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(71) Applicant: **VINTRI TECHNOLOGIES INC.** [CA/CA]; 500-1509 Centre Street S.W., Calgary, Alberta T2G 2E6 (CA).

(72) Inventors: **FUGATE, Lance**; 500-1509 Centre Street S.W., Calgary, Alberta T2G 2E6 (CA). **GEDAMU, Elias**; 4020 Vincent Place NW, Calgary, Alberta T3A 0H3 (CA). **HARRISON, Jonathan Paul**; Box 12, Site 16, RR1, Priddis, Alberta T0L 1W0 (CA).

(74) Agent: **ROBIC**; Centre CDP Capital, Bloc E - 8th Floor, 1001, Square-Victoria, Montréal, Québec H2Z 2B7 (CA).

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(54) Title: OIL AND GAS INFRASTRUCTURE ASSET TRACEABILITY TECHNIQUES

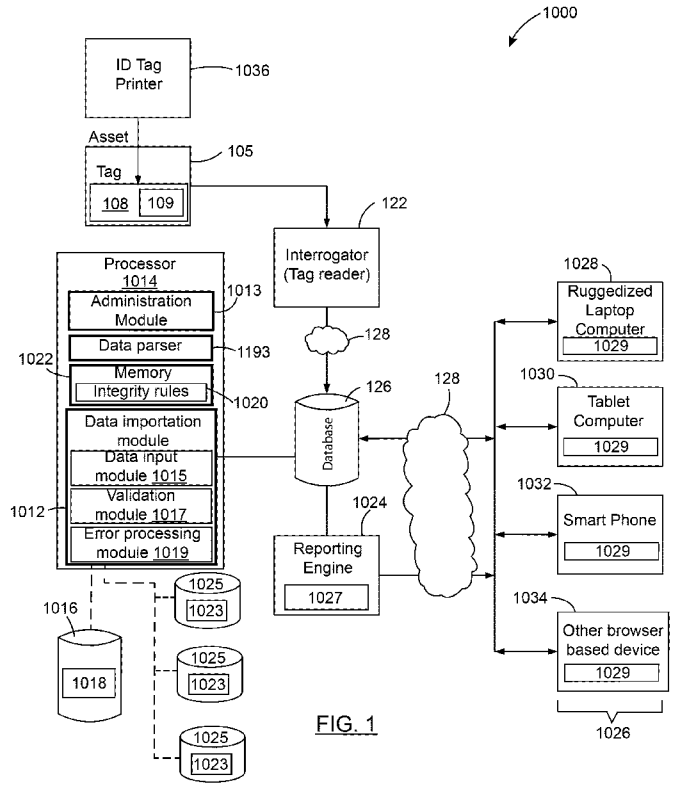


FIG. 1

(57) Abstract: A system for tracking and managing oil and gas infrastructure assets comprises a central database. An identification tag, such as a barcode or RFID for example, is mounted on each asset and stores an identifier. Manufacture information is received from a manufacturer data source and validated against data integrity rules to promote data accuracy in the central database. Further, history information is collected from a plurality of entities, during a lifecycle of the asset. For a given asset, the central host database associates the validated manufacture information and the history information to a unique identifier corresponding to the identifier stored in the identification tag of the corresponding asset. A reporting engine is in communication with the central database and provides accessibility to remote devices, for tracking and managing the asset, from the remote device, based on the manufacture information and the history information.

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OIL AND GAS INFRASTRUCTURE ASSET TRACEABILITY TECHNIQUES

Field of the invention:

The present invention relates to the field of oil and gas infrastructure asset traceability. More particularly, the present invention relates to infrastructure asset traceability systems and methods for tracing oil and gas infrastructure assets, such as pipeline assets.

Background of the invention:

Assets in the oil and gas industries include various components and materials used for building oil and gas infrastructure, including pipelines.

Assets for building such infrastructures are manufactured and channelled through different facilities for processing, storage, installation, etc. It is desirable to identify and obtain history information on such assets.

Today, the industry accepts information the manufacturers are able to provide and in many cases, poor quality data as the standard.

The manufacturing sector, in general, has manually recorded information and invests minimally in information technology systems and infrastructure. Due to the practice of hand recording manufacturing data, data is prone to errors and the information provided to operators is typically limited to what is required for industry regulatory compliance, rather than the information the operator requires.

On the operator's side, data is, in most cases, in paper copy or spreadsheet form and is not easily shared corporate-wide.

Furthermore, governments and regulators historically have defined compliance practices and not defined how operators must maintain records or information to meet the regulators' compliance standards. With the movement of skilled resources in the industry, few operators are easily able to piece together the historic information of an

asset or group of assets to respond to regulator audits without committing substantial effort and resources. The process is time consuming and arduous today due to the lack of integrated and proactive systems.

In the particular case of pipelines, the assets to be tracked include pipe sections which are assembled to construct the arteries of the pipelines. Pipelines are structures for transporting gases, liquids or multiphase mixtures such as slurries. Pipelines may transport fluids such as oils, natural gas, fuels and other fluids, as well as suspension and slurry type materials.

The main components of a pipeline are the pipe sections which are first manufactured at a fabrication plant. After a pipe section is made, it is typically subjected to testing in order to confirm or validate various desirable or required characteristics related to the metallurgy or the geometry of the pipe section. For instance, a pipe section may be tested for characteristics such as roundness, stress and compression resistance, etc. In some cases, a sample from a pipe section may be removed in order to test the metallurgy.

Once the testing is complete, a batch of manufactured pipe sections may be sent for post-manufacture treatment. The manufactured pipes may be stacked and stored outside for days or several months before the post-manufacture treatment is undertaken, depending on inventories and demand for the pipes.

Pipe sections manufactured for certain applications are subjected to a post-manufacture coating treatment in a coating plant. The pipe sections may be coated with a polymer layer at a coating plant. The coating may be necessary for the given end use of the pipe (for example, a pipe serving as a segment of a pipeline may remain in one place for about 30 to 50 years and must be coated to prevent premature corrosion, etc.) or for protecting the pipe from external elements during storage. The coated pipe is then shipped for deployment or stored for a period of time before deployment.

Ensuring traceability of pipe sections through manufacture, coating and deployment has several challenges. According to current practice, information pertaining to the characteristics of each manufactured pipe section is provided on the pipe section in a manual fashion via a hand applied, industry compliant painted stencil. It is also transferred from one part of the pipe to another from manufacture to deployment, which leads to disadvantages related to inaccuracy, inefficiency and unreliability.

More particularly, at the fabrication plant each pipe section may be assigned a “heat and lot number”, which is generally an alpha numeric sequence that is unique to the material of each pipe section. The heat number usually identifies the ingot it came from and the lot number may identify the group of pipe sections that experienced the same heat treatment during the pipe manufacturing process. The manufactured pipe section data typically includes a heat and lot number, and may also include additional codes indicating further characteristics of each pipe section or a batch of pipe sections, such as details on physical properties, composition and manufacturing process conditions. The information regarding the pipe sections is generally stored in a database at the fabrication plant. Other information, such as date, for example, may also be assigned to pipe sections in the database. Current practice is that after the pipe section is made, a labeler manually sprays this information, e.g. the heat and lot number, on the outer surface of the manufactured pipe section.

When the manufactured pipe section arrives at the coating plant or is ready for the coating treatment, the information previously sprayed on the outer surface of the pipe section is copied manually onto the inner surface of the pipe section, prior to the coating treatment. During the transfer to the inside diameter (ID), it is common for manual errors that are a result of misreading the painted stencil information.

The coating process generally involves various treatments including heating, sandblasting and acid washing the outer surface of the pipe before it is coated with an application specific coating (for example, Fusion Bond Epoxy, Abrasion Resistant Coating, Yellow Jacket, etc.). Some of the preliminary treatments, such as

sandblasting the external surface of the pipe, are done to prepare the outer surface by removing an outer layer of rust and/or adding texture to increase adhesion of the coating to be applied. Due to this relatively harsh treatment of the external surface of the pipe sections, the pipe specific information (including pipe ID, heat and lot number, etc.) must be copied onto the inside of the pipe prior to the coating process. Otherwise, the traceability information would be lost in the coating treatments.

Once the pipe section has been prepared for coating, the pipe is slowly heated by induction, typically up to about 250℃ for example, which corresponds to the coating temperature. The coating temperature may depend on the coating process parameters and the plastic material used for coating the pipe. The coating material is initially provided in the form of plastic pellets. In order to apply the coating, the pipe is fed through a cylindrical opening and, as the pipe is channeled through this cylinder, adjacent plastic pellets are heated to an application temperature, for instance about 500℃, and melt around the channeled pipe, to form a plastic web surrounding the pipe. Pipe sections are fed end to end through this plastic coating cylinder.

The pipe section is then cooled down though a quenching process in which water is sprayed onto the pipe. After the quenching, plastic coating material is removed from extremities of the pipe sections that will be joints when the pipes are deployed. In order to clean the interior of the pipe, water is blown into the pipe and an air gun is then directed through the interior of the pipe to remove the residual water.

After the coating is complete, the information (e.g. heat and lot number) which was re-printed onto an interior surface of the pipe is again manually copied and rewritten on the outer coated surface of the pipe. This procedure of copying and re-writing the pipe information leaves room for various errors including inaccurate replication of the information, poor handwriting, and so on. The information is further entered into the coating plant's database, via a computer which is generally located remotely from the pipe, which may further increase risks of error of the data entered into the database.

When the pipe is deployed in the field or at any intermediate step prior to deployment, the identification information appearing on the coated pipe is particularly useful for tracing the pipe's origin or the intermediate steps or treatments it has been subjected to. For example, if a defect is found in a given coated pipe, it is desirable to be able to trace it back to its fabrication plant and/or coating plant and to identify other pipes of the same batch or having similar characteristics.

The current practice for managing the tracing information of the pipes is elaborate, time consuming and energy consuming, and tends to lead to inaccuracies in the information appearing on the pipe as well as in databases. Indeed, errors can occur in the transcription steps before and after the coating, as well as in the manual re-entry of the information to a remote computer at the coating plant. Moreover, possible smudging or erasing of the information on the pipe's surfaces after manufacturing can tend to distort the information that can be read from the pipe. For example, when pipes are stacked for storage and/or otherwise handled or exposed to the elements, the printed information may be erased due to friction, pressure or movement between the pipes, time factor, and so on.

Hence, in light of the aforementioned, there is a need for a technology that would be able to overcome at least some of the disadvantages of known techniques.

Summary of the invention:

An object of the present invention is to provide a system and a method that respond to at least some of the above-mentioned needs and thus provide an improvement over other known asset tracking systems and methods.

In accordance with the present invention, the above mentioned object is achieved, as will be easily understood, by a system and/or method for tracking and managing oil and gas infrastructure assets such as briefly described herein and such as the one exemplified in the accompanying drawings.

In accordance with an aspect of the present invention, there is provided a system for tracking and managing oil and gas infrastructure assets, an identification tag being mounted on each asset and storing a unique identifier. The system comprises a data importation module, integrated in a processor and configured to communicate with a manufacturer data source, for receiving manufacture information related to one of the assets from the manufacturer data source. The data importation module comprises a validation module for validating the manufacture information based on data integrity rules stored in a memory. The data importation module is further configured to receive history information related to the asset from a plurality of entities, during a lifecycle of the asset. The system further comprises a central database being in communication with the data importation module, for storing the manufacture information having been validated and the history information, and for associating the manufacture information and history information with the unique identifier. The system further comprises a reporting engine, integrated in the processor and being in communication with the central database, to report information from the central database on a user-interface of a remote device, for tracking and managing the asset, from the remote device, based on the manufacture information and the history information.

