(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) **World Intellectual Property Organization**
International Bureau

(43) **International Publication Date**
27 June 2024 (27.06.2024)

WIPO | PCT

(10) **International Publication Number**
WO 2024/137906 A1

(51) **International Patent Classification:**
E21B 41/00 (2006.01) ***F23G 7/08*** (2006.01)
E21B 43/34 (2006.01)

(21) **International Application Number:**
PCT/US2023/085292

(22) **International Filing Date:**
21 December 2023 (21.12.2023)

(25) **Filing Language:** English

(26) **Publication Language:** English

(30) **Priority Data:**
63/476,981 23 December 2022 (23.12.2022) US

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(81) **Designated States** *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MU, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ,

(54) **Title:** ADJUSTABLE FLARE TIP

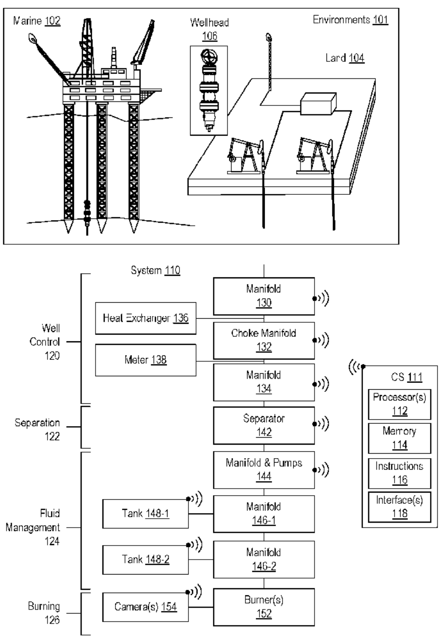

Fig. 1

(57) **Abstract:** A system can include an adjustable flare tip that includes an actuator; an adjustable throat restrictor operatively coupled to the actuator; and an interface for receipt of control instructions, where the actuator responds to the control instructions to adjust the throat restrictor; and a controller that generates the control instructions.

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RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

ADJUSTABLE FLARE TIP

Cross-Reference To Related Application

[0001] This application claims priority to U.S. Provisional Patent Application No. 63/476981, filed on December 23, 2023, which is incorporated by reference herein.

BACKGROUND

[0002] The global oil and gas industry is trending toward improved environmental safety and compliance throughout the various phases of a well lifecycle. Exploration and production involves dynamic well testing that can produce a large amount of hydrocarbons at the surface. As, at times, excess hydrocarbons cannot be stored, they may be disposed of by flaring, which can be relevant for onshore operations and offshore operations. Flaring can occur during various phases or operations, which can in drilling, well testing, production, etc.

[0003] Combustion of hydrocarbon can result various types of emissions, which can include, for example, visible emission, heat energy emission, and smoke. Burner operations (e.g., flaring) can be controlled on site, for example, via air supply adjustment, which may aim to maintain acceptable combustion through variations in fluid properties, flowrates, and weather conditions.

[0004] For the continuous burning phase which can last for days, on site monitoring and regulation of air supply to the burner can be controllable if appropriate control equipment to regulate gas flow and combustion exists on site. A failing to monitor combustion and adjust air supply according to the flame or smoke appearance can have a negative impact on the combustion quality and emissions from the burner. For example, consider short chain hydrocarbons such as methane, propane, ethylene, propylene, butadiene and butane, which under ideal conditions can react efficiently with atmospheric oxygen to form carbon dioxide (CO2) and water. Inefficient combustion (i.e., poor quality combustion) can result in higher emissions of such hydrocarbons along with chemical intermediates. Inefficient combustion can result in environmental and regulatory issues. Flare monitoring can increase awareness of inefficient combustion of lit flares and may provide indications of direct emissions from unlit flares.

SUMMARY

[0005] A system can include an adjustable flare tip that includes an actuator; an adjustable throat restrictor operatively coupled to the actuator; and an interface for receipt of control instructions, where the actuator responds to the control instructions to adjust the throat restrictor; and a controller that generates the control instructions.

[0006] This summary is provided to introduce a selection of concepts that are further described below in the detailed description. This summary is not intended to identify key or essential features of the claimed subject matter, nor is it intended to be used as an aid in limiting the scope of the claimed subject matter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Features and advantages of the described implementations can be more readily understood by reference to the following description taken in conjunction with the accompanying drawings.

[0008] **FIG. 1** is a series of diagrams of example environments and an example of a burner system.

[0009] **FIG. 2** is a diagram of an example of a burner system.

[0010] **FIG. 3** is a diagram of an example of a burner boom.

[0011] **FIG. 4** is a diagram of an example of a burner system.

[0012] **FIG. 5** is a series of example images and an example graphical user interface.

[0013] **FIG. 6** is a diagram of an example of a system.

[0014] **FIG. 7** is a diagram of an example of an adjustable flare tip mechanism.

[0015] **FIG. 8** is a diagram of examples of adjustable flare tip mechanisms.

[0016] **FIG. 9** is a diagram of examples of adjustable flare tip mechanisms.

[0017] **FIG. 10** is a diagram of an example of a method and an example of a system.

[0018] **FIG. 11** illustrates example components of a system and a networked system.

DETAILED DESCRIPTION

[0019] The following description is not to be taken in a limiting sense, but rather is made merely for the purpose of describing the general principles of the implementations. The scope of the described implementations should be ascertained with reference to the issued claims.

[0020] Methane (CH4) is a hydrocarbon that can be classified as an anthropogenic greenhouse gas (GHG) in the atmosphere (e.g., consider carbon dioxide as another type of greenhouse gas). The International Energy Agency (IEA) Methane Tracker 2020 report states that emissions from the oil and gas industry account for approximately 22 percent of anthropogenic sources (see IEA Methane Tracker, Fuel report — March 2020 https://www.iea.org/reports/methane-tracker-2020).

[0021] When natural gas is burned in a flare, CO2 and water are generated as products of the combustion process. Considering that methane is estimated to be 80 times more potent that CO2 in a 20-year lifespan, knowing the status of a flare (e.g., a burner) can be helpful. For example, knowing when flares are unlit and venting uncombusted methane to the atmosphere can be helpful to know for various reasons. As explained, efficient combustion by a lit flare aims to convert hydrocarbons to CO2 and water, which can be considered relatively innocuous compared to direct release of such hydrocarbons into the atmosphere. If an emissions strategy involves combustion, detection of a lit flare can be an indicator that the emissions strategy is being implemented; whereas, detection of an unlit flare (e.g., via a change in status of a previously lit flare) can indicate that the emissions strategy is experiencing issues.

[0022] Satellite data can provide a coarse indicator of potential methane leaks through direct atmospheric methane concentration readings. A couple of public satellites circle the earth every 24 hours and can monitor methane emissions and detect fires. Various satellites can circle the Earth multiple times per day (e.g., consider 2 to 14 times or more). Various satellites have relatively large apertures such that they can observe the entire surface of the Earth (e.g., every day, etc.). As to resolution, some have resolutions that range from approximately 750 m x 750 m (0.56 km^2) to 7 km x 7 km (49 km^2). Some satellites have finer resolutions, for example, consider the Sentinel 2P satellite with a resolution of approximately 20 m x 20 m (e.g., 400 m^2).

[0023] A cost-effective system can monitor flares in a relatively continuous manner to identify when flares have gone out (e.g., become unlit) and, for example, detect unusual atmospheric methane concentrations and alert when issues are found so appropriate actions can be triggered. As an example, an automatic system can detect unlit flares using geospatial data from multiple sources and issue one or more types of signals, for example, when an issue or issues are detected. As explained, such an issue or issues can pertain to an emissions strategy for one or more sites. The issuance of one or more types of signals can provide notifications to take corrective action or control instructions to control equipment to take corrective action.

[0024] **FIG. 1** shows examples of environments 101, including a marine environment 102 and a land environment 104 where the marine environment 102 includes various equipment and where the land environment 104 includes various equipment. As shown, each of the environments 101 can include one or more wellheads 106 (e.g., wellhead equipment). A wellhead can be a surface termination of a wellbore that can include a system of spools, valves and assorted adapters that, for example, can provide for pressure control of a production well. A wellhead may be at a land surface, a subsea surface (e.g., an ocean bottom, etc.), etc. As an example, conduits from multiple wellheads may be joined at one or more manifolds such that fluid from multiple wells can be flow in a common conduit.

[0025] At various times, a well may be tested using a process referred to as well testing. During well testing, reservoir fluids can be produced at a separator at varying rates, for example, according to a predetermined schedule. Such tests may take less than two days to evaluate a single well or may take months to evaluate reservoir extent. As such, flaring, which may depend on test type, etc., may occur over a period of a day or less or more than a month. Well testing can include one or more of a variety of well testing operations where tests may include, for example, one or more of buildup, drawdown, falloff, injection and interference. In various instances, fluid can flow from a well or wells to surface where the fluid is subjected to one or more well testing operations and generates scrap (e.g., waste fluid), which must be handled appropriately, for example, according to circumstances, regulations, etc. For example, consider loading waste fluid into a tanker for transport to a facility that can dispose of the waste fluid. Another manner of handling waste fluid can be through combustion, which can be referred to as burning. As an example, burning can be part of a well testing process, whether burning is for handling waste fluid and/or for analyzing one or more aspects of how one or more waste fluids burn. As to the latter, burning may optionally provide data as to one or more characteristics of well fluid (e.g., a component thereof, etc.).

[0026] As an example, disposal of produced hydrocarbons during one or more types of operations may be via burning, which can include on-site burning and/or off-site burning. Burning can be particularly suitable when facilities are not available for storage (e.g., consider mobile offshore drilling rigs, remote locations onshore, etc.).

[0027] As to the example environments 101 of **FIG. 1**, consider well testing as an operation that may be performed, for example, using equipment shown in the marine environment 102 and/or using equipment shown in the land environment 104. As an example, an environment may be under exploration, development, appraisal, etc., where such an environment includes at least one well where well fluid can be produced (e.g., via natural pressure, via fracturing, via artificial lift, via pumping, via flooding, etc.). In such an environment, various types of equipment may be on-site, which may be operatively coupled to well testing equipment.

[0028] **FIG. 1** shows an example of a system 110 that can be operatively coupled to one or more conduits that can transport well fluid, for example, from one or more wellheads. As shown, the system 110 can include a computational system 111 (CS), which can include one or more processors 112, a memory 114 accessible to at least one of the one or more processors 112, instructions 116 that can be stored in the memory 114 and executable by at least one of the one or more processors 112, and one or more interfaces 118 (e.g., wired, wireless, etc.). In the example of **FIG. 1**, the system 110 is shown as including various communication symbols, which may be for transmission and/or reception of information (e.g., data, commands, etc.), for example, to and/or from the computational system 111. As an example, the computational system 111 can be a controller that can issue control instructions to one or more pieces of equipment in an environment such as, for example, the marine environment 102 and/or the land environment 104. As an example, the computational system 111 may be local, may be remote or may be distributed such that it is in part local and in part remote.

[0029] Referring again to the wellhead 106, it can include various types of wellhead equipment such as, for example, casing and tubing heads, a production tree, a blowout preventer, etc. Fluid produced from a well can be routed through the wellhead 106 and into the system 110, which can be configured with various features for well testing operations.

[0030] In the example of **FIG. 1**, the system 110 is shown to include various segments, which may be categorized operationally. For example, consider a well control segment 120, a separation segment 122, a fluid management segment 124, and a burning segment 126.

[0031] As shown in the example of **FIG. 1**, the well control segment 120 is an assembly of various components such as a manifold 130, a choke manifold 132, a manifold 134, a heat exchanger 136 and a meter 138; the separation segment 122 includes a separator 142; the fluid management segment 124 is an assembly of various components such as manifolds and pumps 144, a manifold 146-1, a manifold 146-2, a tank 148-1 and a tank 148-2; and the burning segment 126 includes a burner 152 and one or more cameras 154.

[0032] As mentioned, in the example of **FIG. 1**, the system 110 includes various features for one or more aspects of well testing operations; noting that the system 110 may include lesser features, more features, alternative features, etc. For example, consider one or more of a gas specific gravity meter, a water-cut meter, a gas-to-oil ratio sensor, a carbon dioxide sensor, a hydrogen sulfide sensor, or a shrinkage measurement device. Various features may be upstream and/or downstream of a separator segment or a separator.

[0033] With respect to flow of fluid from a well or wells, such fluid may be received by the well control segment 120 and then routed via one or more conduits to the separation segment 122. In the example of **FIG. 1**, the well control segment 120 the heat exchanger 136 may be provided as a steam-heat exchanger and the meter 138 for measuring flow of fluid through the well control segment 120.

