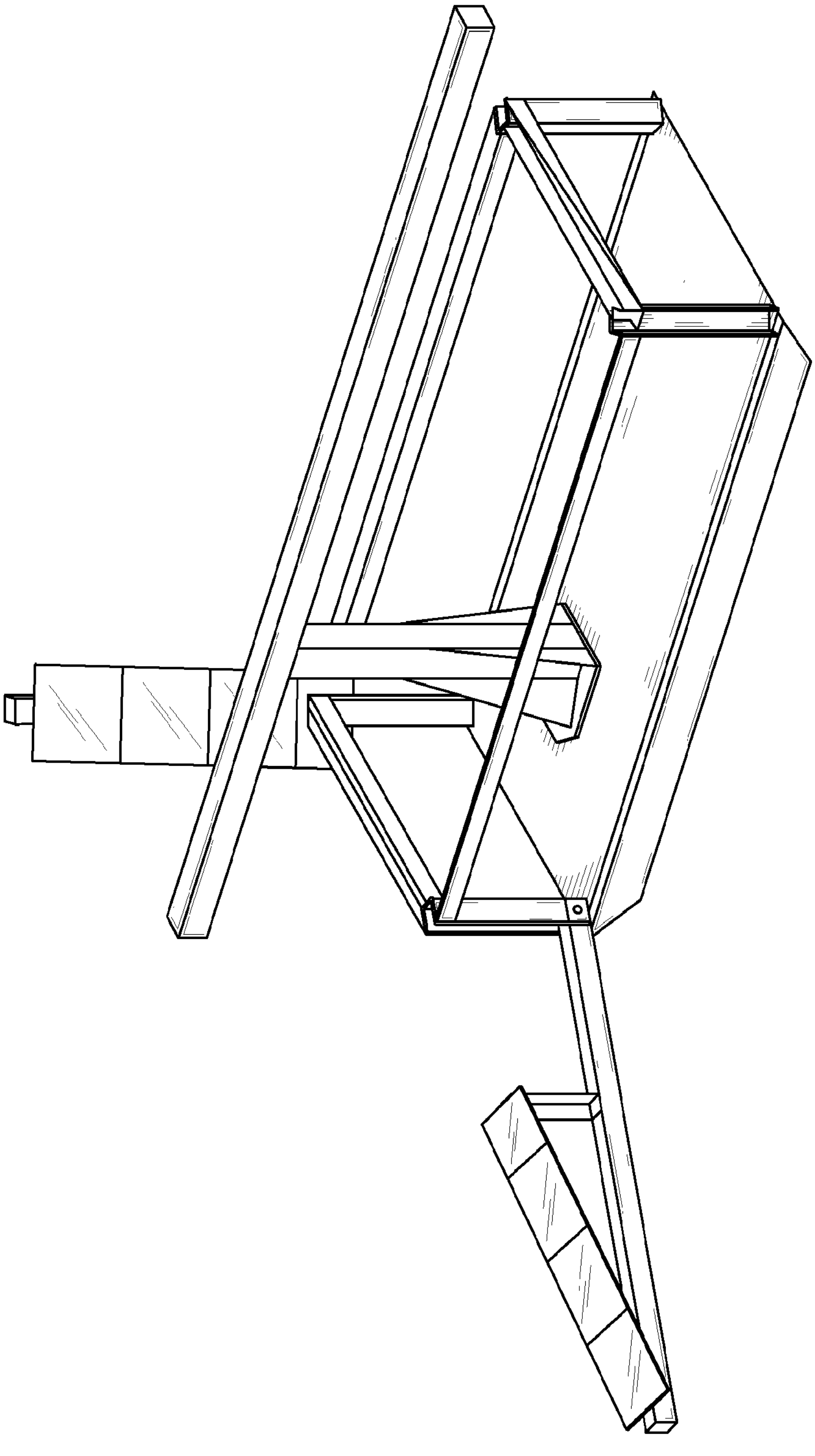

Figure 5

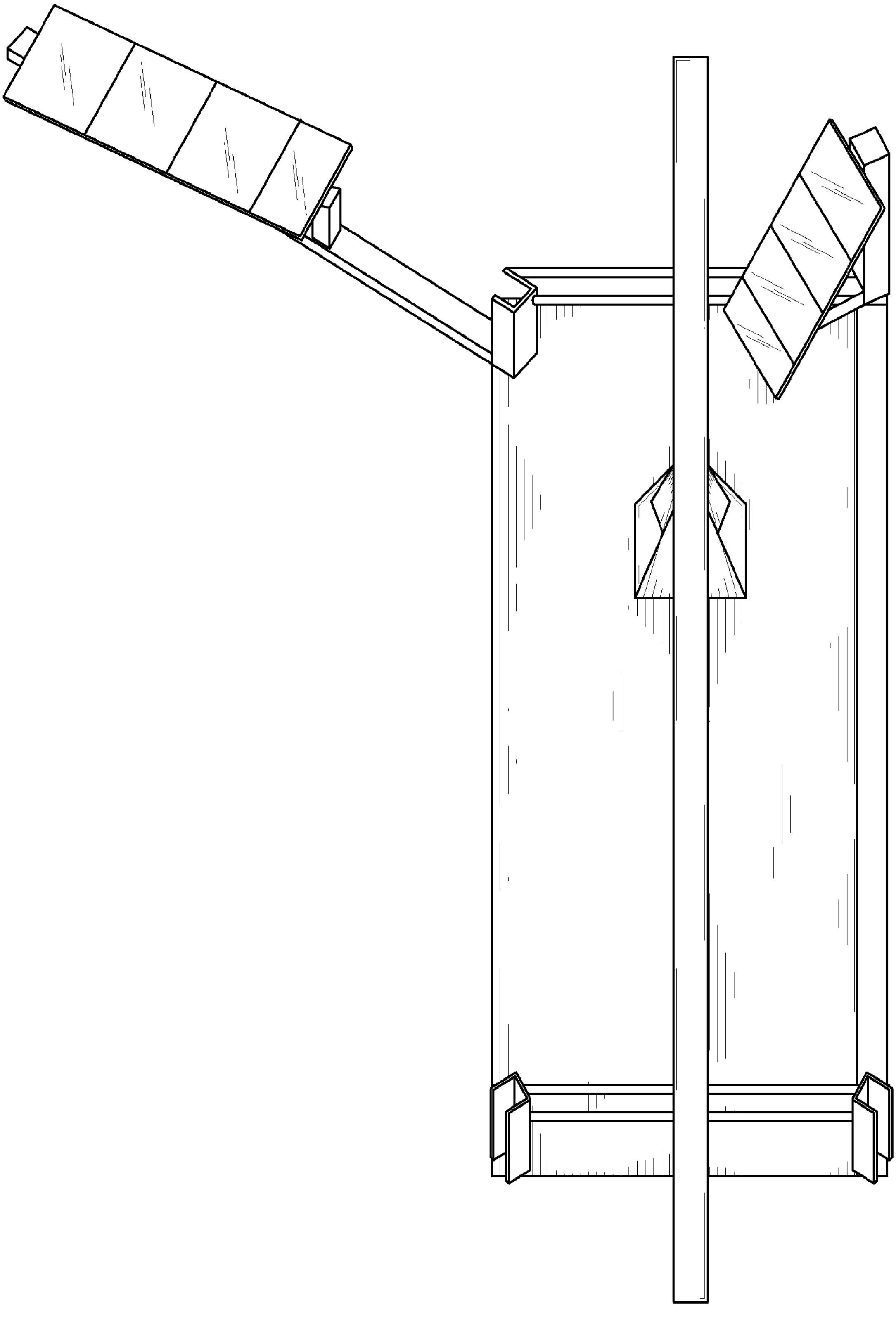

Figure 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 22/44905

A. CLASSIFICATION OF SUBJECT MATTER

IPC - INV. G01N 21/25, G01N 33/00, G01J 3/28, E04H 12/18 (2022.01)

ADD. G01N 21/17, E04H 12/34 (2022.01)

CPC - INV. G01N 33/0004, G01N 33/0009, G01N 33/0036, G01N 33/0047, G01J 3/2823, G01N 21/255, E04H 12/182

ADD. G01N 33/0062, G01J 2003/2826, G01J 3/2823, G01N 2021/1793, E04H 12/34

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)
See Search History document

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X — Y	US 10,063,815 B1 (SPIVEY et al.) 28 August 2018 (28.08.2018), Fig. 3; col 1, ln 27-32; col 2, ln 22-col 3, ln 14; col 4, ln 62-64; col 10, ln 57-59; col 12, ln 16-26	1, 6, 18, 19 — 2-5, 7-17, 20
Y	Hamilton, P. M., "A Discussion on recent research in air pollution-The application of a pulsed-light rangefinder (lidar) to the study of chimney plumes." Philosophical Transactions of the Royal Society of London. Series A, Mathematical and Physical Sciences 265.1161 (1969): 153-172, Fig. 12; pg 160, 163 [online] <https://royalsocietypublishing.org/doi/abs/10.1098/rsta.1969.0044>	2, 3, 14, 15