In accordance with another aspect of the present invention, there is provided a method for tracking and managing oil and gas infrastructure assets. The method comprises importing into a central database manufacture information on a given asset from a manufacturer data source. The importing step comprises validating the data to be imported based on data integrity rules. The method further comprises associating in the central database, the manufacture information having been imported, to a unique identifier stored in an identification tag mounted on the asset. The method further comprises storing in the central database, history information from a plurality of entities, during a lifecycle of the asset after manufacture and associating the history information to the unique identifier, in order to report information from the central database on a user-interface of a remote device.

Various objects, aspects, advantages and features of the present invention will become more apparent upon reading of the following non-restrictive description of embodiments thereof, given for the purpose of exemplification only, with reference to the accompanying drawings.

Brief description of the drawings:

FIG. 1 is a block diagram showing a system for tracking and managing oil and gas infrastructure assets.

FIG. 2 is a schematic diagram showing broadly the interactions between a central database, and operators, regulators and manufacturers.

FIG. 3 is a schematic diagram showing broad features of the overall system.

FIG. 4 is a schematic diagram showing the functional features which interact with an oil and gas asset traceability system.

FIG. 5A to 5C show a flow chart illustrating steps carried out by an oil and gas asset traceability system.

FIG. 6 is a diagram of a traceability process map.

FIG. 7 is a block diagram showing a tagging process.

FIG. 8 is a block diagram showing a steel supplier data input process.

FIG. 9 is a block diagram showing a manufacturing data input process.

FIG. 10 is a block diagram showing a coating data input process.

FIG. 11 is a block diagram showing an asset location data update process.

FIG. 12 is a block diagram showing an asset installation data update process.

FIG. 13 is a diagram of an asset management process map.

FIG. 14 is a diagram of an enterprise reporting process map.

FIG. 15 is a schematic diagram showing a radio frequency identification (RFID) tag.

FIG. 16 is a schematic diagram showing a validation procedure in relation to the RFID tag shown in FIG. 15.

FIG. 17 is a schematic diagram showing a storage yard, the storage yard comprising components related to an asset location data update process.

FIG. 18 is a block diagram of an asset traceability system and method.

FIG. 19 is a block diagram showing additional steps of the method according to the bloc diagram shown in FIG 18.

FIG. 20A to 20C are schematic diagram showing steps of a method.

FIG. 21A to 21C is schematic diagram of a tag, the diagram showing a top plan view (FIG. 21A), an upper cross-sectional view (FIG. 21B) and a side cross-sectional view (FIG. 21C) of the tag.

FIG. 22A to 22C are schematic diagrams showing different examples of secondary adhesives for a tag.

FIG. 23 is a block diagram of another asset traceability system.

FIG. 24A is a schematic diagram of a tripod spreader as a first securing means.

FIG. 24B shows the tripod spreader of FIG. 24A mounted in a pipe.

FIG. 25A is a schematic diagram of a bar spreader as a first securing means.

FIG. 25B shows the bar spreader of FIG. 25A mounted in a pipe.

FIG. 26A is a schematic diagram of a wire spreader as a first securing means, according to an embodiment of the present invention, the wire spreader being shown in a neutral configuration.

FIG. 26B shows the wire spreader of FIG. 26A in an operative configuration.

FIG. 26C shows the wire spreader of FIG. 26A in an operative configuration, mounted in a pipe.

FIG. 27A is a schematic diagram of a custom spreader as a first securing means, the diagram showing a top plan view (FIG. 27A), a side plan view (FIG. 27B) and an elevational view (FIG. 27C) of the custom spreader.

FIG. 27D is a cross-sectional view of two pipes, each having the custom spreader of FIG. 27A to 27C mounted therein, the two custom spreaders being joined by a plug. The plug also prevents the pipes from colliding with each other damaging the bevel.

FIG. 28 is a schematic representation of a drilling pipe.

FIG. 29 is a block diagram of another asset traceability system and method.

Detailed description:

In the following description, the same numerical references refer to similar elements. The embodiments mentioned and/or geometrical configurations and dimensions shown in the figures or described in the present description are embodiments of the present invention only, given for exemplification purposes only.

Broadly described, the asset traceability system according to an embodiment of the present invention, as exemplified in the accompanying drawings, provides a central management of traceability data related to the manufacturing and the lifecycle of an asset, data integrity controls to promote data accuracy, and distributed access to the data in order to meet the individual requirements of operators, regulators and manufacturers.

System and method for tracking and managing oil and gas infrastructure assets

Referring to FIG. 1, an embodiment of a system **1000** for tracking and managing oil and gas infrastructure assets **105** is illustrated. An asset **105** may be for example a pipe section **106** (see FIG. 16), or another asset such as a fitting, a valve, and/or any other component used in the construction and maintenance of oil and gas infrastructure. An identification tag **108** such as a barcode or a radio frequency identification (RFID) tag is mounted on the asset **105**. Alternatively, the identification tag may be provided in the form of a magnetic stripe tag, a tag comprising any suitable electronic chip and/or the like. Preferably, the identification tags **108** are pre-made, each storing a unique identifier **109**, in order to reference the asset **105** on which it is mounted, in a database. In some cases, an identification tag **108** to be mounted on an asset may be generated by a tag printer **1036**, as will be explained further below.

By "mounted", it is meant placed, fixed, secured, fastened, attached, adhered, and/or the like. Some optional ways of mounting certain types of tags will be discussed further below.

Referring to FIG. 1, the system **1000** comprises a data importation module **1012**, integrated in a processor **1014** and configured to communicate with a manufacturer data source **1016**. The data importation module **1012** receives manufacture information **1018** related to assets **105** from the manufacturer data source **1016** and validates the manufacture information **1018** based on predefined data integrity rules **1020** stored in a memory **1022**. The data integrity rules **1020** are preferably defined in compliance with operator's requirements, regulatory requirements, and/or the like.

For example, the manufacturer information **1018** may be received, in the case of pipe sections, from a steel manufacturer **302**, from a pipe mill **312**, and/or from a coating plant **322** (see FIG. 5A).

Referring back to FIG. 1, the data importation module **1012** is further configured to receive history information **1023** related to the asset **105** from a plurality of entities **1025**. Such entities **1025** may include, in the case of pipe sections for example, a transportation system **332**, a storage yard **342**, a construction yard **352**, a pipe cutting facility **362**, a surveyor **372**, an installation facility **382**, an operations and maintenance facility (see FIG 5A, 5B, 5C), etc., during a lifecycle of the asset. The installation data source may include: welding data; x-ray data; pipe cutting data; pipe bend data; coating data; girth weld coating data; pre-commissioning test data; and/or inspection data. The operations and maintenance data source may include: inline inspection data; cathodic protection data; pipe quality data; visual inspections; and cut-out and replacement data.

The data importation module **1012** may further comprise a data input module **1015** for identifying a format of the manufacturer information **1018** received and for reading the manufacturer information **1018** based on the format, as will be described further below with reference to FIG. 8.

The data importation module **1012** may further comprise a data parser **1193** for identifying a correspondence between the manufacturer information **1018** to be imported and fields of the central database **126**, as will be described further below with reference to FIG. 9.

The system **1000** further comprises a central host database **126** being in communication with the data importation module **1012**. The central host database **126** stores the manufacture information **1018** having been validated and the history information **1023**, and further associates the manufacture information **1018** and history information **1023** representing an asset **105** with the unique identifier **109**.

It is to be understood that the database preferably comprises a series of records, each record being referenced to an asset's unique identifier **109** using a reference field. The reference field may contain the unique identifier **109** or it may contain other data which is associated to the unique identifier **109**. For example, the content of the

reference field may append characters to the unique identifier **109**, or it may result from a manipulation of the unique identifier **109**. For example, "123-xyz" in the reference field of the database could be associated to unique identifier **109**: "xyz" of manufacturer "123". In another example, "AAA" in the reference field of the database could be associated to unique identifier **109**: "111", where the manipulation consists in converting the character "A" into digit "1". In yet another example, "YYYY-MM-DD xyz" could be associated to the unique identifier **109** "xyz".

Thus, it is to be understood, in accordance with some embodiments, that the unique identifier **109** may be combined with additional information and/or further processed to correlate with the content of the corresponding reference field, as may be readily understood by a skilled person. Thus it should be understood that though the identifier **109** may be unique within a given group of tags **108**, the content of the reference field of each record identifies one particular asset **105** only, within the database.

Furthermore, while each asset may have a single corresponding tag and identifier, it is to be understood that multiple tags may be associated to the asset, as several of the manufacturing facilities **1016** may provide the asset with their respective identification tags, provided each tag stores an identifier which is unique in the central database. For each tag having a new unique identifier for an asset being associated to another unique identifier in the database, this new unique identifier is stored in the database in association the previously stored unique identifier. Therefore, one given asset may be associated to a plurality of unique identifiers.

Referring back to FIG. 1, the system **1000** further comprises a reporting engine **1024**. The reporting engine **1024** is integrated in the processor **1014** and in communication with the central database **126**, in order to report information from the central database **126** on a user-interface **1029** of a remote device **1028**, so as to track and manage the asset **105**, from the remote device **1026**, based on the manufacture information **1018** and on the history information **1023**. The reporting engine **1024** may be configured to

provide a real-time accessibility to remote devices **1026** via a communication network **128**, for tracking and managing the asset. The remote devices **1026** are further in communication with the database **126** via the communication network **128**.

The reporting engine **1024** may further comprise a data retrieval module **1027** for retrieving information from the database **126** on the basis of a given unique identifier **109** stored on an identification tag **108** of an asset **105**. The reporting engine **1024** may further comprise an output module **1029** for outputting the report to one of the remote devices **1026** via the communication network **128**.

In the context of the present description, the term "processor" refers to an electronic circuitry capable of executing computer-readable instructions, such as a central processing unit (CPU), a microprocessor, a controller, and/or the like. It is to be understood that the processor **1014** described and illustrated herein may be provided by a plurality of such processors which cooperate, either independently or within a distributed system, as can be understood by a skilled person. For example, the reporting engine **1024** and the data importation module **1012** may each be provided in a separate processor. Moreover, the reporting engine **1024** and the data importation module **1012** may each be provided in a plurality of such processors. The processor **1014** may be provided within one or more general purpose computer, for example, and/or any other suitable computing device.

In the context of the present description, the term "network" refers to any suitable communication system for transmitting data, and may include a local area network (LAN) or the like, a wide area network (WAN), a global area network (GAN), the Internet, etc., and may be provided by wired or wireless technologies. Wireless technologies may use, for example, microwave, radio, infrared communication technologies and/or the like.

The remote devices **1026** may include a ruggedized laptop computer **1028**, a tablet computer **1030**, a smart phone **1032**, a hand-held computer device, and/or any other suitable computer device **1034** enabled to provide a web browser application. The

communication network **128** (also referred to herein as "network connection"), may be an Ethernet, WiFi, 3G, 4G, connection and/or any other suitable communication network.

It is to be understood that the system **1000** may be adapted to operate in a client-server architecture, where the database **126** is comprised in a server **124** (see FIG. 18) and the remote devices **1026** are client devices. Preferably, each remote device comprises a client application (for example, an internet browser or the like, and/or a dedicated application stored on the remote device). It is to be understood that the client application, may operate differently (for example, in terms of display format, accessible data for reading, accessible data for updating, reporting capabilities, functional features of updating the database or only reading from the database, etc.) depending on the particular device **1026**, depending on the user permissions and/or role of the user associated to the device **1026** or the user being logged on to the application). For example, a field operator at a given stage of the lifecycle of an asset may access a client application on a particular device **1026** in order to retrieve and/or validate "birth" data relative to one or more assets, while in another example, a regulator personnel may access a client application on another device **1026** in order to retrieve information relative to the lifecycle of given assets, for controlling purposes and/or obtaining statistic information. Thus, the reporting capabilities may be provided in a variety of ways, as can be easily understood by the skilled person, and in view of additional explanations given further below with reference to FIG. 14.