[0034] As mentioned, the well control segment 120 can convey fluid received from one or more wells to the separator 142. As an example, the separator 142 can be a horizontal separator or a vertical separator, and can be a two-phase separator (e.g., for separating gas and liquids) or a three-phase separator (e.g., for separating gas, oil, and water). A separator may include various features for facilitating separation of components of incoming fluid (e.g., diffusers, mist extractors, vanes, baffles, precipitators, etc.).

[0035] As an example, fluid can be single phase or multiphase fluid where "phase" refers to an immiscible component (e.g., consider two or more of oil, water, and gas).

[0036] As an example, the separator 142 can be used to substantially separate multiphase fluid into its oil, gas, and water phases, as appropriate and as present, where each phase emerging from the separator 142 may be referred to as a separated fluid. Such separated fluids may be routed away from the separator 142 to the fluid management segment 124. In various instances, the separated fluids may not be entirely homogenous. For example, separated gas exiting the separator 142 can include some residual amount of water or oil and separated water exiting the separator 142 can include some amount of oil or entrained gas. Similarly, separated oil leaving the separator 142 can include some amount of water or entrained gas.

[0037] As shown in the example of **FIG. 1**, the fluid management segment 124 includes flow control equipment, such as various manifolds and pumps (generally represented by the block 144) for receiving fluids from the separator 142 and conveying the fluids to other destinations, as well as additional manifolds 146-1 and 146-2 for routing fluid to and from fluid tanks 148-1 and 148-2. While two manifolds 146-1 and 146-2 and two tanks 148-1 and 148-2 are depicted in **FIG. 1**, it is noted that the number of manifolds and tanks can be varied. For instance, in one embodiment, the fluid management segment 124 can include a single manifold and a single tank, while in other embodiments, the fluid management segment 124 can include more than two manifolds and more than two tanks.

[0038] As to the manifolds and pumps 144, they can include a variety of manifolds and pumps, such as a gas manifold, an oil manifold, an oil transfer pump, a water manifold, and a water transfer pump. In at least some embodiments, the manifolds and pumps 144 can be used to route fluids received from the separator 142 to one or more of the fluid tanks 148-1 and 148-2 via one or more of the additional manifolds 146-1 and 146-2, and to route fluids between the tanks 148-1 and 148-2. As an example, the manifolds and pumps 144 can include features for routing fluids received from the separator 142 directly to the one or more burners 152 for burning gas and oil (e.g., bypassing the tanks 148-1 and 148-2) or for routing fluids from one or more of the tanks 148-1 and 148-2 to the one or more burners 152.

[0039] As noted above, components of the system 110 may vary between different applications (e.g., operations, etc.). As an example, equipment within each functional group of the system 110 may also vary. For example, the heat exchanger 136 could be provided as part of the separation segment 122, rather than of the well control segment 120.

[0040] In certain embodiments, the system 110 can be a surface well testing system that can be monitored and controlled remotely. Remote monitoring may be effectuated with sensors installed on various components. In some instances, a monitoring system (e.g., sensors, communication systems, and human-machine interfaces) can enable monitoring of one or more of the segments 120, 122, 124, and 126. As shown in the example of **FIG. 1**, the one or more cameras 154 can be used to monitor one or more burning operations of the one or more burners 152, which may aim to facilitate control of such one or more burning operations at least in part through analysis of image data acquired by at least one of the one or more cameras 154.

[0041] **FIG. 2** shows an example of a system 250, which may be referred to as a surface well testing system. The system 250 can include various features of the system 110 of **FIG. 1**. Various equipment of the system 250, such as flaring equipment, may be present at one or more types of sites (e.g., production sites, well testing sites, etc.).

[0042] In **FIG. 2**, a multiphase fluid (represented here by arrow 252) enters a flowhead 254 and is routed to a separator 270 through a surface safety valve 256, a steam-heat exchanger 260, a choke manifold 262, a flow meter 264, and an additional manifold 266. In the example of **FIG. 2**, the system 250 includes a chemical injection pump 258 for injecting chemicals into the multiphase fluid flowing toward the separator 270.

[0043] In the depicted embodiment of **FIG. 2**, the separator 270 is a three-phase separator that generally separates the multiphase fluid 252 into gas, oil, and water components. The separated gas is routed downstream from the separator 270 through a gas manifold 274 to either of the burners 276-1 and 276-2 for flaring gas and burning oil. The gas manifold 274 includes valves that can be actuated to control flow of gas from the gas manifold 274 to one or the other of the burners 276-1 and 276-2. Although shown next to one another in **FIG. 2** for sake of clarity, the burners

276-1 and 276-2 may be positioned apart from one another, such as on opposite sides of a rig, etc.

[0044] As shown, the separated oil from the separator 270 can be routed downstream to an oil manifold 280. Valves of the oil manifold 280 can be operated to permit flow of the oil to either of the burners 276-1 and 276-2 or either of the tanks 282 and 284. The tanks 282 and 284 can be of a suitable form, but are depicted in **FIG. 2** as vertical surge tanks each having two fluid compartments. This allows each tank to simultaneously hold different fluids, such as water in one compartment and oil in the other compartment. An oil transfer pump 286 may be operated to pump oil through the well testing system 250 downstream of the separator 270. The separated water from the separator 270 can be similarly routed to a water manifold 290. Like the oil manifold 280, the water manifold 290 includes valves that can be opened or closed to permit water to flow to either of the tanks 282 and 284 or to a water treatment and disposal apparatus 294. A water transfer pump 292 may be used to pump the water through the system.

[0045] A well test area in which the well testing system 250 (or other embodiments of a well testing system) is installed may be classified as a hazardous area. In some embodiments, the well test area is classified as a Zone 1 hazardous area according to International Electrotechnical Commission (IEC) standard 60079-10-1:2015.

[0046] In the example of **FIG. 2**, a cabin 296 at a wellsite may include various types of equipment to acquire data from the well testing system 250. These acquired data may be used to monitor and control the well testing system 250. In at least some instances, the cabin 296 can be set apart from the well test area having the well testing system 250 in a non-hazardous area. This is represented by the dashed line 298 in **FIG. 2**, which generally serves as a demarcation between the hazardous area having the well testing system 250 and the non-hazardous area of the cabin 296.

[0047] The equipment of a system can be monitored during a process to verify proper operation and facilitate control of the process. Such monitoring can include taking numerous measurements, examples of which can include choke manifold temperature and pressures (upstream and downstream), heat exchanger temperature and pressure, separator temperature and pressures (static and differential), oil flow rate and volume from the separator, water flow rate and volume from the separator, and fluid levels in tanks of a system.

[0048] As an example, a mobile monitoring system may be provided. In such an example, monitoring of a process can be performed on a mobile device (e.g., a mobile device suitable for use in Zone 1 hazardous area, like the well test area). Various types of information may be automatically acquired by sensors and then presented to an operator via the mobile device. The mobile monitoring system may provide various functions, such as a sensor data display, video display, sensor or video information interpretation for quality-assurance and quality-control purposes, and a manual entry screen (e.g., for a digital tally book for recording measurements taken by the operator).

[0049] **FIG. 3** shows an example of a burner boom 300, which can be configured for horizontal mounting, mounting at an angle, vertical mounting, etc. For example, the burner boom 300 can be mounted on a rig with a rotating base plate and guy lines. In such an example, horizontal guy lines can help to orient the burner boom 300; vertical guy lines, which are fixed to the rig's main structure, can support the burner boom 300. A rotating base can enable horizontal and vertical positioning of the burner boom 300 and its burner. As an example, the burner boom 300 may be positioned slightly above horizontal so that oil left in piping after flaring operations does not leak out. Flaring equipment such as the burner boom 300 may be present at one or more types of sites (e.g., production sites, well testing sites, etc.) to provide for flaring operations.

[0050] As an example, a burner can be boom mounted or mounted on another type of support structure. As an example, a structure can support various conduits that provide fluid such as, for example, one or more of air, water, oil, and propane.

[0051] In the example of **FIG. 3**, conduits or lines include an additional gas line 310, pilot line cables 320, an oil line 330, a water line 340, a water wall screen line 350, an air line 360, and a main gas line 370.

[0052] As to the burner boom 300 of **FIG. 3**, its burner can be configured and controlled to perform in a desirable manner. For example, it may be desired to burn in a fallout-free and smokeless manner for combustion of liquid hydrocarbons produced during well testing. As an example, a burner geometry can utilize pneumatic atomization and enhanced air induction. As an example, a burner can be equipped with one or more pilots, a flame-front ignition system (BRFI), and a built-in water screen to reduce heat radiation. As an example, a burner can be fitted with an automatic shutoff valve that prevents oil spillage at the beginning and end of a burning run.

[0053] As to burner control, a burner can include a high turn-down feature (e.g., 1:5), which may be optionally further extended to a higher ratio (e.g., 1:30) using a multirate kit (BMRK) option, which allows for selecting the number of operating nozzles. For onshore operations, a skid may be utilized for skid-mounting.

[0054] As to burner efficiency, a burner may be suited for high efficiency burning with one or more types of oil (e.g., including particularly heavy and waxy oils). As an example, a burner may operate effectively up to a water cut rating (e.g., up to 25 percent water cut), which may be desirable for various types of cleanup operations.

[0055] As a burner may be operational in a manner that provides for substantially no liquid fallout and substantially no visible smoke emissions, such a burner may be particularly suited for operations in environmentally sensitive areas.

[0056] **FIG. 4** is a system diagram of an example of a burner control system 400. The system 400 includes at least one camera 407-1 and 407-2 positioned to capture one or more images 402-1 and 402-2 of a flare emitted by a burner 401. In the example of **FIG. 4**, two cameras 407-1 and 407-2 are shown capturing images 402-1 and 402-2 from different locations to acquire image data from more than one image plane of the flare. The burner 401 includes a fuel feed 403 that flows fuel to the burner 401 (see, e.g., the burners 276-1 and 276-2 of **FIG. 2**, the burner 300 of **FIG. 3**, etc.). The burner 401 also includes an air feed 405 that flows air to the burner 401. Flow rate of the air feed 405 is controlled by a control valve 408, where an air flow sensor 411 senses flow rate of air into the burner 401. A fuel flow sensor 413 senses flow rate of fuel to the burner 401. Other sensors 404, along with the at least one camera 407-1 and 407-2, are operatively coupled to local electronic equipment 420. The sensors 404 may sense, and produce signals representing, combustion effective parameters such as temperature, wind speed, and ambient humidity. The sensors 404, 411, and 413, and the cameras 407-1 and 407-2 send data, including data representing the images 402-1 and 402-2, along with data representing readings of the sensors 404, 411, and 413, directly and/or indirectly, to the local electronic equipment 420, which may be present at a wellsite in a production phase and/or a drilling phase (e.g., in a doghouse, a cabin, etc.). The data sent to the local electronic equipment 420 can represent a state of combustion taking place at the burner 401.

[0057] As shown in the example of **FIG. 4**, the local electronic equipment 420 can be in communication with remote electronic equipment 440. For example, consider use of one or more wired and/or wireless interfaces that allow for communications between the local and remote electronic equipment 420 and 440. In such an example, various computational tasks may be executed locally and/or remotely. For example, consider a local computing device that can include an application that can render a graphical user interface (GUI) to a display. In such an example, the GUI can include control graphics that are selectable to issue instructions such as, for example, one or more application programming interface (API) calls, which may be directed to the local electronic equipment 420, the remote electronic equipment 440, etc., to cause one or more actions to occur such as formulation of a response to an API call.

[0058] As an example, the local and remote electronic equipment 420 and 440 may be configured in a client-server arrangement where the local electronic equipment 420 operates as a client and the remote electronic equipment 440 operates as a server. As an example, data acquired by the local electronic equipment 410 (e.g., as part of the system 400) may be processed for local control and/or transmitted (e.g., as raw and/or processed data) for processing, storage, etc., by the remote electronic equipment 440. As an example, the remote electronic equipment 440 can include one or more cloud-based resources. In such an example, the remote electronic equipment 440 may provide services such as, for example, software as a service. As an example, control effectuated by the system 400 to control the burner 401 can be based on local and/or remote computing (e.g., using the local electronic equipment 420, the remote electronic equipment 440, etc.).