Y	US 2018/0259418 A1 (ACCENTURE GLOBAL SOLUTIONS LIMITED) 13 September 2018 (13.09.2018), Fig. 3; para [0016]-[0019], [0023], [0031]-[0043], [0046], [0051]-[0059],	4, 5, 7, 10-13, 16
Y	US 2016/0131514 A1 (INSTITUT NATIONAL D'OPTIQUE) 12 May 2016 (12.05.2016), abstract; para [0033]-[0037], [0043]-[0045]	8, 9
Y	US 2012/0151852 A1 (THOREN et al.) 21 June 2012 (21.06.2012), abstract; Fig 2A-2C; para [0041], [0046]	17, 20
A	WO 2018/044378 A1 (KONICA MINOLTA LABORATORY U.S.A., INC.) 08 March 2018 (08.03.2018), entire document	1-20
A	WO 2020/150388 A1 (BRIDGER PHOTONICS, INC.) 23 July 2020 (23.07.2020), entire document	1-20

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
08 December 2022	FEB 16 2023
Name and mailing address of the ISA/US	**Authorized officer**
Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	Kari Rodriquez Telephone No. PCT Helpdesk: 571-272-4300

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 22/44905

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	HONEYWELL RAE, Brochure_AreaRAE Pro_DS01173_07-17 Copyright 2017 Honeywell International Inc. [online] < https://sps.honeywell.com/content/dam/his-sandbox/products/gas-and-flame-detection/documents/Brochure_AreaRAE20Pro_DS01173_07-17_LR.pdf>	1-20