The system **1000** may further comprise a tag reader **122** which is in communication with the database **126** over a communication network **128** for exchanging information with the database **126**, the tag reader **122** having a reading module for reading the identifier **109** stored on the tag **108** of each asset **105**. The tag reader **122** allows an operator to read the tag **108** and to interact, via one of the devices **1026**, with the database **126**, by inputting the tag identifier **109**. For example, it may be desirable to retrieve manufacture or history information **1018**, **1023** related to the asset **105**, or to

update the database **126** with additional history information **1023**, as will be further explained in view of the explanations further below with reference to FIG. 5A, 5B, 5C.

The system **1000** may further comprises an administration module **1013**, integrated in the processor **1014**, for administering user accounts and associated permissions to access the central database **126**. More particularly, the administration module **1013** allows the initialisation of user accounts, managing user permissions, security and/or access to project specific data.

The system **1000** may further comprise a tag printer **1036** for printing a new identification tag **108**.

A method, which may be executed by the above-mentioned system **1000**, may be broadly described as follows with reference to FIG. 1, 5A-5C and 9. A step of the method comprises importing **1180** into a central database **126** manufacture information **1018** on a given asset **105** from a manufacturer data source **1016**. The importing **1180** step comprises validating **1194** the data **1016** to be imported based on data integrity rules **1020**. Another step of the method comprises associating **1202** in the central database **126**, the manufacture information **1018** having been imported, to a unique identifier **109** stored in an identification tag **108** mounted on the asset **105**. Yet another step of the method comprises storing in the central database **126**, history information **1023** from a plurality of entities **1025**, during a lifecycle of the asset **105** after manufacture and associating the history information **1023** to the unique identifier **109**, in order to report information from the central database **126** on a user-interface **1029** of a remote device **1028**, for tracking and managing the asset **105**, from the remote device **1028**, based on the manufacture information **1018** and on the history information **1023**. The various steps of the method will be described with further detail hereinbelow.

FIG. 2 broadly illustrates the interactions between the central database **126** and the operators **1040**, regulators **1042** and manufacturers **1044**.

FIG. 3 depicts broad features of the overall system. Namely, the identification of the critical assets **1052** to be tracked and data collection **1054** may be defined based on an organization's requirements and further to a gap analysis **1062** for comparison with best practices. Moreover, data accuracy **1056** and data integrity **1058** are desirable in order to leverage risk management. Data distribution **1060** relates to the accessibility to centralized data from remote locations where the data is desired and also to reporting or the like. A tagging solution **1064** physically identifies assets and reading tools **1066** are used for reading the identification tags mounted on the assets.

FIG. 4 schematically illustrates functional features which may interact with the system **1000**, which is shown with the central host database **126**. Asset management **1072** broadly encompasses asset tracking **1074**, procurement controls **1076**, and preventative maintenance **1078**. Traceability and reporting system **1080** encompasses engineering specification controls **1082**. Engineering specific controls **1082** are specific engineering attributes that an asset must adhere to or fit within the confines of. For example, the wall thickness of a pipe may have to be a minimum thickness. Application interfaces **1084** are provided for interacting between the system **1000** and external systems **1086**, such as external control systems, geospatial systems, ERP systems, system integration and/or any other third party system. Application maintenance and releases **1088** also solicit the system **1000**. Custom reporting **1092** is intended to provide real-time field access and reporting **1096**, as well as dashboard and data analytics **1094**.

The flow charts **300** shown in FIG. 5A, 5B and 5C exemplify broad steps that may be carried out by a pipeline asset traceability system, according to embodiments of the present invention, in relation to different facilities encountered in the lifecycle of pipe sections. Steps **304**, **314**, **324**, **334**, **344**, **354**, **364**, **374**, **384**, **394**, are carried out at the sites **302**, **312**, **322**, **332**, **342**, **352**, **362**, **372**, **382**, **392**, respectively. The data being processed at the host database **126** for each of the steps is shown at blocs **306**, **316**, **326**, **336**, **346**, **356**, **366**, **376**, **386**, **396**, respectively. Moreover, value chain details **308**, **318**, **328**, **338**, **348**, **358**, **368**, **378**, **388**, **398**, and design considerations

310, **320**, **330**, **340**, **350**, **360**, **370**, **380**, **390**, **400** are further detailed for each of the steps.

The previously-mentioned step of importing **1180** (see FIG. 9) the manufacture information **1018** comprises importing steel manufacturer information **306** from a steel manufacturer **302**. At the steel manufacturer **302**, a steel manufacturer tag **304** is applied onto the coil or slab for tracking a Mill Test Report (MTR) data capture. A feedback loop is executed in order to signal when coils are received (**310**), and to trigger data capture (**310**). At **306**, the following information is imported into the central host database **126**, and associated to a corresponding record containing the identifier **109** of the tag **304**: origin details, metallurgy data and MTR data. This data capture advantageously allows inventory location tracking (**308**).

The step of importing **1180** (see FIG. 9) the manufacture information **1018** further comprises importing pipe mill information **316** from a pipe mill **312**. At the pipe mill **312**, a pipe mill identification tag **314** is applied for tracking and "birth" data capture. More particularly, a unique identifier is assigned to each pipe section in the central host database **126**. The asset is thus associated in the central database **126** with a new unique identifier stored on a corresponding pipe mill identification tag **314** mounted on the asset **105** at the pipe mill. At **316**, the following data is stored in association with this unique identifier **109** in the central host database **126**: Tally data; Mill Run data; Inspection Result data; and Work Order integration data. In the importation of the pipe mill data, an automated and/or enforced error and exception tracking is applied (**320**), in order to promote data integrity within the database **126**. This improves traceability, reduces returning articles unnecessarily, and improves data integrity through digital data capture (**318**).

The pipe is then transferred to a coating plant **322**. The step of importing **1180** (see FIG. 9) the manufacture information **1018** thus comprises coating plan information **326** from a coating plant **322**. At this stage, the pipe mill data **316** is verified in order to increase data integrity, and digital data and audit trail captured while manual data

entry is avoided (**328,330**), i.e. the step of validating **1194** (see FIG. 9) further comprises validating the pipe mill information **316** based on the manufacturer data **1018** stored in the database **126**. Moreover, additional identification tags are applied to the pipe section for redundancy and coating data capture. The additional tags are in conformity with the coating plant's **322** requirements, and may contain a new unique identifier **109**, different from the one stored on the pipe manufacturer tag (**314**). Indeed, multiple identifiers may reference a same asset in the database **126**. The following coating plant information **326** is imported into the central host database **126**: tally data; inspection result data; and coating specification data.

The pipe is then processed for transportation (e.g. via rail car). Thus, one of the entities **1025** of the storing step in the above-mentioned method is a transportation facility **332** and the storing of history information **1023** comprises storing transportation information **336**. The following transportation information **336** is imported into the central host database **126**, through batch processing: data related to way bills and/or bills of lading; shipper data; tracking sub-contractors; and receiving information. This stage allows inventory management and asset location tracking (**338**). The batch processing reduces the risk of error, and eliminates manual data entry (**340**).

The next stage is the storage of the pipe at a storage yard. Thus, one of the entities **1025** of the storing step in the above-mentioned method is a storage facility **342** and the storing of history information **1023** comprises storing storage information **346**. At this stage, the shipping and receiving information from the rail car is validated, based on shipping related information being previously stored in the database **126**. Moreover, upon receipt of the asset at the storage yard, the physical location of the asset is updated in the central host database **126**. The following storage information **346** is imported into the central host database **126** through batch separation and/or three-way matching in the enterprise resource planning (ERP) system of the storage yard: purchase order (PO) number; and vender identification, in order to synchronize

the data from the database **126** with the ERP of the storage yard. This stage provides inventory management and asset location tracking (**348**).

The pipe is then eventually transferred to a construction yard. Thus, one of the entities **1025** of the storing step in the above-mentioned method is a construction facility **352** and the storing of history information **1023** comprises storing construction yard information **356**. At this stage, the shipping and receiving information is validated (**360**) against shipping related information being previously stored in the database **126**. Indeed, the afore-mentioned method may further comprise storing in the database shipping and receiving information related to the asset **105**; and validating **360**, at the construction facility, the shipping and receiving information. The following construction yard information **356** is imported into the central host database **126**: material testing reports and location information within the construction yard. Advantageously, inventory information is updated from the construction yard which reduces the need for re-ordering assets due to logistic errors, thereby reducing waste of assets, returning of asset and write-offs (**358**).

The following stage may include the cutting of the pipe and/or bending of the pipe. Thus, one of the entities **1025** of the storing step in the above-mentioned method is a pipe cutting facility **362** or a pipe bending facility and the storing of history information **1023** comprises storing pipe cutting information **366** or pipe bending information. At this stage, the system is solicited for data recording **364**. More particularly, the information recorded includes information on bends, joints (single, double, triple); and pipe information is updated and tracked. The following pipe cutting information **366** is stored in the central host database **126**: cut and joint related information, X-ray testing data; and child and parent association data. Advantageously, bends and joints information is recorded and the child and parent relationships are tracked (**368**). Indeed, when a pipe is cut, one or more child data is generated for each cut section of the pipe and associated to a parent identifier representing the pipe prior to cutting. Thus, pipe lineage is associated with all child segments of cut pipe, and the imported data is validated against specification drawings mapping the positioning plan in the

field (**370**). The following pipe bending information is further stored in the central host database **126**: bending specification information; and structural integrity impact information.

Each pipe section is eventually given an installation location which is mapped by a surveyor. Thus, one of the entities **1025** of the storing step in the above-mentioned method is a surveyor entity **372** and the storing of history information **1023** comprises storing surveyor information **376**. At this stage, the surveyor interacts with the system for location data services (**374**), which update survey mapping information. The following surveyor information **376** is further stored in the central host database **126**: pipe latitude, longitude, elevation; and integration with third party mapping services such as Google™, esri™, BLACKBOX™. Location data is digitally captured and automatically associated in the database (**380**). Advantageously, storage information is centralized and integrated (**378**).

Another stage is the installation of the pipe and maintenance. Thus, one of the entities **1025** of the storing step in the above-mentioned method is an installation facility **382** and the storing of history information **1023** comprises storing installation information **386**. The system provides secure access to pipe history information in an organized and real-time dashboard environment (i.e. user interface) for ongoing information (**384**). The following installation information **386** is further stored in the central host database **126**: maintenance data; reporting options data; depth of buried pipe; preventative quality control measures taken; and maintenance related work information. Moreover, the database **126** may be accessed for reporting.

Referring now to FIG. 6, a traceability process map **1100** is shown according to another embodiment.

The following are preliminary processes **1102** which may be carried out for promoting data integrity of the data stored centrally in the database **126** (see FIG. 1):

- every supplier of assets or materials for producing the assets is required to supply manufacturing data to the central host database **126**;
- data collection points are required to be configured with an electronic data transfer capability;
- manufacture data and composition material origin information is to be submitted to the system electronically either directly or via a file transfer;
- data to be imported into the database **126** is subjected to integrity rules before approval and storage in the database; and
- data integrity standards are defined based on an analysis with the supplier as well as the customer's requirements.