[0059] As to control of a burner, a model can be used, which may be a physics-based model, a machine learning model, a hybrid model, etc. As an example, a model-based approach can allow for prediction of various parameters such as, for example, air control parameters based on the data from the sensors 404, 411, and 413 and the at least one of the one or more cameras 407-1 and 407-2. As an example, one or more air control parameters can be applied to the control valve 408 to control air supply to the burner 401, which can be part of a combustion process that generates a flare that can be captured, as depicted in the one or more images 402-1 and 402-2.

[0060] Camera as used herein, means an imaging device. A camera can capture an image of electromagnetic (EM) radiation in a medium that can be converted to data for use in digital processing. The conversion can take place within the camera or in a separate processor. The camera may capture images in one wavelength or across a spectrum (e.g., or spectra), which may encompass the ultraviolet (UV) spectrum, the visible spectrum, and/or the infrared spectrum. For example, a camera may capture an image of wavelengths from approximately 350 nm to approximately 1,500 nm. As an example, one or more of a broad spectrum imaging device such as a LIDAR detector, a narrower spectrum detector such as a charged-coupled device (CCD) array, and a short-wave infrared detector can be used as an imaging device or as imaging devices. Cameras can be monovision cameras or stereo cameras.

[0061] In the example of **FIG. 4**, the local electronic equipment 420 is shown as including an image processing unit 410, which may include and/or be operatively coupled to a model or models for purposes of processing one or more of the images 402-1 and 402-2 as captured by the at least one camera 407-1 and 407-2. As an example, a data set, along with sensor data representing oil flow rate, gas flow rate, water or steam flow rate, air flow rate, pressure, temperature, wind speed, ambient humidity, and other combustion effective parameters, can be considered different types of inputs. As an example, a model can receive input or inputs and can output one or more air control parameters, such as flow rate, pressure, and/or temperature, for the burner 401 (e.g., or burners) controlled by the system 400.

[0062] As to a machine learning model (ML model), such a model can be a neural network model (NN model). As an example, a trained ML model can be utilized to control one or more burners. As an example, a trained ML model can be trained with respect to a particular burner and/or type of burner. In such an approach, a trained ML model can be selected based at least in part on burner specifications (e.g., manufacturer, model, features, history, etc.).

[0063] Various types of data may be acquired and optionally stored, which may provide for training one or more ML models and/or for offline analysis, etc. For example, air control parameters output by a trained NN model can be stored in digital storage for later analysis, which may include further training, training a different ML model, etc. During control of an ongoing burning operation, one or more air control parameters can be transmitted to one or more control valves that control air supply to one or more burners as may be operatively coupled to the system controlled by the control system. Subsequent images and sensor data acquisitions can be captured, and the control cycle repeated as many times as desired. Frequency of repetition can depend on various time constants of the system 400. As an example, a cycle may be as short as a fraction of a second or as long as five to ten minutes. As an example, consider a 1 Hz operational frequency where several images are captured in a one second interval as in a video feed where computing air control parameters and applying the computed air control parameters to a control valve controlling air supply to the burner are based on the images in the one second interval. As an example, video may be live, with some amount of latency due to transmission and processing time, or video may be deliberately delayed by a delay amount.

[0064] As an example, the image processing unit 410 can convert signals derived from photons received by the one or more cameras 407-1 and 407-2 into data. The image processing unit 410 may be within or separate from a camera. As an example, the image processing unit 410 can convert signals received from the one or more cameras 407-1 and 407-2 into digital data representing photointensity in defined areas of the image and can assign position information to each digital data value. As an example, photointensity may be deconvolved into constituent wavelengths to produce a spectrum for each pixel. Such a spectrum may be sampled in defined bins, and the data from such sampling structured into a data set representing spectral intensity of the received image, for example, as a function of x-y position in the image. As an example, a timestamp can be added. For example, camera circuitry can include a digital clock and/or network circuitry that can receive a clock signal.

[0065] As an example, an image can be a pixel image with pixel position coordinate, a pixel depth and a timestamp. As to depth, various conventions may be utilized and depend on equipment and/or processing. Where color is utilized, a color depth can be referenced. For example, 8-bit color and 24-bit color can be the same where, in an RGB color space, 8-bits refers to each R, G, and B (e.g., subpixel), while 24-bit is a sum of the three 8-bit channels (e.g., 3x8 = 24). Standards can include, for example, monochrome (e.g., 1-bit) to 4K (e.g., 12-bit color, which provides 4096 colors), etc.

[0066] As an example, a method for assessing imagery can include accessing one or more resources as to color models (e.g., as a plug-in, external executable code, etc.). For example, consider a method that includes instructions to access an algorithm of a package, a computing environment, etc., such as, for example, the MATLAB computing environment (marketed by MathWorks, Inc., Natick, MA). The MATLAB computing environment includes an image processing toolbox, for example, with algorithms for color space (e.g., color model) conversions, transforms, etc. As an example, the MATLAB computing environment includes functions “rgb2hsv” and “hsv2rgb” to convert images between the RGB and HSV color spaces (see, e.g., http://www.mathworks.com/help/images/converting-color-data-between-color-spaces.html).

[0067] As an example, a model may be a simulated version of an environment, which may include one or more sites of possible emissions. As an example, a simulator may include features for simulating physical phenomena in an environment based at least in part on a model or models. A simulator, such as a weather simulator, can simulate fluid flow in an environment based at least in part on a model that can be generated via a framework that receives satellite data. A simulator can be a computerized system (e.g., a computing system) that can execute instructions using one or more processors to solve a system of equations that describe physical phenomena subject to various constraints. In such an example, the system of equations may be spatially defined (e.g., numerically discretized) according to a spatial model (e.g., of the Earth, the atmosphere, the oceans, etc.).

[0068] As an example, a system can monitor flares from space and detect when flares are unlit by fusing geospatial data from multiple sources and alerting when issues are detected. In such an example, an alert may be issued via a network interface to one or more destinations, which may include workstations, controllers, etc.

[0069] As to some examples of satellites, consider during night-time, the Visible Infrared Imaging Radiometer Suite (VIIRS) sensor, which exists on the NOAA-20 satellite, which can be used for detecting and characterizing combustion sources. As another example, during daytime, the TROPOspheric Monitoring Instrument (TROPOMI) sensor, which is onboard on the Sentinel 5P Precursor satellite, from the European Space Agency (ESA) uses a short-wave infrared radiation sensor can measure methane concentrations on columns with a base area of 7 x 3.5 km^2. As yet another example, consider the Sentinel 3 satellite with the Sea and Land Surface Temperature Radiometer (SLSTR) instrument from the European Space Agency (ESA), which is also used to measure gas flares and give confidence to the VIIRS sensor. Yet another example is the Sentinel 2 satellite, which, as mentioned, has a resolution as fine as 20 m x 20 m.

[0070] The VIIRS sensor provides for observation of gas flaring. At night, the VIIRS sensor records data in three near- to short-wave infrared channels (NIR and SWIR) designed for daytime imaging. With sunlight eliminated (e.g., night time), features detected in these three channels include combustion sources. The shortwave IR channel, at 1.61 μm, is at a wavelength at, or proximate to, peak radiant emissions from gas flares. The 4-μm channel, widely used in satellite fire detection, detects large flares due to the fact that it falls on the trailing edge of gas flare radiant emissions and observes a mixture of flare plus background radiant emissions. Generally, flare radiant emissions in the 4-μm channel are about a third of the emissions at 1.65 μm, which limits detection of smaller flares in standard satellite fire products based on channels set at the 4 μm wavelength. An article by Elvidge et al., Methods for Global Survey of Natural Gas Flaring from Visible Infrared Imaging Radiometer Suite Data, Energies 2016, 9, 14 (December 2015), is incorporated herein by reference in its entirety.

[0071] As an example, a method can include accessing satellite data as raw data and/or as processed data. For example, processed satellite data as to radiant heat and/or flow rate measurements can be received, which may be associated with flares (e.g., identified and/or not identified in the processed satellite data).

[0072] As an example, images from satellites, environmental data from weather stations, and high frequency satellite imagery can be fed to a system and processed to identify unlit flares.

[0073] **FIG. 5** shows example imagery 510 and imagery with a graphical user interface 530. The imagery 510 shows a combination of TROPOMI and flares from VIIRS satellite data for a region of Algeria. The imagery 510 shows methane mixing ratio on the grid where the markers indicate detected flares. The flares are sized based on amount of radiant heat that is output. As to the imagery and GUI 530, it shows some testing related operations in Algeria based on an event where a flare had gone off where the lower portion is an alternative or additional way to render VIIRS and TROPOMI data. As explained, imagery can provide data as to one or more types of flares for one or more types of flaring operations (e.g., production, well testing, etc.).

[0074] High levels of gas flaring can present various types of issues for producers of hydrocarbons, which can include environmental issues, human safety issues, regulatory issues, etc. For example, consider gas exports under the European Union's carbon border adjustment mechanism (CBAM), which aims to introduce a tax on some products imported into the European Union (EU) based on carbon content, which may include crude oil or petroleum products. Such regulations may impact a region such as Algeria which, in 2020, exported 35 percent (approximately 364,000 b/d) of its total crude oil production to the EU. Data from the World Bank Group's Global Gas Flaring Reduction Partnership (GGFR) showed that Algeria flared some 9.3 bcm in 2020, making it the fifth-largest flarer in the world; noting that there was a slight reduction on the 9.34 bcm of 2019. Algeria's flare intensity, defined as gas flared per barrel of oil produced, was approximately 22.7 m^3/bbl, which is the second-highest worldwide behind Venezuela, and higher than the global average of 5.1 m^3/bbl. According to the GGFR, gas flaring satellite data from 2020 reveals that Russia, Iraq, Iran, the United States, Algeria, Venezuela and Nigeria remain the top seven gas flaring countries for nine years running, since the first satellite was launched in 2012. These seven countries produce 40 percent of the world's oil each year, but account for roughly two-thirds (65 percent) of global gas flaring.

[0075] **FIG. 6** shows an example of a workflow diagram 600. In the example of **FIG. 6**, various sources of data 620, 640, 660 and 680 are shown, for example, consider VIIRS source data, Sentinel 5P source data, Sentinel 3 source data and weather data, noting that one or more alternative and/or additional types of source data may be included. For example, consider one or more of local site data, local control data, solar wind data, etc. As shown in **FIG. 6**, various data can be fused using a method 610.

[0076] In the example of **FIG. 6**, the system 600 can include a weather data source or sources 680. In such an example, weather variables information (e.g., wind speed, direction, cloud cover, etc.) can be extracted. Such information can be utilized in a weather data spatial and/or temporal analysis, which may, for example, provide for aggregating weather data on a temporal basis and/or spatial basis.

[0077] As to the method 610, data may be joined per a join block 611 where such data, or a portion thereof, can be utilized to train one or more machine learning (ML) models per a train block 612, which may provide output as to wind control per a wind control block 613. For example, a trained ML model can predict how to control flaring for particular wind conditions, which can be for a particular location. As shown, the method 610 can evaluate a wind control output per an evaluation block 614. For example, consider using a digital twin (e.g., an avatar) of a flaring site where the digital twin can be subject to wind conditions and the wind control to determine if a result is favorable or unfavorable. In such an example, the method 610 may proceed to implement the wind control per a control block 616, for example, where the evaluation is favorable (e.g., or optionally neutral).

[0078] As an example, the system 600 can include features for evaluation of regional flare metrics, continuous and/or intermittent behaviors, flare presence or absence, etc.; can include features for evaluation of methane mixing ratio signals; can include features for evaluation of flare classification; and can include features for evaluation of weather variables.

[0079] As explained, there are a few public satellites that go around the Earth in polar orbits circling the Earth every 90 minutes. This means various public satellites can cover the whole surface of the earth approximately every 24 hours.

[0080] During night-time, the VIIRS sensor, which exists on the NOAA-20 satellite, can be used for detecting and characterizing combustion sources. During daytime, the TROPOMI sensor, which is onboard on the Sentinel 5P Precursor satellite, from the European Space Agency using a short-wave infrared radiation sensor can measure methane concentrations on columns with a base area of 7 x 3.5 km^2. The Sentinel 3 satellite with the Sea and Land Surface Temperature Radiometer (SLSTR) instrument from the European Space Agency may also be used to measure gas flares and give confidence to the VIIRS sensor.

[0081] There are also constellations of earth-imaging satellites that capture images with resolutions from 50 cm to a few meters that can also be used to monitor and confirm flare conditions.