At the steel manufacturer **1104**, coil and heat information is electronically submitted to the system **1000** (see FIG. 1) from the manufacturer's data source. The steel supplier data input process and the manufacturing data input process will be explained further below, with reference to FIG. 8 and 9, respectively.

At **1106** an appropriate type of identification tag is selected based on the needs and requirements of the supplier or participant and mechanical requirements. The tagging process will be discussed further below, with reference to FIG. 7.

At the pipe mill **1108**, a pipe identifier, corresponding to the identification tag, is assigned in the database **126** and associated with the stored coil and heat information. Pipe manufacturing quality information is also updated in the database **126**. The identification tag may be applied after the welding process on the outside diameter.

In the storage yard **1110**, the pipe location is updated in the database with rack and row information. As an optional measure, an active tag is assigned to the pipe to provide real-time location in the storage yard, by means of a suitable reading device.

The asset location data update process will be discussed further below, with reference to FIG. 11.

At the coating plant **1112**, the identification tag is scanned for updating the corresponding record in the database **126**. Namely, location information and post-coating information is updated in the database **126**. Furthermore, confirmation data is returned, and a permanent tag is applied on the outside diameter of the coated pipe. The coating data input process will be discussed further below, with reference to FIG. 10.

The pipe arrives at the transportation facility, where the outside diameter tag is scanned to read the identifier and thereby access the corresponding record in the database. The corresponding location information is updated in the database **126**. The asset location data update process will be explained further below, with reference to FIG. 11. Moreover, manifest and way bill information is added to the database, at this stage.

At the construction yard **1116**, the tag is scanned, in order to update the location information. The asset installation data update process will be discussed further below, with reference to FIG. 12.

At **1118**, the recorded data is then made available via browser or administrator dashboard (i.e. the afore-mentioned client application) for reporting purposes and/or obtaining real-time information for operation.

FIG. 7 illustrates the afore-mentioned tagging process **1120**. Broadly, with reference to components shown in FIG. 1, a step **1122** comprises providing the identification tag **108** having the unique identifier **109** stored thereon. Another step **1134** comprises mounting the identification tag **108** on the asset **105**. If the tagging process is not completed **1138**: (i) a new unique identifier is generated in the database; (ii) a new identification tag having the new unique identifier stored thereon is provided; (iii) the new identification tag is mounted on the asset **108**; and (iv) if the tagging process

1138 is not completed, steps (i) to (iii) are repeated **1140**. As exemplified at FIG. 7, an identification tag is selected **1122** among different types of tags, such as an RFID tag **1124**, a bar code with an RFID tag **1126**, a barcode **1128**, a 2D bar code **1130**, and/or any other suitable identification tag **1132**, for mounting onto the asset at a given facility. At **1134**, a given number of tags are applied to the asset, at a given facility. At **1136**, commissioned tags are associated with a unique identifier in the central database **126**, using an interrogator **122**. If another tag is to be mounted to the asset at **1138**, then the process is repeated **1140** until the final tag has been placed on the asset **1142**. It is to be understood that steps **1122** to **1134** may be executed for different facilities. For example, a first loop **1140** may be executed at the pipe mill **312** to apply a pipe mill identification tag, and another loop **1140** may be executed at the coating plant **322** to apply a coating plant **322** identification tag, with reference to FIG. 5A.

FIG. 8 illustrates the afore-mentioned steel supplier data input process **1150** for importing steel supplier data into the central host database **126**. An identification tag is selected among different types of identification tags **1152** (for example RFID tag **1154**, bar code **1156**, a bar code with an RFID tag **1158** and/or any other suitable identification tag **1160**) for identifying a coil or slab. At **1162**, the data associated with the steel (metallurgy, test data, etc.) is collected from the steel suppliers data source. At **1164**, the data input means is determined, via the data input module **1015** (see FIG. 1), based on the input data format for example, a PDF file **1166**, an MS Word file **1168**, an image file **1170**, and/or any other suitable electronic data transfer format **1172**. Under this format, each set of data related to an asset is associated by a unique identifier in the central host database (typically the heat number), at **1174**. At **1176**, the data is imported into the central database **126**. The data is then available as a clickable link on the user interface for accessing the database, at **1178**.

FIG. 9 shows the afore-mentioned manufacturing data input process **1180**. Data to be imported from the manufacturer data source is first formatted at **1182**, for example in a CSV file **1184** or a XLS/XLSX file **1186**, or alternatively, a direct database

connection **1188** is established. Any other suitable data importation method **1190** may be used, as can be understood. Thus the importing step **1180** of the afore-mentioned method comprises identifying **1182** a format of the manufacturer information received. At **1192**, the data to be imported is then processed through the data parser **1193** (see FIG. 1). More particularly, the importing step **1180** of the afore-mentioned method comprises parsing **1192** the manufacturer information **1018** based on the identified format in order to identify a correspondence between the manufacturer information **1018** to be imported and fields of the central database **126**. At **1194**, the data to be imported is then verified through data integrity rules. At **1196**, if the data conforms to the integrity rules, then it is further processed for storage into the database **126**, at **1202**. The data integrity rules may be preferably predefined. The data importation module **1012** (see FIG. 1) may further comprise an error processing module **1019** (see FIG. 1) for processing an error output from the validation module **1017** (see FIG. 1).

Examples of data integrity rules may include at least one among: validating that the number of digits in a heat number corresponds to an expected number of digits; validating that a temperature reading is within a predefined range of temperature; validating numeric and alphanumeric character requirements in a given pipe number; validating that a wall thickness or coating thickness falls within a given range; and/or the like. If the data does not conform to one or more of the integration rules, an error report is generated and escalated, according to an escalation process at **1198**, and the error is processed to correct the data to be parsed by the data parser **1193** at **1200**. As part of the escalation process, an email or other electronic message containing the information to respond to, is sent to an individual identified as being responsible for handling an escalation. A corporate hierarchy may be defined in the error processing module **1019** to manage the escalation process.

Thus, the importing **1180** step (a) of the afore-mentioned method may further comprise after the validating **1194** step: receiving **1196** an error output from the

validating step; processing **1198** the error output; and receiving **1200** data correction instructions.

FIG. 10 illustrates the afore-mentioned coating data input process **1204**. At **1206**, the pipe enters a coating production line. At **1208**, if the pipe is provided with a suitable identification tag, the tag is scanned on the inside diameter of the pipe **1210**, otherwise a tag is commissioned and placed on the inside of the pipe **1212**. The central host database **126** is then accessed at **1214**. At **1216**, the system determines whether the asset exists in the database **126**. If not, the following information is entered in the database **126** at **1218**: pipe identifier, heat number and length. Furthermore, an escalation email addressed to an appropriate person is sent out. If the asset does exist in the database **126**, then the pipe follows the coating plant process according to **1220**. If the coating is not complete, the pipe is further processed for coating at **1220**. Once the coating is completed at **1224**, the inside diameter tag is removed and a final identification tag is commissioned and applied to the outside diameter of the pipe. At **1226**, the database **126** is updated with final status information on the coating of the pipe as well as all events that occurred during the coating process (temperature, coating thickness, deficiencies, etc.). The database **126** is further updated with location information at **1228**, as exemplified above with reference to FIG. 5C.

FIG. 11 illustrates the afore-mentioned asset location data update process **1230**. At **1232**, the asset is received on location. At **1234**, if the pipe already has a suitable identification tag having been recorded in the central host database **126**, then the tag which is located on the outside diameter is scanned at **1240**. Otherwise a pipe identification number should be stenciled on the pipe and a tag is commissioned at **1236** and paired with the stenciled pipe identification number; furthermore, the asset is flagged at **1238**, as being manually updated and an escalation email addressed to an appropriate person is sent out for verification procedures regarding manually updated assets. At **1242**, the asset is updated with current location which may be preprogrammed by the interrogator **122** (see FIG. 1). The database **126** is then

updated with the location information at **1244**, as exemplified above with reference to FIG. 5C.

FIG. 12 illustrates the afore-mentioned asset installation data update process **1250**. At **1252**, the asset is received at the installation location. At **1254**, if the pipe already has a suitable identification tag having been recorded in the central host database **126**, then the tag which is located on the outside diameter is scanned at **1258**. Otherwise a pipe identification number should be stenciled on the pipe and a tag is commissioned at **1256** and paired with the stenciled pipe identification number; furthermore, the asset is flagged at **1260**, as being manually updated and an escalation email addressed to an appropriate person is sent out for verification procedures regarding manually updated assets. At **1262**, the asset follows field specific installation procedures. The database **126** is then updated with the installation information at **1264**. Installation information may include weld information, x-ray information, final location coordinates, etc.

FIG. 13 shows an asset management process map, in accordance with an embodiment of the present invention.

The following are preliminary processes **1168** that may be carried out for promoting data integrity of the data stored centrally in the database **126** (see FIG. 1):

- the asset is manufactured, shipped and installed in accordance with the lifecycle process described hereinabove;
- asset information is stored in the database, including location, manufacturing information, metallurgical information; and
- asset location is updated as the asset moves along its lifecycle steps.

At **1270**, data related to the following operational activities may be exchanged with the central host database **126**:

- operator tasks;
- operational policies;
- logs;
- metering; and
- risk assessment.

At **1272**, data related to the following maintenance activities may be exchanged with the central host database **126**:

- planning;
- regulatory;
- preventative; and
- emergency.

At **1274**, data related to the following change management activities may be exchanged with the central host database **126**:

- change request and review/approvals;
- associated work orders;
- related work association; and
- materials management.

At **1276**, the following incident-related data may be exchanged with the central host database **126**:

- classification;

- related records, other incidents, change requests, etc.
- investigation.

At **1278**, the following dashboard-related data may be exchanged with in the central host database **126**:

- Highlights exceptions;
- Customization of view based on role/need;
- Pre-formatted fields for easy data entry.

At **1280**, the following reports may be pulled from the central host database **126**:

- Work schedules;
- Maintenance reports;
- Incident reports;
- Others as defined.

At **1282**, the recorded data may then be made available via a browser for obtaining real-time information for operation or via administrator dashboard for reporting purposes.

FIG. 14 illustrates the enterprise reporting process map, in accordance with an embodiment of the present invention.

The system may be configured according to the following specifications (**1286**):

- access to data stored in the central database **126** is granted through a secure user count system;

- user profiles are restricted based on role, business unit and areas of responsibility;
- the ability to add or change or manipulate data is granted based on profiles with all changes being recorded in a change log; and
- copies of all uploaded documents are stored inside the database **126**; and full history of created and printed report is created and tracked inside the database.

At **1288**, the asset in question is identified through the scanning of the identification tag mounted on the asset (RFID tag, bar code, and/or the like), or performing a search on the database, through a user interface application.

Data may be accessed on any internet enabled, browser-based device including computers, tablets, smartphones, and/or the like (**1290**).

At **1292**, a dashboard-type user interface is displayed on a display screen after logging in based on user profile and areas of responsibility and permissions. Immediate access is provided for commonly used features and works basis.

For traceability reporting **1294**, the user can access to assess specific information including metallurgy, manufacturing and coating information.

Regulatory reporting **1296** includes obtaining specific regulatory report through a regulator dashboard (i.e. client application accessed from a remote device for access by regulator personnel).

At the field data level **1298**, on-demand reporting is possible directly from the field, preferably with real-time access to the database **126**, using a tablet, smartphone or laptop.

Custom reporting and interfaces **1299** are configured to interact with third party systems such as SAP™, JD Edwards™, etc., preferably in real-time.