[0082] If weather data are incorporated into a system, then various emission sources may be located using such weather data, for example, by analyzing plume sources, plume shapes and wind conditions (speed and direction). As an example, where satellite imagery (e.g., day time and/or night time) varies with respect to flyover times in terms of images and regions imaged (e.g., where a region or portion thereof may be in a different image frame over multiple flyover passes of a satellite), a method can include utilizing a trained machine learning model to identify sites in one or more images for a region imaged. In such an example, pattern-based identification (e.g., pattern recognition) may be utilized where lit flares can define a pattern, which may change over time due to wind conditions.

[0083] As an example, the system 600 can provide for flaring optimization in unfavorable wind conditions. Such a system may provide for control of flaring during testing operations, bleed off and flowback operations, one or more other onshore and/or offshore operations involving gas flaring, etc.

[0084] As an example, a control action can provide for configuring gas flaring for onshore and/or offshore facilities with unfavorable wind conditions. As an example, a system can provide for performing process computations, computational fluid dynamics (CFD) and dispersion studies, monitoring and acquisition and automation.

[0085] As an example, a defined flare sizing and configuration can be determined and/or controlled that can be utilized onshore and/or offshore to optimize the dispersion of combustion gases and mitigate the associated risks. Where determinations can be made in real-time or near real-time, actions may be taken more rapidly, which may reduce detrimental aspects of non-optimal flaring. As an example, a system can reduce lost time and emissions when the wind conditions are unfavorable. Such a system can help to achieve proper dispersion of combustion gases.

[0086] As to control, a system can utilize multiple flare tip sizes at defined angles to achieve efficient dispersion of combustion gases under various wind conditions, which can include a zero wind condition (e.g., less than 0.01 kph, etc.) or even a sudden gust of wind in an opposite direction.

[0087] As an example, a system can provide for a selected combination of monitoring, data logging and programmable automated equipment control. As an example, a system can incorporate such features into a deployable framework to ensure rapid reaction times and to reduce risks of human error associated with flaring operations.

[0088] As an example, a system may be deployable as a combination of hardware and software that can include site-based hardware and optionally remote hardware (e.g., circuitry, processors, memory, etc.). Such a system may be deployed to retrofit one or more existing well testing packages, optionally with minimal modifications to the core process equipment.

[0089] As an example, an adjustable flare tip can include a combination of hardware, circuitry (e.g., hardware and optionally software), one or more sensors, one or more interfaces (e.g., data, network, etc.), etc.

[0090] As an example, an adjustable flare tip can be temporarily installed at a site for purposes of determining an optimal type of flare tip and/or may be permanently installed as at site, for example, to provide for adjustments to the flare tip, optionally responsive to control instructions, etc.

[0091] In various instances, from a process design standpoint, a flare tip is sized for maximum flow rate, back pressure in steady state. This means that for others conditions (e.g., lower most of the time) the sizing is not optimum and does not fit evolving process conditions. As such, there can be poor combustion of gas, dispersion issues, HSE risks for the personnel, etc.

[0092] As an example, a flare tip can be adjustable such that one or more selected parameters directly affecting combustion, dispersion, velocity, pressure in the line, etc., can be adjusted.

[0093] As an example, a flare tip can be adjusted in a manner capable to flow at the maximum rate at a given line pressure but also adjusted in a manner capable outside of such process values, for example, to maintain an optimum size of the flare tip. Being capable to adapt to transient processes can be beneficial for surface processes when flowing a well, bringing in a well, change rate, adding or removing well, etc.

[0094] As an example, a mechanism can be utilized to adjust the orifice size of a flare tip where the mechanism may be fit to a flare. For example, consider a diaphragm mechanism (e.g., an iris design), a perforated disks rotating one versus the other mechanism, an adjustable vanes mechanism, an adjustable jet engine nozzle, etc.

[0095] As explained, a system can include an actuator that can adjust a flare tip or flare tips. In such an example, one or more flare tips may be adjusted to control line back pressure. For example, during flaring and/or flaring related operations (e.g., whether flaring or not flaring), back pressure can affect various flare tip parameters, which can include speed, dispersion, combustion, etc. As an example, a system may be deployed at surface on a permanent basis or on a temporary basis. As an example, a system may be deployed to optimize one or more flare tip parameters and then removed where operations may continue using optimized parameter values.

[0096] As explained, from a process design standpoint, a flare tip tends to be sized for maximum flow rate and back pressure in steady-state. Thus, for other conditions (e.g., lower most of the time), sizing is not optimal. As explained, a system can provide for flare tip adjustment in a more optimal manner, which can include, for example, making adjustments responsive to evolving process conditions (e.g., production conditions, testing conditions, environmental conditions, etc.). Such an approach can improve combustion of gas, dispersion, reduction of HSE risks for personnel, etc.

[0097] As an example, a system can include a flare tip that adjusts to one or more selected parameters that can directly affect one or more of combustion, dispersion, velocity, pressure in a line, etc. For example, a system can provide a flare tip that is capable of flowing the maximum rate at a given line pressure but also adjusting when outside of such process values where adjustments can aim to maintain the optimum size of the flare tip. Such a system can adapt to transient processes, which can occur when flowing a well, when bringing in a well, when changing a rate, when adding or removing well, when testing a well, etc.

[0098] As an example, a flare tip may be adjustable using one or more mechanisms, which may include, for example, one or more of a diaphragm (e.g., an iris design), perforated disks rotating one versus another, an adjustable nozzle that may include one or more features of an adjustable jet engine nozzle, etc.

[0099] As an example, a system may provide for adjustments in low to no wind conditions such that one or more sizes of one or more flare tips are appropriate. As an example, during field operation, depending on a rate of flow at a wellsite, one or more flare tips can be activated that can best suit one or more goals (e.g., combustion, back pressure, dispersion, etc.). As an example, a system may aim to provide for laminar flow for a desired length or volume size from a flare tip or flare tips, which can depend on back pressure and hence flare tip configuration (e.g., angle, size, etc.), for example, to provide desirable dispersion. As an example, a desirable dispersion pattern may be one in which the risk of flow back towards a rig and/or other facility is reduced. Where a flare tip or flare tips are sized for maximum flow, at times, conditions can exist where dispersion does result in flow back towards a rig and/or other facility.

[00100] **FIG. 7** shows an example of a diaphragm mechanism 700 that can provide for adjusting a throat area of a flare tip. As shown, the diaphragm mechanism 700 can include a series of leaves. For example, consider a smoothly adjustable aperture shape where an iris or irises include of an array of curved, spring-steel leaves whose orientation is determined by a relative position of two rings. In such an example, a pin handle on one of the rings can provide for adjustment to the aperture without risk of obstructing a flow path through the aperture.

[00101] **FIG. 8** shows an example of a rotating disks mechanism 800 and a rotating vanes mechanism 810, where each of the mechanisms 800 and 810 can be utilized to adjust a flare tip.

[00102] **FIG. 9** shows examples of adjustable mechanisms 900 and 910 that include a series of elements that can be controlled to adjust a flare tip. The mechanisms 900 and 910 can form and adjust nozzles, which can be flare tip nozzles. A mechanism may change and maintain its configuration by actuators. As shown in **FIG. 9**, actuators may be selected from one or more types.

[00103] As an example, one or more CFD simulations may be performed to determine one or more flare tip parameters for desirable flaring and/or flaring-related behaviors.

[00104] As an example, a system may be operable in a fail safe manner, for example, where it can automatically return to the maximum opening in case of a system failure, for example, to reduce risk of over pressurizing a flare line.

[00105] As an example, a mechanism can provide for restricting flaring at one or more locations, for example, such that a method can provide for controlling combustion and/or dispersion by changing the flow conditions (flow type, pressure, velocity, etc.).

[00106] As an example, a system may monitor, analyze, control, etc., one or more operations in a basin region such as, for example, an onshore and/or an offshore region. For example, consider the Permian Basin, where gas production can exceed pipeline capacity exiting the Permian Basin region, which may result in increased flaring. The Permian Basin is predominantly a shale oil play and has large quantities of associated gas production. Permian crude and natural gas liquids (NGL) production are expected to grow from 3.3 MMb/d in 2017 to 8.8 MMb/d by 2025, which in turn is expected to cause natural gas production to rise from 7.1 to 16.0 bcfd over the same time frame.

[00107] **FIG. 10** shows an example of a method 1000 and an example of a system 1090. As shown, the method 1000 includes a reception block 1010 for receiving wind conditions data; a determination block 1020 for determining a control action to control a flaring operation at a site using the wind conditions data; and an issuance block 1030 for issuing the control action to control the flaring operation.

[00108] The method 1000 is shown as including various computer-readable storage medium (CRM) blocks 1011, 1021, and 1031 that can include processor-executable instructions that can instruct a computing system, which can be a control system, to perform one or more of the actions described with respect to the method 1000.

[00109] In the example of **FIG**. **10**, the system 1090 includes one or more information storage devices 1091, one or more computers 1092, one or more networks 1095 and instructions 1096. As to the one or more computers 1092, each computer may include one or more processors (e.g., or processing cores) 1093 and a memory 1094 for storing the instructions 1096, for example, executable by at least one of the one or more processors 1093 (see, e.g., the blocks 1011, 1021 and 1031). As an example, a computer may include one or more network interfaces (e.g., wired or wireless), one or more graphics cards, a display interface (e.g., wired or wireless), etc.

[00110] As an example, the method 1000 may be a workflow that can be implemented using one or more frameworks that may be within a framework environment. As an example, the system 1090 can include local and/or remote resources. For example, consider a browser application executing on a client device as being a local resource with respect to a user of the browser application and a cloud-based computing device as being a remote resources with respect to the user. In such an example, the user may interact with the client device via the browser application where information is transmitted to the cloud-based computing device (or devices) and where information may be received in response and rendered to a display operatively coupled to the client device (e.g., via services, APIs, etc.).

[00111] As an example, an adjustable flare tip can include an actuator; an adjustable throat restrictor operatively coupled to the actuator; and an interface for receipt of control instructions, where the actuator responds to the control instructions to adjust the throat restrictor. In such an example, the throat restrictor can include one or more of an iris mechanism, a rotating disc, rotating vanes, shapable elements, and adjustable elements that form a nozzle.

[00112] As an example, an adjustable flare tip can include a fail safe mode that adjusts an adjustable throat restrictor to a maximum flow position to reduce risk of over pressurizing a fuel supply line.

[00113] As an example, an adjustable flare tip can generate, issue and/or respond to control instructions to control fuel line back pressure.

[00114] As an example, an adjustable throat restrictor can be adjustable responsive to wind speed. For example, consider a controller that can receive wind speed information and issue an instruction to an actuator to adjust an adjustable throat restrictor. As an example, an adjustable throat restrictor can be adjustable responsive to plume dispersion, wind speed and/or combustion quality. As an example, an adjustable throat restrictor can be adjustable responsive to presence and absence of combustion.

[00115] As an example, a system can include an adjustable flare tip that includes an actuator; an adjustable throat restrictor operatively coupled to the actuator; and an interface for receipt of control instructions, where the actuator responds to the control instructions to adjust the throat restrictor; and a controller that generates the control instructions. In such an example, the actuator may be driven by an electromagnetic mechanism (e.g., a motor, etc.), a hydraulic actuator, a mechanical actuator, etc.

[00116] As an example, a system can include a controller that can include a sensor interface that receives sensor data where such sensor data may include one or more of wind data, plume dispersion data, combustion data, back pressure data, and flow data indicative of laminar and/or non-laminar flow.

[00117] A computer-readable storage medium (or computer-readable storage media) is non-transitory, not a signal and not a carrier wave. Rather, a computer-readable storage medium is a physical device that can be considered to be circuitry or hardware.

[00118] **FIG. 11** shows components of an example of a computing system 1100 and an example of a networked system 1110 with a network 1120. The system 1100 includes one or more processors 1102, memory and/or storage components 1104, one or more input and/or output devices 1106 and a bus 1108. In an example embodiment, instructions may be stored in one or more computer-readable media (e.g., memory/storage components 1104). Such instructions may be read by one or more processors (e.g., the processor(s) 1102) via a communication bus (e.g., the bus 1108), which may be wired or wireless. The one or more processors may execute such instructions to implement (wholly or in part) one or more attributes (e.g., as part of a method). A user may view output from and interact with a process via an I/O device (e.g., the device 1106). In an example embodiment, a computer-readable medium may be a storage component such as a physical memory storage device, for example, a chip, a chip on a package, a memory card, etc. (e.g., a computer-readable storage medium).

[00119] In an example embodiment, components may be distributed, such as in the network system 1110. The network system 1110 includes components 1122-1, 1122-2, 1122-3, . . . 1122-N. For example, the components 1122-1 may include the processor(s) 1102 while the component(s) 1122-3 may include memory accessible by the processor(s) 1102. Further, the component(s) 1122-2 may include an I/O device for display and optionally interaction with a method. The network may be or include the Internet, an intranet, a cellular network, a satellite network, etc.

[00120] As an example, a device may be a mobile device that includes one or more network interfaces for communication of information. For example, a mobile device may include a wireless network interface (e.g., operable via IEEE 802.11, ETSI GSM, BLUETOOTH, satellite, etc.). As an example, a mobile device may include components such as a main processor, memory, a display, display graphics circuitry (e.g., optionally including touch and gesture circuitry), a SIM slot, audio/video circuitry, motion processing circuitry (e.g., accelerometer, gyroscope), wireless LAN circuitry, smart card circuitry, transmitter circuitry, GPS circuitry, and a battery. As an example, a mobile device may be configured as a cell phone, a tablet, etc. As an example, a method may be implemented (e.g., wholly or in part) using a mobile device. As an example, a system may include one or more mobile devices.

[00121] As an example, a system may be a distributed environment, for example, a so-called "cloud" environment where various devices, components, etc. interact for purposes of data storage, communications, computing, etc. As an example, a device or a system may include one or more components for communication of information via one or more of the Internet (e.g., where communication occurs via one or more Internet protocols), a cellular network, a satellite network, etc. As an example, a method may be implemented in a distributed environment (e.g., wholly or in part as a cloud-based service).

[00122] As an example, information may be input from a display (e.g., consider a touchscreen), output to a display or both. As an example, information may be output to a projector, a laser device, a printer, etc. such that the information may be viewed. As an example, information may be output stereographically or holographically. As to a printer, consider a 2D or a 3D printer. As an example, a 3D printer may include one or more substances that can be output to construct a 3D object. For example, data may be provided to a 3D printer to construct a 3D representation of a subterranean formation. As an example, layers may be constructed in 3D (e.g., horizons, etc.), geobodies constructed in 3D, etc. As an example, holes, fractures, etc., may be constructed in 3D (e.g., as positive structures, as negative structures, etc.).

[00123] Although only a few example embodiments have been described in detail above, those skilled in the art will readily appreciate that many modifications are possible in the example embodiments. Accordingly, all such modifications are intended to be included within the scope of this disclosure as defined in the following claims. In the claims, means-plus-function clauses are intended to cover the structures described herein as performing the recited function and not only structural equivalents, but also equivalent structures. Thus, although a nail and a screw may not be structural equivalents in that a nail employs a cylindrical surface to secure wooden parts together, whereas a screw employs a helical surface, in the environment of fastening wooden parts, a nail and a screw may be equivalent structures.

CLAIMS

What is claimed is:

1. An adjustable flare tip comprising:
   an actuator;
   an adjustable throat restrictor operatively coupled to the actuator; and
   an interface for receipt of control instructions, wherein the actuator responds to the control instructions to adjust the throat restrictor.

2. The adjustable flare tip of claim 1, wherein the throat restrictor comprises an iris mechanism.

3. The adjustable flare tip of claim 1, wherein the throat restrictor comprises a rotating disc.

4. The adjustable flare tip of claim 1, wherein the throat restrictor comprises adjustable elements that form a nozzle.

5. The adjustable flare tip of claim 1, comprising a fail safe mode that adjusts the adjustable throat restrictor to a maximum flow position to reduce risk of over pressurizing a fuel supply line.

6. The adjustable flare tip of claim 1, wherein the control instructions control fuel line back pressure.

7. The adjustable flare tip of claim 1, wherein the adjustable throat restrictor is adjustable responsive to wind speed.

8. The adjustable flare tip of claim 1, wherein the adjustable throat restrictor is adjustable responsive to plume dispersion.

9. The adjustable flare tip of claim 1, wherein the adjustable throat restrictor is adjustable responsive to combustion quality.

10. The adjustable flare tip of claim 1, wherein the adjustable throat restrictor is adjustable responsive to presence and absence of combustion.

11. A system comprising:

an adjustable flare tip that comprises an actuator; an adjustable throat restrictor operatively coupled to the actuator; and an interface for receipt of control instructions, wherein the actuator responds to the control instructions to adjust the throat restrictor; and

a controller that generates the control instructions.

12. The system of claim 11, wherein the controller comprises a sensor interface that receives sensor data.

13. The system of claim 12, wherein the sensor data comprise wind data.

14. The system of claim 12, wherein the sensor data comprise plume dispersion data.

15. The system of claim 12, wherein the sensor data comprise combustion data.

16. The system of claim 12, wherein the sensor data comprise back pressure data.

17. The system of claim 12, wherein the sensor data comprise flow data indicative of laminar and/or non-laminar flow.

18. The system of claim 12, wherein the controller generates the control instructions to reduce risk of gas flow from the adjustable flare tip towards a facility.

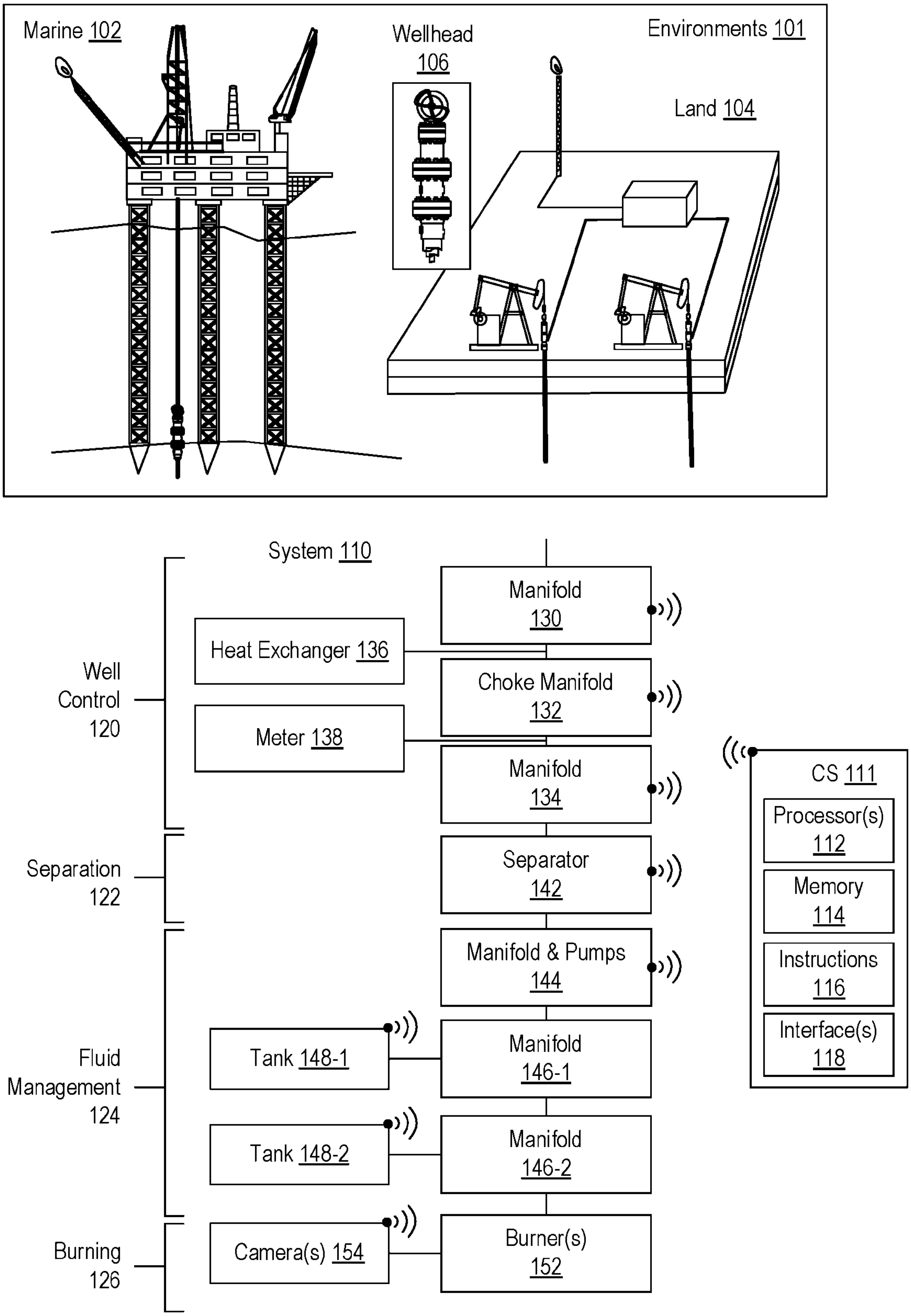

Marine 102
Wellhead 106
Environments 101
Land 104
System 110
Well Control 120
Separation 122
Fluid Management 124
Burning 126
Manifold 130
Heat Exchanger 136
Choke Manifold 132
Meter 138
Manifold 134
Separator 142
Manifold & Pumps 144
Tank 148-1
Manifold 146-1
Tank 148-2
Manifold 146-2
Camera(s) 154
Burner(s) 152
CS 111
Processor(s) 112
Memory 114
Instructions 116
Interface(s) 118

Fig. 1

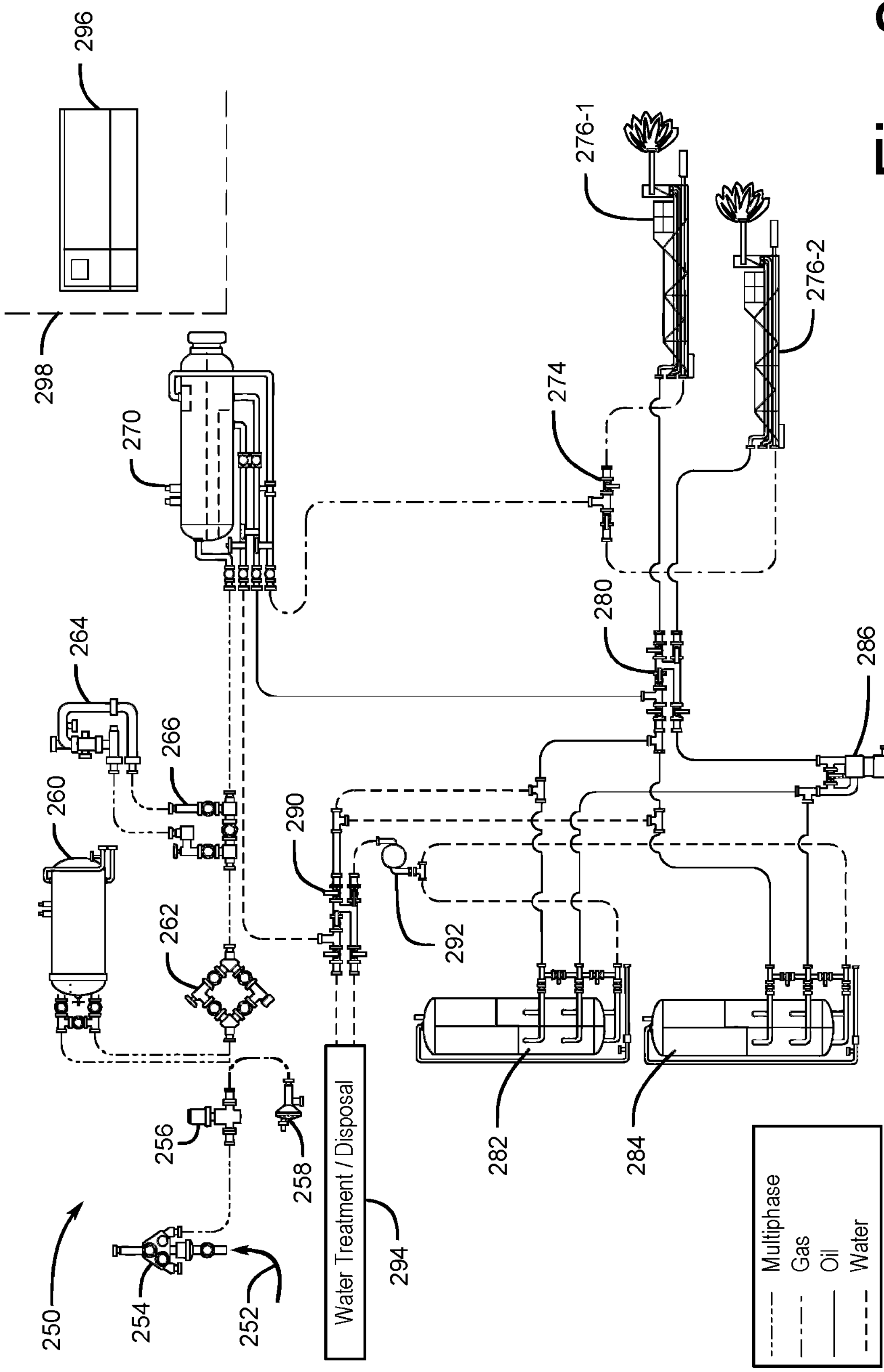

250
252
254
256
258
260
262
264
266
270
274
276-1
276-2
280
282
284
286
290
292
294
296
298
Water Treatment / Disposal
Multiphase
Gas
Oil
Water