With further reference to FIG. 1, the afore mentioned method may further comprise: receiving a reporting request, which was sent from the remote device **1026**, the request comprising the unique identifier **109** of the asset **105**; retrieving the requested information from the database **126**; and returning a report to the remote device **1026**, in response to the request, for presentation on the remote device **1026**. The sending step and the retrieving step are preferably executed in real-time. The report comprises at least one of: manufacturer information **1018** and history information **1023** retrieved from the database **126**. The reporting request may originate from a workspace accessed via the remote device **1026** based on login information from a user. The login information preferably comprises a user identifier associated to the user, and the accessing step further comprises verifying a user permission based on the user identifier. The retrieving step preferably comprises retrieving the requested information for which the user permission allow access to. The unique identifier **109** of the receiving step may originate from a reading of the identification tag **108** of the asset **105**, via a tag reader **122**, and/or from a user entry. Alternatively, the reporting request may comprise a plurality of the unique identifiers **109** associated to a plurality of corresponding one of the assets **105**.

Referring now to FIG. 15 and 16, an RFID identification tag **108** to be mounted on a pipe section **106**, or other asset **105**, is illustrated, for exemplification purposes, in accordance with an embodiment of the present invention. Alternatively, the tag **108** may include any other identification medium, such as a bar code for example.

The tag **108** illustrated in FIG. 15 and 16 comprises a polymer body **1302** encasing an RFID circuit **1304**. The polymer body **1302** has a composition which withstands temperatures reaching 300°C, in order to resist the rigors of the manufacturing process and protect the RFID chip **1304**.

The body **1302** of tag **108** comprises a mounting surface **1306** which faces the pipe **106** when the tag **108** is mounted thereon, and an outer surface **1308** opposite the mounting surface **1302**. A primary stage securing mechanism **123** comprises a

magnet **1310** within the body **1302** near the mounting surface **1302** and an adhesive **1312** on the mounting surface **1302**, covered by a peel away tape **1314**. The magnet **1310** and the adhesive **1312** create a bond with a surface of the pipe **106**, such that tag **108** cannot move under an air pressure reaching 1000 psi, to which the pipe may be subjected to during the coating process.

A secondary stage securing mechanism **118** may comprise an adhesive strip **1316** to be placed over the tag **108**, onto the outer surface **1308**, and extending onto the pipe's surface **1318** by approximately one inch about the tag **108**. The adhesive strip **1316** provides increased adhesion surface with the pipe **106**, and further prevents the tag **108**, which protrudes from the surface of the pipe, from being sheared off.

Thus, prior to the coating process, a tag **108** is temporarily mounted on the inside **116** of the pipe **106**, by means of the magnet and adhesive on the mounting surface. After the coating process, the tag **108** is removed from the inside **116**, placed on the outside **120** and the adhesive strip **1316** is adhered over the tag **108** and further to a portion of the pipe's surface **1318** surrounding the tag **108**.

According to known methods, pipes are surrounded at each end with a nylon rope to provide a buffer between adjacent pipes when they are stacked, for storage for example. The nylon rope has a thickness of about one inch. Thus, the polymer body **1302** may have a profile which is no thicker than the nylon rope when compressed under the weight of the stacking pipes.

Typically, pipes may be stacked over about 5 levels. Thus, the polymer body **1302** is designed to withstand about 5 tons of weight, to which the pipe may be subjected to during storage, for example when several pipes are stacked.

In a manufacturing example, once a steel pipe is cool enough, the tag may be mounted onto the pipe, and the pipe may be tracked as it is going through the manufacturing process. In an alternative example where the pipe manufacturer does not apply any tags, then the tag may be mounted on the pipe on a first bench of the

manufacturing process, that is to say, a pipe coming from a storage yard is put on the first bench, it is cleaned, then warmed up to a specific temperature and then the tag is mounted on the pipe. Then the pipe is subjected to the coating process where the temperature reaches up to 300℃.

Referring now to FIG. 17, an asset location feature is schematically illustrated, in the context of a storage yard **1320**. More particularly, global positioning system (GPS) devices **1322** are positioned about the storage yard **1320** in order to provide location of stacked pipes **106** by pile. Using an interrogator **122** (see FIG. 1), a particular pipe **106** may be located within a stack. Based on the identifier of the particular pipe **106**, the database **126** (see FIG. 1) may be accessed in order to obtain history information in real-time. A stand-alone sensor **1324** is further provided at the entrance of the storage yard **1320**, in order to detect assets entering and leaving the yard, thereby facilitating real-time inventory management of the assets and preventing unauthorized transportation of assets.

In accordance with an embodiment, the afore-mentioned method may further comprise, after installation of the asset storing, in the database **126**, operational procedures relative to an asset **105**. The method further includes generating a procedure message for presenting the operational procedures on the user-interface of the remote device. The method further includes receiving from the remote device, status information relative to the operational procedures. The completion status represents a "completed task" or an "uncompleted task". The method further includes associating a completion status in the database **126**, to each of the operational procedures based on the status information received.

Preferably, a set of such operational procedures are defined in the database in relation to given stages in the lifecycle of the asset, after installation (examples of such stages include: a maintenance of an installed asset, a prescheduled verification, a displacement of an installed asset, scheduled replacement of the asset, etc.). At a given stage, or shortly before or thereafter, the remote device may display the

operational procedures, via the afore-mentioned client device, on the user-interface for viewing by an operator. The client application, then receives the status information, which may be input manually by the operator or entered automatically further to completing an operational task, as to whether the procedure was successfully completed or not. Preferably, status information is received for each procedure presented. Input validation rules may be provided to process some of the status information. For example, when a given procedure is marked as non-completed, then other procedures depending on this given procedure are automatically marked as non-completed.

The method may further comprise: if one of the procedure is identified as having a status representing a non-completed task, generating an exception report identifying the asset and the procedure. This step may be executed at the above-mentioned given stage, or at a later stage in the lifecycle of the asset. The exception report is preferably sent for presentation on the same remote device, to return a message to the operator, or another remote device, for control purposes for example.

Embodiments of the present invention are advantageous in that for example the introduction and maintenance of the records in the database is subjected to validation and verification, in order to promote the integrity of the data in the database **126**, thereby allowing to meet operators' and regulators' compliance requirements.

Examples: traceability of pipe sections

A particular embodiment directed to the traceability of pipe sections for constructing pipeline infrastructure will now be described, as an example, with reference to FIG. 18 and 19. Broadly, transportable identification tags each storing data related to a particular one of the assets are each placed on a first location of the pipe section, and subsequently placed, further to a handling of the asset, on a second location of the pipe section.

More particularly, FIG. 18 shows a pipeline traceability system **100**, in the context of a fabrication plant **200** and of a coating plant **202**. As can be seen, with further reference to FIG. 21A-21C and 22A-22C, the pipeline traceability system **100** includes: a source database **102** (that may be located at the fabrication plant **200**) for storing data **104** related to a plurality of pipes **106** (that are examples of manufactured parts that will become infrastructure assets) to be traced; an RFID tag **108** associated to one of the plurality of pipes **106**, the tag **108** including a data storage medium **110** for an identifier **109** associated to the corresponding pipe **106**, a first securing means **114** for temporarily securing the tag **108** to a first location **116** of the pipe **106**, and a second securing means **118**, for securing the tag **106** to a second location **120** of the pipe **106**; and a scanner (preferably a reader and writer) **122** adapted to retrieve the data **104** associated to the corresponding one of the plurality of pipes **106** from the source database **102** and to communicate with the tag **108** in order to store the read identifier **109**onto the data storage medium **110** of the tag **108**.

The system **100** may include two main hardware components, namely a host server **124** and RFID tags **108**. A scanner **122** is also provided. The scanner **122** comprises a client application stored thereon in order to interact with the tag **108** and with the source database **102**.

In the fabrication plant **200**, the following steps are carried out, with reference to FIG. 18.

At step (1), the host server **124** communicates with the fabrication plant's **200** database **102**, in order to obtain a unique identifier **109** and all available data **112** on the asset being tracked (e.g. pipe **106**). The data **112** may include a heat and lot number. The host server **124** may be synchronized with the fabrication plant's database **102** to ensure that the correct data is being associated to the tags **108**.

At step (2), the host server **124** communicates with the scanner **122** to transfer pertinent data **112** on the asset **106** being tracked to the scanner **122** and verify the

integrity of the data transfer. The data **112** pertaining to the asset **106** is obtained from the fabrication plant's database **102**.

At step (3), the scanner **122** communicates with the tags **108** and writes the respective identifiers **109** obtained from fabrication plant's database **102** to the tags **108** as well as receives confirmation **113** that the data has been written correctly. The data displayed on the screen **126** of the scanner **122** may be synchronized with the process at the fabrication plant **200** to ensure that the pipes **106** being fabricated are being labeled with the appropriate identifiers. Human verification may be done by visually comparing the identifier displayed on the screen of the scanner **122** with the identifier displayed on the pipe **106** before writing to the tag **108** (quality control).

At step (4), the host server **124** writes all data **112** pertaining to the tagged pipe **106** (obtained from the fabrication plant's database **102**) to the host database **126** through a network connection **128**, such as Ethernet, WiFi, 3G, 4G, or the like. In addition to the data **112** from the fabrication plant **200**, additional data **113** such as a confirmation that the tags **108** were written and the labels were manually verified is added to the host database **126**. It should be noted that the host database **126** may be offsite (for example, in a different city) and the data **113** transferred to host database **126** may include additional information other than the manufactured asset data.

According to an alternative embodiment, the data **112** obtained from the fabrication plant's interface at step (3) is not transcribed onto the tags **108**, in order to protect the data **112**. Thus, only the unique identifier **109** is stored in the RFID tag's **108** memory **110**.

In the context of the present description, the "memory" **110** may be any suitable transportable storage device capable of storing digital information. In the case of an RFID tag, the storage device is a memory chip.

The interactions at the fabrication plant **200** shown in FIG. 18 will now be summarized. Initially, when a pipe **106** is scheduled for fabrication, the database **102** at the fabrication plant **200** starts communicating with the host server **124**. Once the pipe **106** is fabricated and all the required tests have been completed, the database **102** at the fabrication plant **200** signals the host server **124** and provides the host server **124** with an identifier **109** associated with the manufactured pipe **106** (step 1). The host server **124** transfers the pipe's identifier **109** to the scanner **122** (step 2). A user, such as a fabrication plant worker, visually verifies that an identifier displayed on the scanner **122** matches the identifier appearing on the pipe **106** and encodes the tag **108** with the pipe's data **112** obtained from the host server **124** (step 3). The scanner **122** receives confirmation that the tag **108** was written with the pipe identifier **109** (step 3) and the confirmation is transferred to the host database **102** (step 4) through the host server **124**. At this point, the identifier **109** received from the fabrication plant's database **102** is transferred to the host database **126** (step 4). It should be noted that this data transfer may also occur immediately at step (1).

During the manufacturing process, an RFID tag or other identification tag, such as a barcode may be mounted on the asset **106**, in order to record in the database **126** information regarding tests carried out on the asset **106** during the manufacturing process. Typically, three labels having bar codes marked thereon are mounted on the pipe, for reading during particular steps of the fabrication. The bar codes are preferably removed after the manufacturing process.

The steps carried out in the coating plant **202** will now be described, still with reference to FIG. 18.

At step (5), a scanner **122** communicates with the tags **108** and reads the identifier **109** prior to exiting the coating plant **202**. Preferably, there is at least a first scanner **122** at the fabrication plant **200** and at least a second scanner **122** at the coating plant **202**.

At step (6), the scanner **122** communicates with the host server **124** to add confirmation data **115** to the host database **126** indicating that the asset has completed all the required steps at the coating plant **202**. The tags **108** provide the host database **126** with information to identify the asset **106** and facilitate populating the database **126**. It should again be noted that the host database **126** may be offsite (for example, in a different city) with respect to the coating plant, and that the data transferred to the host database **126** is not limited to a confirmation **115**. The scanner **122** also communicates with the host server **124** to receive the status **117** of the data being written to the database **126**.

At step (7), the host server **124** communicates with the host database **126** to populate the database **126** with data from the coating plant **202** which is associated with the tags **108** (e.g. confirmation **115**). The host server **124** verifies that the data has been correctly written to the host database **126** and provides the scanner **122** with a status report **119**.

At step (8), the scanner **122** may replicate tags **108** for redundancy when necessary (e.g. the scanner **122** may have a copy-and-paste function to facilitate the replication of tags **108** for redundancy). Replicated data, i.e. identifier **109**, may be added to host database **126** (e.g. the host database **126** is updated with all new tag information **130**).

The interactions occurring at the coating plant **202**, shown in FIG. 18, will now be summarized. Once the pipe **106** arrives at the coating plant **202** from the fabrication plant **200**, the pipe **106** undergoes several steps until the final coating is applied. Although the data for these steps are not necessarily tracked, the system has the ability to track this data. After the pipe **106** is coated, an employee at each end of the pipe **106** may scan the tags **108**. The data **112** from the tags **108** can be used to populate the host database **126** through the host server **124** and the status of populating the database **126** can be sent back to the scanner **122** from the host database **126** through the host server **124**. Workers may visually verify that the status

on the scanner **122** indicates that the data was successfully written to the database **126** (quality control). In the event that a new tag **108** is needed, replication is initiated by the worker(s) and the host database **126** is populated using the same system for the new tag(s) **108**.

It is to be understood that, according to an alternative embodiment, the scanner **122** at the fabrication plant **200** may be in direct communication with the source and host databases **102**, **126**, as exemplified in FIG. 23, so as to write directly to the database **102**, **126** (i.e. send data from the scanner directly to the database **102**, **126**). Similarly, still with reference to FIG. 23, the scanner **122** at the coating plant **200** may be in direct communication with the host database **126**, in order to transfer data directly thereto.

Thus, in some embodiments, the tag may include communication means for communicating with a tag reader and/or tag writer device (also referred to herein as "scanner"). The tag reader device and tag writer device may preferably be the same scanner device, though they may be different devices.

Referring now to FIG. 19, the pipeline traceability system **100** at deployment in the field **204** will be described. Shown in FIG. 19 are two particular cases ("Case A" and "Case B") where the scanner **122** communicates with tag(s) **108**.

Case A, represented by step (9) in FIG. 19, applies when the asset **106** is deployed. The scanner **122** communicates with the tag **108** and reads the data **112** (see FIG. 21A-21C), upon deployment of the asset **106**.

Case B, represented by step 10 in FIG. 19, applies when changes occur to the structure of the asset **106**, such as when the asset **106** is split into several unattached parts, e.g. cutting a pipe **106** into several smaller sections **106i, 106ii, 106iii**, as exemplified in FIG. 22C. Still referring to FIG. 22C, the scanner **122** communicates with the original tag **108a** placed at the fabrication plant **200** and reads the data **112a** therefrom. A new tag **108b** is added to each unattached part **106ii** of the asset **106**

that is without such a tag. The scanner **122** replicates the data **112a** from the original tag **108a** to all new tag(s) **108b** using a copy-and-paste function. Replicated data **112b** is added to host database **126** (i.e. the host database **126** is updated with all new tag information **112b**), as illustrated in FIG. 19.

The uploading of the data to the host database **126** via the scanner **122** will now be described according to two methods, namely methods "A" and "B", also illustrated in FIG. 19.

Method A, represented by steps 11 and 12 in FIG. 19, involves the host server **124**. At step (11), the scanner **122** communicates with a host server **124** a network connection **128**, such as Ethernet, WiFi, 3G, 4G, or the like to add confirmation data **119** to host database **126** indicating that the asset **106** has been deployed.

It should be noted that the host database **126** may be offsite (could be in a different city) and the amount of data transferred to the host database **126** is not limited to a confirmation **119**. The host server **124** returns the status **121** of the data written to the database **126** (e.g. a confirmation that the data was written correctly to the database) to the scanner **122**.

At step (12), the host server **124** communicates with the host database **126** to populate the database **126** with data from the field; data that is associated with the tags **108** (e.g. confirmation data **119**). The host server **124** verifies that the data has been correctly written to the host database **126** and provides the scanner **122** with a status report through the host server **124**.

According to method B, the scanner **122** communicates with the host database **126** directly over a secure network connection **128**, such as Ethernet, WiFi, 3G, 4G, and/or the like, as represented by step (13) in FIG. 19, in order to populate the database **126** with data from the field, i.e. the data associated with the tags **108** (e.g. confirmation data **119**). The scanner **122** verifies that the data has been correctly written to the host database **126**.

It is to be understood that the data transfer from the pipes **106** in the field **204** to the host database **126** may be accomplished in a variety of alternative methods. A limiting factor may be accessibility to a network. If a network exists, then the data from the tags **108** may be transferred to the database **126** through a host server **124** or directly using 3G, 4G, or the like. If no such broad network is available to service the tag **108**, then the scanner **122** may be used to read the tag, and then be connected to a computer (or enter in communication with the computer when located in proximity thereto or via a network connection) in order to upload the data to the host database **126** at a later time when a communication network is accessible.

The interactions occurring in the field **204**, shown in FIG. 19, will now be summarized. After the pipes **106** are coated at the coating plant **200**, they are transported to the field **204** to be either deployed or cut into smaller sections to fit a particular length before deployment. In the former case, the scanners **122** are used to scan the tags **108** and populate the host database **126** with data associated with the deployment of the asset. In the latter case and as exemplified in FIG. 20C, the scanners **122** are used to replicate the original data **112a** from the tags **108a** at either end of the pipe **106** to all new tag(s) **108b**. The scanner **122** is then used to scan the new tags **108b** and populate the host database **126** with all pertinent data at the time of deployment. The host database **126** may be populated either through a host server **124**, directly using a secure network **128**, or physically connecting the scanner **122** to the host database **126** using a secure network line.

Referring now to FIG. 20A-20C, the method for providing pipe traceability from construction (at the fabrication plant **200**), to the coating plant **202**, and then to deployment of pipes in the field **204**, will be described.

Referring to FIG. 20A, at the fabrication plant **200,** the tags **108a** are placed inside **116** the pipe **106** at a pre-determined distance to ensure the tag **108a** is protected during structural tests and not lost or damaged during the cleaving procedure (a minimum required distance is set by a cleaving procedure), and then encoded using

scanners **122** (see FIG. 18). As better illustrated in FIG. 20C, tags **108a** are placed, by means of a first securing means such as a magnet **114** for example (see FIG. 21A-21C), at both ends of the pipe **106** to ensure redundancy (i.e. multiple tags **108a** reduce the probability of data loss) and insensitivity to pipe orientation, which can be an issue along the process pipeline.

Referring to FIG. 20B, after the final step at the coating plant **202**, the tags **108a** at both ends of the pipe **106** are moved from the inside **116** of the pipe **106** to the outside **120** of the pipe **106**, at each end **106i**, **106iii** of the pipe **106**. A secondary adhesive **118** (see FIG. 22A-22C) is used to secure the tags **108a** to the outside **120** of the pipe **106**. The tags **108a** are placed near the seam and contralateral to each other (i.e. if a tag is placed to the left of the seam, the other tag **108a** is placed to the right of the seam). The tag **108** is used to encode completion of coating.

In the field **204**, a pipe **106** may be cut to fit a particular length prior to deployment, as previously mentioned with reference to FIG. 20C. Although a single cut should not affect the traceability of a pipe, multiple incisions would compromise pipeline traceability. In the event that a pipe **106** is cut in multiple locations, new tag(s) **108b** are placed on all pieces **106ii** of pipe that do not have such a tag. The data is copied from the original tags **108a** at either end of the pipe **106** and used to encode the new tags **108b**. The new tags **108b** are secured with a secondary securing mechanism **118**. If multiple incisions are made, all unmarked pieces of pipe are tagged using the above procedure.

Preferably, the afore-mentioned "first location" is a protected location on the asset and the "second location" is an exposed location of the asset. For example, in the context of pipelines, where the asset is a pipe section, the first location may correspond to an inner portion of the pipe section and the second location may correspond to an outer portion of the pipe section.

By "securing means" it is meant any suitable mechanism, assembly, sub-component thereof, or material for fastening, attachment, mounting, adhering, etc. the tag to the asset.

Furthermore, it is to be understood that, according to embodiments of the present invention, the tag **108** may be initially placed on the pipe **106** at the steel manufacturer (i.e. steel mill), at the pipe manufacturer (i.e. pipe mill) or at the coating company **202**, or even at any step prior to deployment of the pipe **106** into the field **204**, for example at a storage location.

The tag **108** may be mounted on the pipe **106** manually by a worker or it may be applied by an automated system, for example by means of a robotic arm.The securing mechanisms used in this embodiment are divided into two groups: primary stage and secondary stage. Securing mechanisms **114** in the primary stage, shown in FIG. 21A-21C, are used to temporarily bind the tags **108a** to the pipe **106** before the tags **108a** are transitioned to their final location and the securing mechanisms **118** in the secondary stage, shown in FIG. 22A-22C, are used to permanently bind the tags **108** to the pipes. The primary stage is necessary because the tags **108** need to be placed in a location that is protected from the harsh testing and coating treatment performed on the pipes before they can be placed in a location where the scanner **122** can more readily communicate with the tags **108**.

Referring now to FIG. 21A-21C, primary stage securing mechanisms will be described, according to embodiments of the invention. The tags **108** may have a magnetic portion **114** and peel away section that composes the primary stage securing mechanism (FIG. 21A-21C). At the fabrication plant **200** the magnetic portion **114** of the tags **108** are used to attach the tags **108** to the interior of the pipe. At the coating plant **202**, the tags **108** are moved from the inside **116** to the outside **120** of the pipe **106** (see FIG. 20B) and a peel away adhesive layer **118** may be used to attach the tags **108** to the pipe **106** before the secondary stage securing mechanism is applied. The primary securing mechanism may be a chemical adhesive

such as glue. The primary securing mechanism may also be a mechanical device that is adapted for mounting within a pipe section.

Referring now to FIG. 22A-22C, secondary stage securing mechanisms **118** will be described, according to embodiments of the invention. Three kinds of secondary securing mechanisms **118** are shown: spray on (FIG. 22A), over paint (FIG. 22B), and tape (FIG. 22C). Each secondary securing mechanism **118** may be applied to the tags **108** after they have been placed in their final location. This may occur after the last step at the coating plant **202** or in the field **204** when new tags **108** have been added (see FIG. 20A-21C). The secondary securing mechanisms **118** have been designed to produce a durable permanent bind to the asset that can endure extreme conditions.

Another particular embodiment directed to the traceability of drilling pipes, e.g. OCTG (Oil Country Tubular Goods), will now be described, as an example, with reference to FIG. 28 and 29. An OCTG drilling pipe does not require a coating procedure because the pipe is used dynamically, in that it is used from one drilling location to another (i.e it does not remain in a same location for long periods of time as is the case of a pipe serving as a segment of a pipeline). Instead, once the pipe is fabricated, the pipe is ready for use in the field. The identification tags are therefore not exposed to the same environmental constraints as afore-described pipes that require coating.