Fig. 2

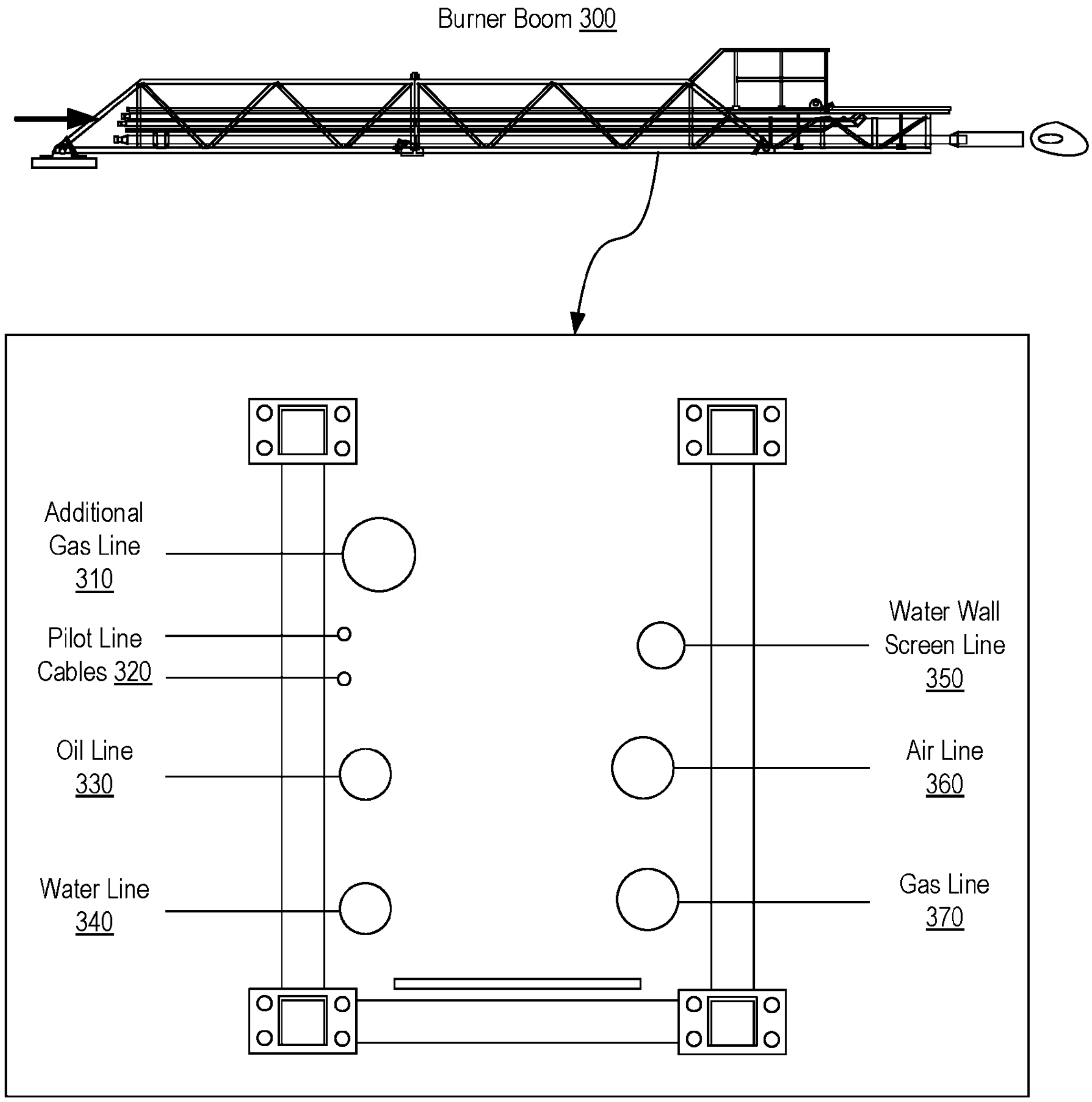

Burner Boom 300
Additional Gas Line 310
Pilot Line Cables 320
Oil Line 330
Water Line 340
Water Wall Screen Line 350
Air Line 360
Gas Line 370

Fig. 3

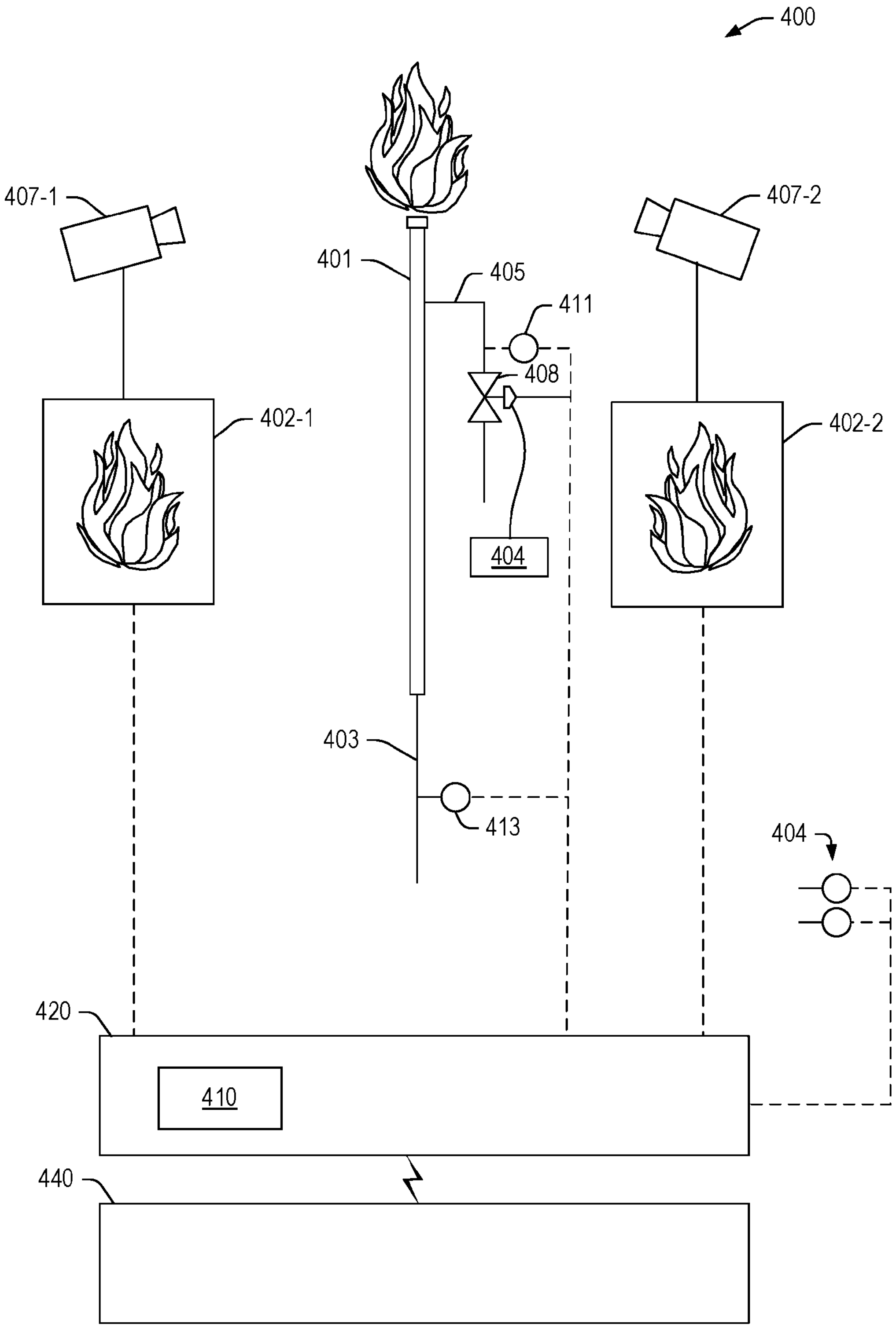
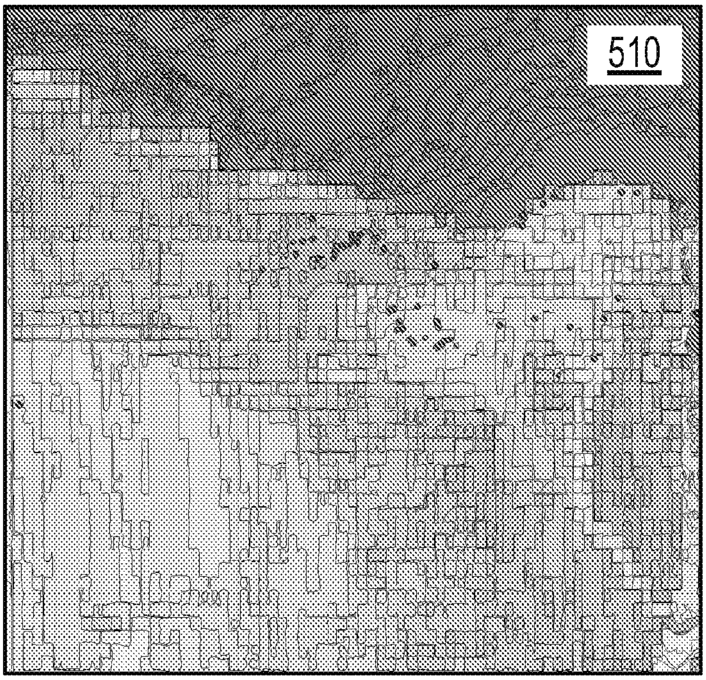
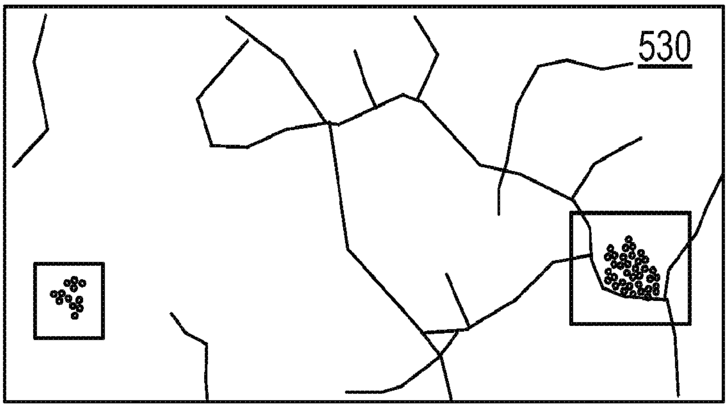