FIG. 28 illustrates a drilling pipe **106**. At the fabrication plant **200**, identification tags **108** are placed outside of the pipe **106** once the pipe is manufactured. Identification tags **108** are placed at both ends of the pipe **106** to ensure redundancy, as multiple identification tags reduce the probability of data loss, and insensitivity to pipe orientation, which can be an issue along the process pipeline. An adhesive, such as the secondary adhesives **118**, described herein with reference to FIG. 22A, 22B, 22C, is used to permanently secure the identification tags **108** to the pipe **106**. The identification tags **108** are placed near a seam **107** of the pipe **108** and contralateral

to each other, that is to say if a first identification tag **108** is placed to one side of the seam **107**, the other identification tag **108** is placed to the other side of the seam **107**.

Referring now to FIG. 29, the pipeline traceability system **150** at deployment in the field **152** will be described. The system **150** includes two main hardware components, namely a host server **124** and the scanner **122**.

At step (14), the scanner **122** communicates with the identification tag(s) **108** by automatically reading each tag **108** as the drilling pipes **106** are deployed into the ground.

The uploading of the drilling pipe data to the host database **126** will now described according to two methods, namely methods "A" and "B", still with reference to FIG. 29.

Method A, represented by steps 15 and 16, involves the host server **124**. At step (15), the scanner **122** communicates with a host server **124** over an on-site hard-wired network link **127**, in order to add confirmation data **119** to host database **126** indicating that the asset **106** has been deployed. It is to be understood that the communication between the scanner **122** and the host server **124** may also be provided over any suitable communication network, including Ethernet, WiFi, 3G, 4G, or the like.

It should be noted that the host database **126** may be offsite (may be in a different city, for example) and the amount of data transferred to the host database **126** is not limited to the confirmation **119**. The host server **124** returns the status **121** of the data written to the database **126** (e.g. a confirmation that the data was written correctly to the database) to the scanner **122**.

At step (16), the host server **124** communicates with the host database **126** in order to populate the database **126** with data from the field, i.e. data that is associated with the tags **108** (e.g. confirmation data **119**). The host server **124** verifies that the data

has been correctly written to the host database **126** and provides the scanner **122** with a status report through the host server **124**.

According to method B, the scanner **122** communicates with the host database **126** directly over a secure line **129**, as represented by step (17) in FIG. 29, in order to populate the database **126** with data from the field, i.e. the data associated with the tags **108** (e.g. confirmation data **119**). The scanner **122** verifies that the data has been correctly written to the host database **126**. It is to be understood that the communication between the scanner **122** and the host server **124** may also be provided over any suitable communication network, including Ethernet, WiFi, 3G, 4G, and/or the like

The interactions occurring in the field **152**, shown in FIG. 29, will now be summarized. After the pipes **106** are made at the fabrication plant **200** (FIG. 28), they are transported to the field **204** where they will be used for drilling. An automated scanner **122** is used to scan the tags **108** as the pipes are deployed into the ground and populate the host database **126** with data associated with the deployment of the asset. The host database **126** may be populated either through a host server **124**, directly using a secure network line **129**, where the scanner **122** is physically connected to the host database **126** using a secure network line.

Advantageously, embodiments of the present invention increases source data integrity in comparison to conventional systems, by transferring the source information **1018**, including metallurgical data of the source manufacturer **302**, **312**, **322** from one (or more) database **1016** (or spreadsheet or the like) to another database (or spreadsheet or the like), thereby reducing human intervention and consequently reducing human error. Data is further verified at various steps and stages in the lifecycle of the asset **105**, further promoting the integrity of the data recorded in the database **126**.

Furthermore, in the case of pipe assets **106**, the steel mill producing the coil or the pipe manufacturer producing the pipe provides the host database **126** with the source

data **1018** in electronic form and that data **1018** remains associated with the asset **106** for the life of the asset **106**. Furthermore, events occurring to the pipe section **106** may be added in the database **126** as history data **1023**. Thus, the source data as well as the event history of a particular pipe **106**, remains available for distribution to an end user.

Still advantageously, according to embodiments of the present invention, one or more of the tag **108** may be embedded into the pipe either during the pipe manufacturing process which may include the coating process. Of course, the tag may be mounted on the pipe after coating. A permanently placed tag **108** is configured to withstand the rigors of the manufacturing process and to permanently stay with the pipe **106** for the life of that pipe **106**.

Still advantageously, the tag **108** is useful for the entire lifecycle of the pipe **106**. For the purpose of inspecting a pipeline that has been installed, a worker may access information concerning a particular pipe of the pipeline via a scanner **122**, which may be provided by a smartphone. By means of the smartphone, the worker accesses, via an application interface executed on the smartphone, history information related to this particular piece of pipe, including manufacturing source data as well as every event that has occurred to that pipe since its manufacturing.

At the time of underground installation of a pipeline in the field **204**, a longitude and latitude is plotted by a survey company, for referencing each pipe **106** to a map. The scanner **122** reads the tag **108** of a given pipe **106** and communicates with the host database **126**, in accordance with the method shown in FIG. 19, to associate the pipe **106** with the longitude and latitude for future identification of the particular pipe **106** and the retrieval of corresponding information. It is to be understood that a similar plot reference may also be associated to a pipe **106** installed above ground. Alternatively, an above-ground pipe **106** is readily accessible for identification by a scanner **122**, and it may therefore not be necessary to reference it to a map.

Thus, this embodiment provides a field reporting feature, in that the inventory or other asset information may be retrieved on the basis of the location of the pipes **106** as they are displaced in the field **204**. The field reporting feature is advantageous over conventional inventory management systems that generally provide theoretical or static inventory information, in that the field reporting feature is based on data **112** tied to the physical assets **106** deployed in the field **106**.

In accordance with an embodiment of the present invention, the host database **126** and host server **124** are hosted by host company. A client company owns assets **106** and uses tags **108** for identifying their assets **106**. The host database **126** stores information **112** related to the tags **108** and assets **106** of the client company. The client company may access the host database **126** for their particular tags **108** and assets **106**, in exchange for a fee charged based on a volume of tags **108** to be used by the client company. This fee may vary for example between 20$ to 300$ per asset. Alternatively, the client company may purchase a corporate license for accessing the host database independently of the number of tags **108**, for example when the number of tags **108** used by a client company exceeds a given threshold.

Several modifications could be made to the above-described asset traceability system, without departing from the scope of the present invention. Indeed and for example, the first securing means **114** may include a mechanical apparatus such as a tripod spreader **132** (7A, 7B), a bar spreader **134** (see FIG. 25A, 25B), a wire spreader **136** (26A, 26B), a custom spreader **138** (see FIG. 27A to 27D), as well as any other suitable securing system including multi-pod spreaders, compression spring systems, ratchet based systems, expansion rings, suction cups, latches, and hooks, adhesions like glue, tape, and magnetic materials.

The system may also include heat protection means for protecting the RFID tag from the elevated temperatures of the coating process. The heat protection means may hold the RFID tag in spaced relation with respect to the interior surface of the pipe section and may be composed of a material with low heat conductivity. The heat

protection means may also include encasings that act as a buffer between the heat and RFID, insulation material to envelop the RFID, and spray on chemicals that dissipate prior to the heat affecting the RFID.

Other optional aspects and implementations

Various optional scenarios and examples of systems, methods and certain components for pipeline asset traceability techniques will be described below. It should be understood that the scenarios described below may be combined with other aspects of the traceability as described hereinabove in accordance with various embodiments of the present invention.

In some scenarios, there is provided a pipeline asset traceability method for tracking coated pipeline assets from manufacturing to deployment, the method including:

temporarily tagging manufactured pipe sections by removably mounting an identification tag at a protected location within each of the manufactured pipe sections, such that each of the identification tags is protected with respect to a post-manufacturing coating treatment of an outside surface of each of the manufactured pipe sections to produce the coated pipeline assets, wherein each of the identification tags includes a readable-and-writable data storage medium storing pipe manufacture data associated with the corresponding manufactured pipe section;

removing each of the identification tags from the protected location within each of the coated pipeline assets after the corresponding post-manufacturing coating treatment;

re-tagging the coated pipeline assets by mounting each of the removed identification tags to an outer coating of a corresponding one of the coated pipeline assets; and

deploying the tagged coated pipeline assets for construction of pipeline infrastructure.

In accordance with another scenario, there is provided a pipeline asset traceability system for tracking coated pipeline assets from manufacturing to deployment, the system including:

a set of identification tags, each identification tag including:

a readable-and-writable data storage medium; and

a first mounting mechanism for removably mounting the data storage medium at a protected location within a manufactured pipe section, such that each data storage medium is protected with respect to a post-manufacturing coating treatment of an outside surface of the manufactured pipe sections to produce the coated pipeline assets;

a secondary mounting mechanism for re-installing each data storage medium to a corresponding outer surface of each of the coated pipeline assets;

a database for receiving pipe manufacture data associated with each of the manufactured pipe sections; and

a scanner for receiving the pipe manufacture data from the database and writing the pipe manufacturing data associated with each of the manufactured pipe sections to the corresponding data storage medium mounted to the corresponding coated pipeline asset, and for reading the pipe manufacture data from each of the tags, thereby allowing traceability of the coated pipeline assets.

It is to be understood that the pipe manufacture data may be uploaded to the tag in a number of ways. Indeed and for example, the tag may be in communication with the host server or source database so as to receive corresponding information directly

therefrom, instead of having the scanner write to the identification tag. In some aspects, the pipe manufacture data or a portion thereof is pre-stored in the tag prior to mounting the tag onto the pipe.

In accordance with another scenario, there is provided a pipeline asset traceability system for tracking coated pipeline assets from manufacturing to deployment, the system including:

a database for storing pipe manufacture data associated with manufactured pipe sections;

a set of tags, each tag including:

a data storage medium for receiving pipe manufacture data associated with one of the manufactured pipe sections; and

a first mounting mechanism for removably mounting the tag at a protected location within the corresponding manufactured pipe section, such that each data storage medium is protected with respect to a post-manufacturing coating treatment of an outside surface of the manufactured pipe sections to produce the coated pipeline assets;

a secondary mounting mechanism for re-installing each data storage medium to a corresponding outer surface of each of the coated pipeline assets; and

a scanner for obtaining the pipe manufacture data from each of the tags, thereby allowing traceability of the coated pipeline assets.

In accordance with another scenario, there is provided a traceability tag for tagging coated pipeline assets for tracking from manufacturing to deployment, the traceability tag including:

a readable-and-writable data storage medium for receiving pipe manufacture data associated with a manufactured pipe section and providing the pipe

manufacture data to ensure traceability of the coated pipeline asset including the manufactured pipe section;

a mounting mechanism connected with respect to the readable-and-writable data storage medium, for removably mounting the same at a protected location within the manufactured pipe section; and

heat protection means connected with respect to the readable-and-writable data storage medium, such that the readable-and-writable data storage medium is protected from temperatures up to about 250ºC in the post-manufacturing coating treatment.

The heat protection means may be provided for protection of the data storage medium from temperatures up to about 300ºC, 350ºC, 400ºC, 450ºC or 500ºC, in the post-manufacturing coating treatment. The heat protection means may include a structure or composition enabling the data storage medium to resist or minimize heat transfer from other parts of the hot pipe section while the pipe section is undergoing coating, thereby allowing the data storage medium to remain at lower temperatures until the coated pipe section is quenched and cooled.

In accordance with another scenario, there is provided a traceability kit for tracking coated pipeline assets from manufacturing to deployment, the traceability kit including:

a readable-and-writable data storage medium for storing pipe manufacture data associated with a manufactured pipe section, in order to ensure traceability of the coated pipeline asset including the manufactured pipe section;

a first securing mechanism for cooperating with the readable-and-writable data storage medium, to removably secure the same at a protected location within the manufactured pipe section; and

a second securing mechanism for cooperating with the readable-and-writable data storage medium, for re-securing the same with respect to an outer surface of the coated pipeline asset.