400
407-1
401
405
411
408
407-2
402-1
404
402-2
403
413
404
420
410
440

Fig. 4



VIIRS - Algeria Calibration Point



VIIRS and Sentinel 5P Correlation

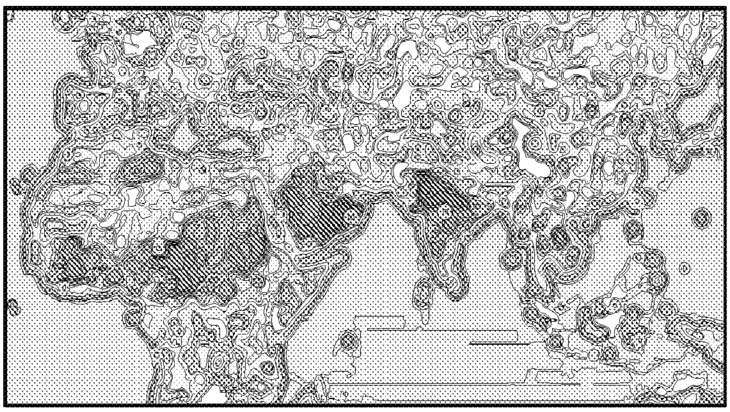


FIG. 5

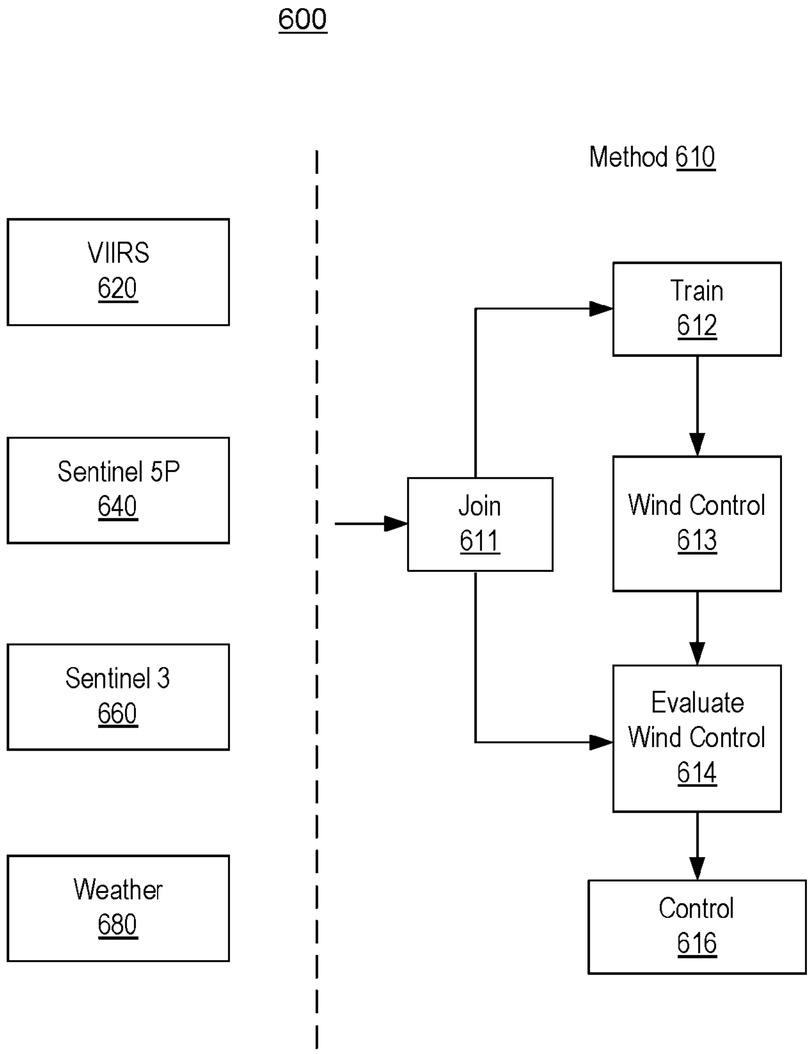

600
Method 610
VIIRS
620
Sentinel 5P
640
Sentinel 3
660
Weather
680
Join
611
Train
612
Wind Control
613
Evaluate
Wind Control
614
Control
616

Fig. 6

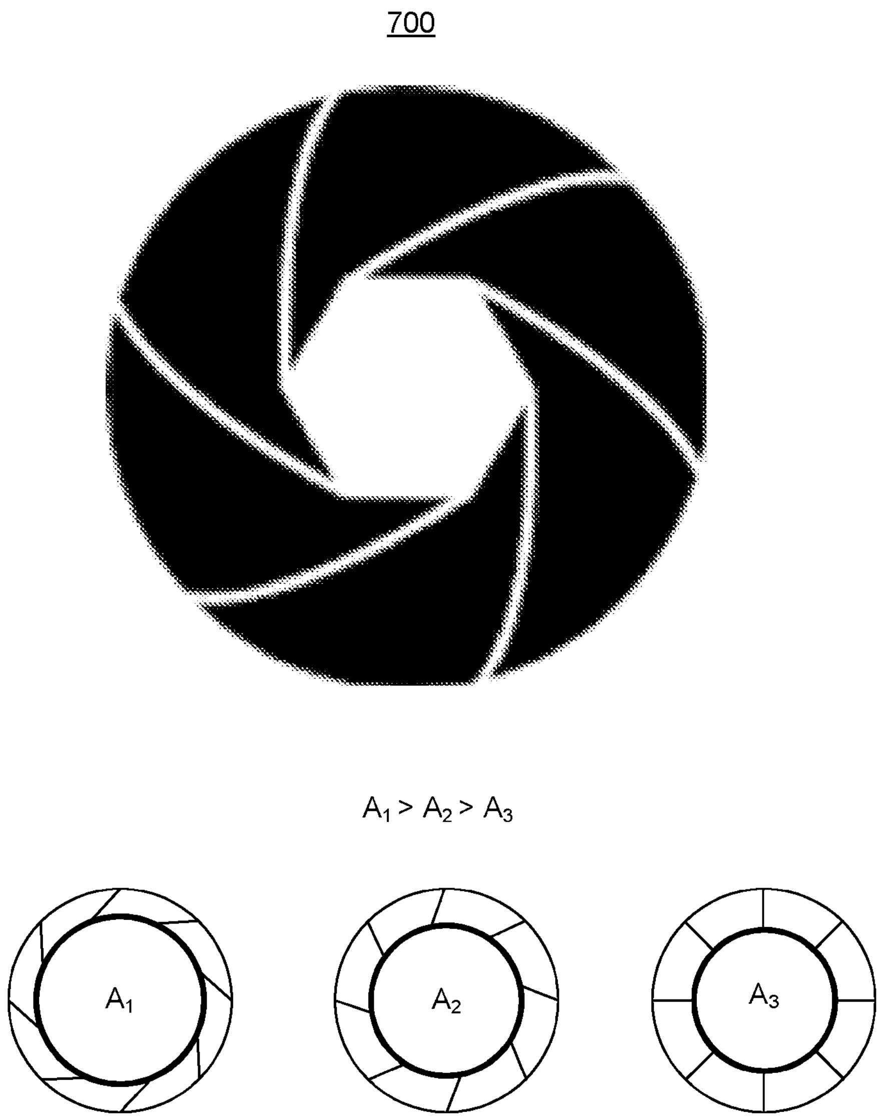


Fig. 7

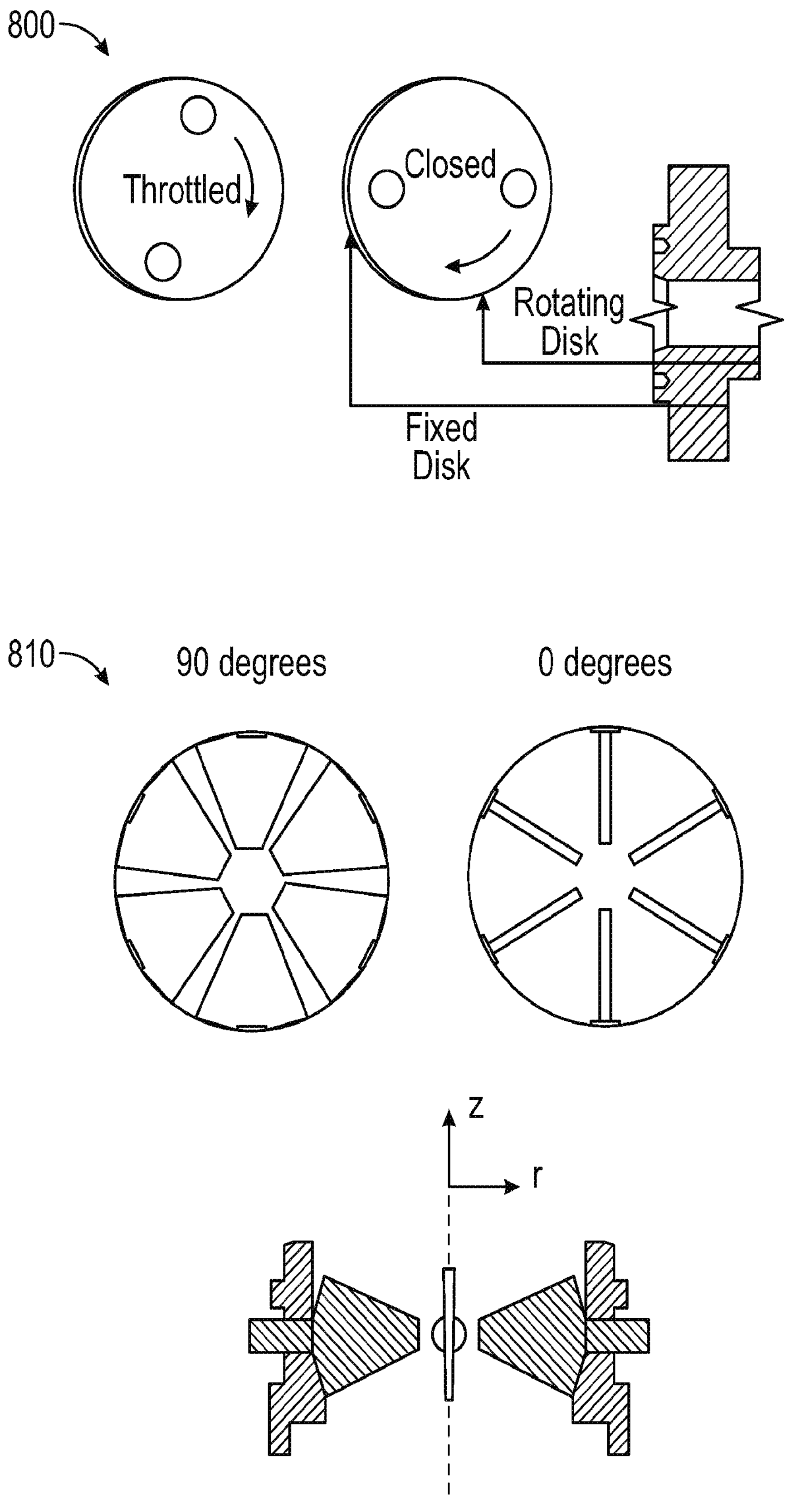

800
Throttled
Closed
Rotating
Disk
Fixed
Disk
810
90 degrees
0 degrees
z
r

FIG. 8

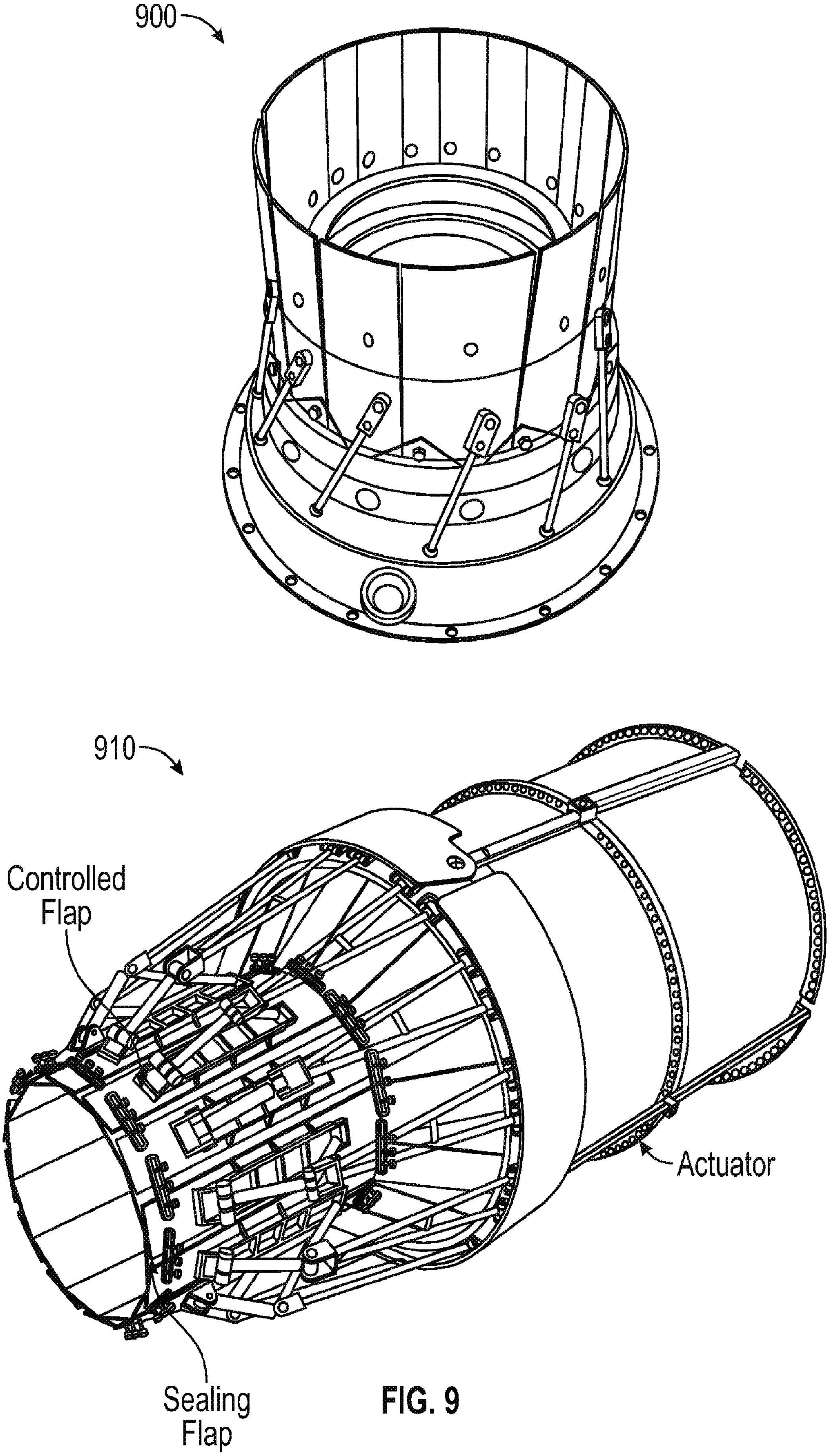


FIG. 9

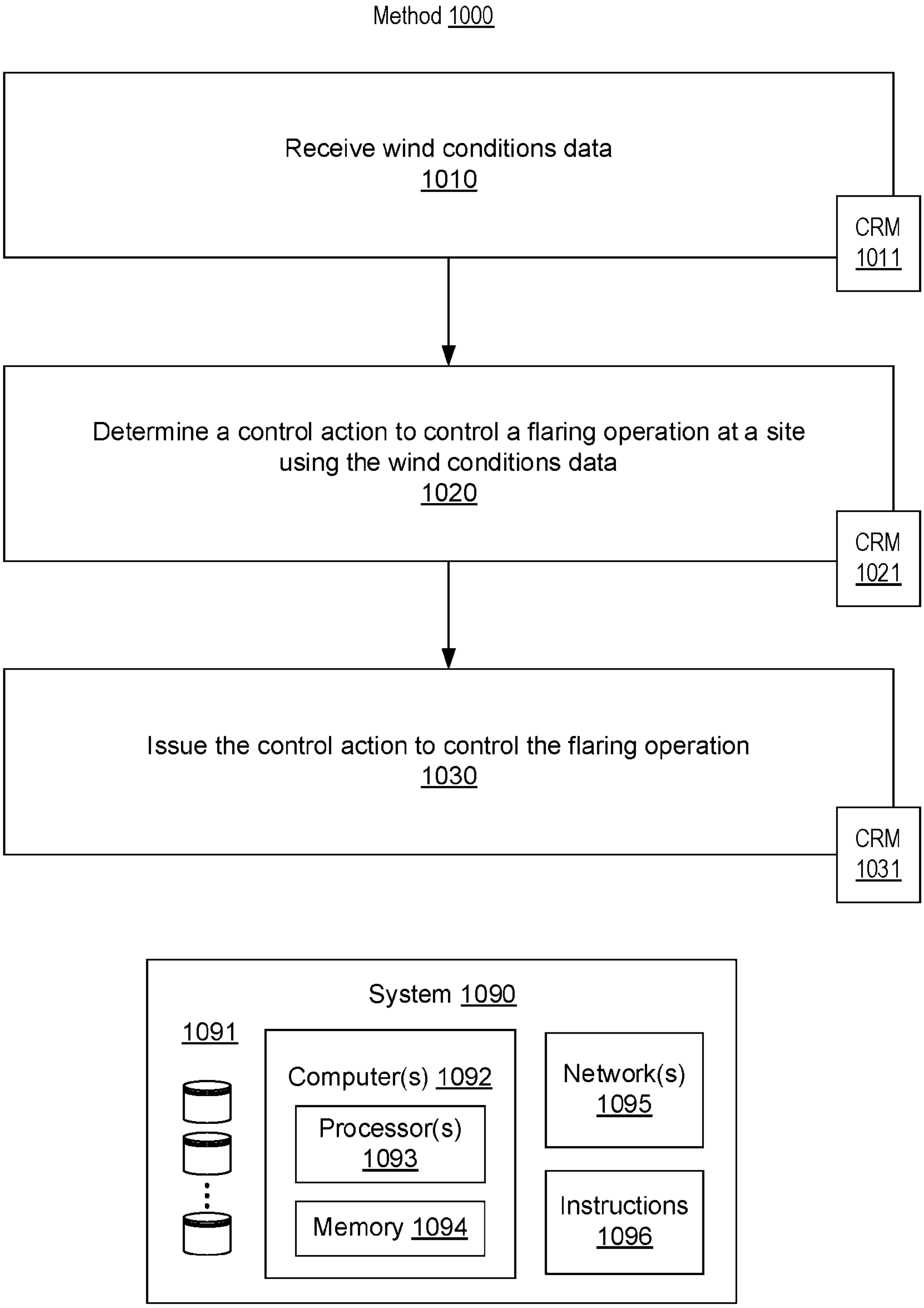

Method 1000
Receive wind conditions data
1010
CRM
1011
Determine a control action to control a flaring operation at a site using the wind conditions data
1020
CRM
1021
Issue the control action to control the flaring operation
1030
CRM
1031
System 1090
1091
Computer(s) 1092
Processor(s)
1093
Memory 1094
Network(s)
1095
Instructions
1096

Fig. 10

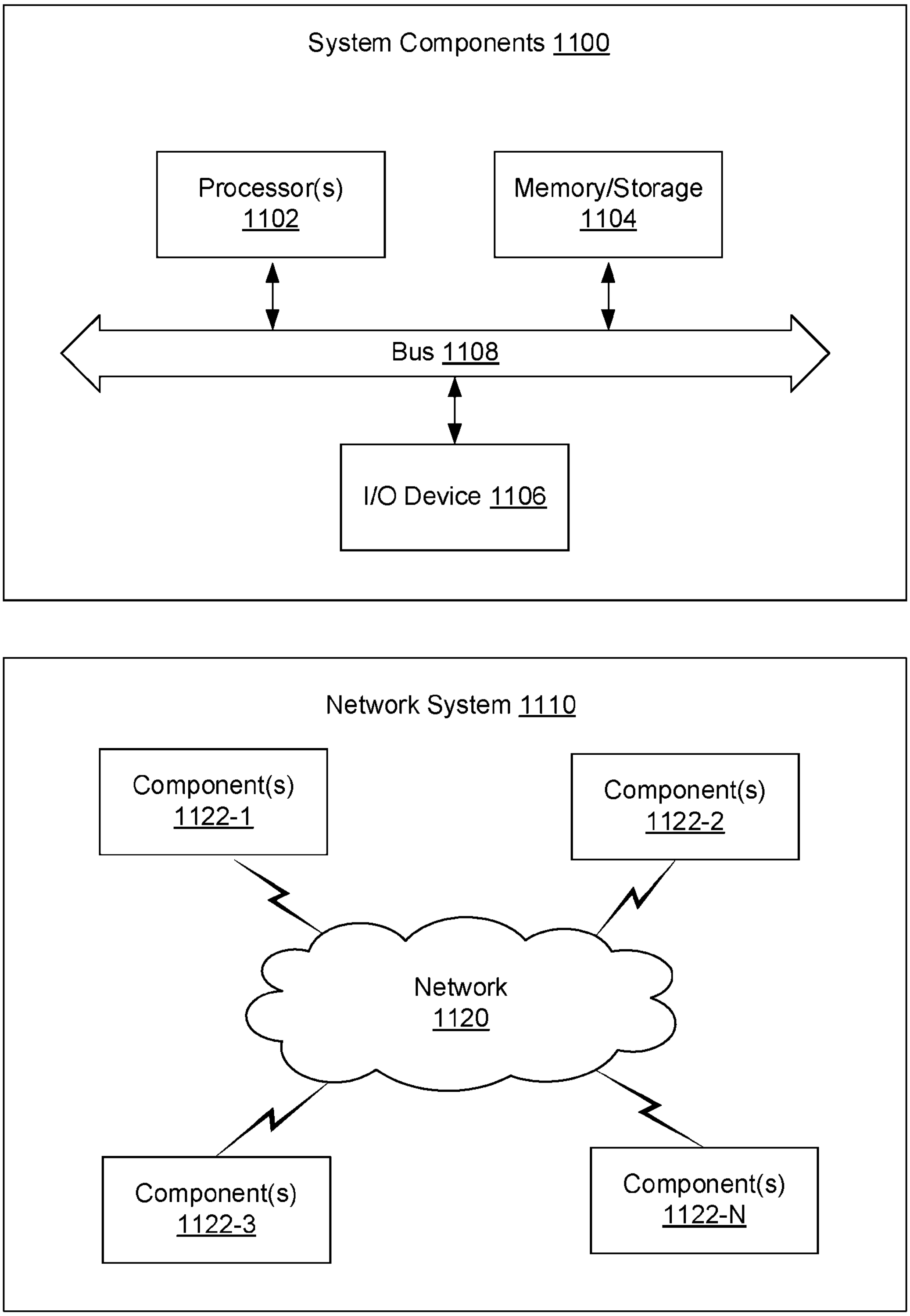

System Components 1100
Processor(s) 1102
Memory/Storage 1104
Bus 1108
I/O Device 1106
Network System 1110
Component(s) 1122-1
Component(s) 1122-2
Network 1120
Component(s) 1122-3
Component(s) 1122-N

Fig. 11

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2023/085292

A. CLASSIFICATION OF SUBJECT MATTER

E21B 41/00(2006.01)i; **E21B 43/34**(2006.01)i; **F23G 7/08**(2006.01)i

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)

E21B 41/00(2006.01); F16K 3/06(2006.01); F16K 31/54(2006.01); F23G 5/00(2006.01); F23G 7/06(2006.01); F23G 7/08(2006.01); G05B 13/02(2006.01); G05B 13/04(2006.01); G05D 7/06(2006.01); G06N 3/08(2006.01)

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

Korean utility models and applications for utility models
Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & Keywords: flaring, flare tip, interface, combustion, hydrocarbon, fuel gas

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2013-0143170 A1 (KREBBER et al.) 06 June 2013 (2013-06-06) paragraph [0039] and figures 1-4	1-18
Y	US 2022-0325887 A1 (BAKER HUGHES HOLDINGS L.L.C.) 13 October 2022 (2022-10-13) paragraphs [0002], [0042], [0060], [0061], [0070], [0072], [0079], [0083], [0114]-[0116] and figures 1, 4	1-18
Y	US 4094492 A (BEEMAN et al.) 13 June 1978 (1978-06-13) column 2, line 60 - column 3, line 6 and figure 1	2,7
A	US 2015-0293506 A1 (HONEYWELL INTERNATIONAL INC.) 15 October 2015 (2015-10-15) paragraphs [0025]-[0031] and figure 3	1-18
A	US 2020-0387120 A1 (HONEYWELL INTERNATIONAL INC.) 10 December 2020 (2020-12-10) claim 1 and figures 3-5	1-18

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"D" document cited by the applicant in the international application
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"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
23 April 2024	**24 April 2024**

Name and mailing address of the ISA/KR	Authorized officer
Korean Intellectual Property Office **189 Cheongsa-ro, Seo-gu, Daejeon** **35208, Republic of Korea**	**PARK, Tae Wook**
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/US2023/085292

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		CL 2013000486 A1	18 October 2013
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		CO 6650401 A2	15 April 2013
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		MX 2013002091 A	03 April 2013
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		UA 108385 C2	27 April 2015
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US 2022-0325887 A1	13 October 2022	EP 4320385 A1	14 February 2024
		WO 2022-217208 A1	13 October 2022
US 4094492 A	13 June 1978	None	
US 2015-0293506 A1	15 October 2015	AU 2015-248158 A1	27 October 2016
		AU 2015-248158 B2	11 July 2019
		CN 106662327 A	10 May 2017
		CN 106662327 B	30 April 2019
		EP 3132199 A1	22 February 2017
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		EP 3132199 B1	22 May 2019
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		CA 3081967 C	28 June 2022
		EP 3748444 A1	09 December 2020
		EP 3748444 B1	14 December 2022
		US 11927944 B2	12 March 2024
		WO 2020-247358 A1	10 December 2020