In accordance with yet another scenario, there is provided an identification tag for tracking an asset, the identification tag including:

a data storage medium for storing data associated to the asset; and

a securing means adapted to cooperate with the data storage medium to temporarily secure the data storage medium to a first location of the asset and to subsequently secure the data storage medium permanently to a second location of the asset.

In accordance with still another scenario, there is provided an identification tag for tracking an asset, the tag including:

a data storage medium for storing data associated to the asset;

a first securing means adapted to cooperate with a protected location of the asset to temporarily secure the data storage medium to said protected location of the asset; and

a second securing means adapted to cooperate with an exposed location of the asset to permanently secure the data storage medium to said exposed location of the asset.

The above-mentioned data storage medium may include a memory. By "memory" it is meant any suitable transportable storage device capable of storing digital information. Indeed, and for example, the identification tag may take the form of a radio frequency identification (RFID) tag, wherein the data storage medium is a memory chip. Alternatively, the data storage medium may be provided in the form of a bar code,

magnetic stripe, any suitable electronic chip and/or the like. The data storage medium is preferably readable and rewritable.

In some embodiments, the tag may further include communication means for communicating with a tag reader and/or tag writer device (also referred to herein as "scanner"). The tag reader device and tag writer device may preferably be the same scanner device, though they may be different devices.

In accordance with yet another scenario, there is provided an asset traceability system including the above-described tag. More particularly, the asset traceability system includes:

a source database for storing data related to a plurality of assets to be traced;

a tag associated to one of the plurality of assets, the tag including a data storage medium for storing data associated to the asset;

a securing means adapted to cooperate with the data storage medium to temporarily secure the data storage medium to a first location of the asset and to subsequently secure the data storage medium permanently to a second location of the asset; and

a scanner for reading data stored on the data storage medium of the tag secured to one of said plurality of assets, in order to trace the corresponding asset.

In an embodiment, the system further includes a host server being in communication with the source database over a communication network.

In an embodiment, the scanner is adapted to communicate with the source database in order to retrieve therefrom the data associated to the corresponding one of the plurality of assets, and to communicate with the tag in order to store the read data onto the data storage medium of the tag.

In accordance with yet another scenario, there is provided a pipeline asset traceability method for tracking non-coated pipeline assets from manufacturing to deployment, the method including:

tagging manufactured pipe sections by mounting an identification tag to an outer surface of each of the manufactured pipe sections, wherein each of the identification tags includes a readable-and-writable data storage medium;

storing on each on the readable-and-writable data storage medium, pipe manufacture data associated with the corresponding manufactured pipe section; and

deploying the tagged manufactured pipeline assets for construction of pipeline infrastructure.

Preferably, an identification tag is placed at each end of each of the manufactured pipe sections at the tagging step. Preferably, each of the pair of identification tags for a given pipe section are mounted near a seam of the pipe section and contralateral to each other, in that a first one of the pair is mounted on one side of the seam while a second one of the pair is mounted on the other side of the seam.

In accordance with another scenario, there is provided a pipeline asset traceability system for tracking non-coated pipeline assets from manufacturing to deployment, the system including:

a set of identification tags, each identification tag including a readable-and-writable data storage medium;

a mounting mechanism for installing each identification tag to an outer surface of a corresponding one of the manufactured pipeline assets;

a database for receiving pipe manufacture data associated with each of the manufactured pipe sections; and

a scanner for receiving the pipe manufacture data from the database and writing the pipe manufacturing data associated with each of the manufactured pipe sections to the data storage medium of the identification tag mounted to the corresponding coated pipeline asset, and for reading the pipe manufacture data from each of the tags, thereby allowing traceability of the manufacture pipeline assets after deployment.

In accordance with yet another scenario, there is provided a method for tracing an asset by means of the afore-mentioned tag and system. More particularly, the method includes steps of:

providing a tag including a data storage medium, having stored thereon data associated to the asset;

securing the tag temporarily to a first location of the asset for a treatment of the asset; and

further to said treatment of the asset, securing the tag on a second location of the asset.

The method preferably includes, prior to the step of providing a tag, the step of storing the data associated to the asset on to said data storage medium of the tag, by means of a writer (or scanner) such as the one described above.

For example, in the case where the asset is a pipe, the scanner may first retrieve information from the host database, related to a particular pipe section asset and feeds this data onto the data storage medium of the tag. Thus, the tag stores data related to a specific pipe section, for example a heat and lot number, as well as a unique identifier of the tag, i.e. example of step of providing a tag. Upon fabrication of the corresponding pipe section, the tag is secured inside the pipe, i.e. example of

step of securing the tag on a first location. The pipe section is then subjected to various one or more post-manufacture treatments, which may include heating, sandblasting, acid washing, coating, cooling, cleaning, etc. Further to a coating treatment, the tag is removed from the inner portion of the pipe and then secured to the outside of the pipe, i.e. example of step of securing the tag on a second location. At any of the above-mentioned steps or at any intermediate sub-step thereof, data may be read from the tag, for verification purposes for example, and/or data may be written on the tag, for example when new information is relevant, such as when a treatment or testing step has been completed. Another example where new information is created occurs when a given pipe asset is split or cut into two or more smaller pipes prior to deployment. In this case, for each cut, a separate untagged pipe asset is created and a new tag is thus provided on the new pipe asset and the pipe manufacture data is written onto the new tag. The data may be read from the tag of the cut pipe asset having the original tag, and then written onto the new tag of the other cut pipe asset. After the tag information is updated with this new information (for a previously existing tag and/or for a newly created tag), the scanner also preferably updates the host database, in order to centrally store the new information. Alternatively, some of the new information is generated from the host database for the scanner to feed onto the tag. Status information related to the tag may then be transferred back to the host database.

Thus, the afore-mentioned method preferably includes reading the data stored on the data storage medium, via the scanner before, after or during steps of providing a tag, of securing the tag on a first location and/or of securing the tag on a second location. For example, the read data may be presented on the display screen of the scanner for verification purposes, at different steps in the testing and treatment of the pipe.

The method may further include updating the data stored on the data storage medium after steps of providing a tag, of securing the tag on a first location and/or of securing the tag on a second location, via the scanner.

Preferably, the method may include retrieving the updated data from the tag, preferably via the scanner, and updating the host database.

In another scenario, there is provided a pipeline asset traceability method for tracking a pipeline asset for deployment in a pipeline infrastructure, the method including:

securing a first identification tag including a data storage medium to the pipeline asset, the data storage medium storing pipe data related to the pipeline asset;

cutting the pipeline asset into at least first and second pipeline asset parts, the first pipeline asset part having the first identification tag secured thereto;

retrieving the pipe data from the data storage medium of the first identification tag;

providing the retrieved pipe data to a second identification tag secured to the second pipeline asset part; and

deploying the first and second pipeline assets in the pipeline infrastructure.

Although some embodiments as illustrated in the accompanying drawings includes components such as a source database, a host server, a scanner, an RFID tag, securing mechanisms such as glue, a magnet, adhesives, etc., and although the preferred embodiment of the asset traceability system and corresponding parts thereof include certain configurations as explained and illustrated herein, not all of these components and configurations are essential to the invention and thus should not be taken in their restrictive sense, i.e. should not be taken as to limit the scope of the present invention. It is to be understood, as also apparent to a person skilled in the art, that other suitable components and cooperations therein between, as well as other suitable configurations and architectures may be used for the asset traceability system according to the present invention, as will be briefly explained herein and as

can be easily inferred herefrom, by a person skilled in the art, without departing from the scope of the invention.

Furthermore, although the present description provides examples and aspects related to pipelines and other assets in the field of oil and gas, the present invention may be applicable to other similar assets which require or would benefit from tracking and managing, and which in some cases may be limited in terms of location where identification information may be placed while they are being handled, as can also be easily understood by a person skilled in the art, without departing from the scope of the present invention. Various techniques are described herein in relation to traceability of pipeline assets, for example coated or uncoated pipeline assets. The assets may be dedicated for deployment in a pipeline infrastructure for transporting gas, liquid, suspensions or slurries various distances. The assets may therefore have properties and structures suited for the dedicated purpose. The pipeline assets may be for use in the petro-chemical industry, the energy industry or other industries such as waste and sewage management, water and air treatment, construction, and so on.

It should be noted moreover that many other types of infrastructure assets, in the field of oil and gas or in other fields, may be tracked using techniques as described herein. Such assets may include transportation infrastructure assets that are pre-fabricated prior to deployment, such as railroad component assets, road component assets, building component assets, and so on.

Additionally, although the present description provides examples and aspects related to pipes made of a metallic composition, it is to be understood that the present invention may be useful for pipes or other assets made of other compositions, for example polyethylene pipes.

In addition, according to embodiments of the present invention, components or devices additional to those described herein, may be incorporated with the above-described systems, methods and/or components thereof, without departing from the scope of the invention, as can be understood by a person skilled in the art.

The above-described embodiments are considered in all respects only as illustrative and not restrictive, and the present application is intended to cover any adaptations or variations thereof, as apparent to a person skilled in the art. Of course, numerous other modifications could be made to the above-described embodiments without departing from the scope of the invention, as apparent to a person skilled in the art.

Claims:

1. A system for tracking and managing oil and gas infrastructure assets, an identification tag being mounted on each asset and storing a unique identifier, the system comprising:

a data importation module, integrated in a processor and configured to communicate with a manufacturer data source, for receiving manufacture information related to one of the assets from the manufacturer data source, the data importation module comprising a validation module for validating the manufacture information based on data integrity rules stored in a memory, the data importation module being further configured to receive history information related to the asset from a plurality of entities, during a lifecycle of the asset;

a central database being in communication with the data importation module, for storing the manufacture information having been validated and the history information, and for associating the manufacture information and history information with the unique identifier; and

a reporting engine, integrated in the processor and being in communication with the central database, to report information from the central database on a user-interface of a remote device, for tracking and managing the asset from the remote device, based on the manufacture information and the history information.

2. The system according to claim 1, wherein the data importation module comprises a data input module for identifying a format of the manufacturer information received and for reading the manufacturer information based on the format.

3. The system according to claim 1 or 2, wherein the data importation module comprises a data parser for identifying a correspondence between the manufacturer information to be imported and fields of the central database.

4. The system according to any one of claims 1 to 3, wherein the data integrity rules are predefined.

5. The system according to any one of claims 1 to 4, wherein the data integrity rules comprise validation of the number of digits in a heat number against an expected number of digits.

6. The system according to any one of claims 1 to 5, wherein the data integrity rules comprise validation of a temperature reading against a predefined range of temperatures.

7. The system according to any one of claims 1 to 6, wherein the data integrity rules comprise validation of numeric and alphanumeric character requirements in a given pipe number

8. The system according to any one of claims 1 to 7, wherein the data integrity rules comprise validation of a wall thickness against a given range of wall thicknesses.

9. The system according to any one of claims 1 to 8, wherein the data integrity rules comprise validation of a coating thickness against a given range of coating thicknesses.

10. The system according to any one of claims 1 to 9, wherein the data integrity rules are defined based on an asset operator's requirements.

11. The system according to any one of claims 1 to 10, wherein the data integrity rules are defined based on regulatory requirements.

12. The system according to any one of claims 1 to 11, wherein the data importation module comprises an error processing module for processing an error output from the validation module.

13. The system according to any one of claims 1 to 12, further comprising an administration module, integrated in the processor, for administering user accounts and associated permissions to access the central database.

14. The system according to any one of claims 1 to 13, further comprising a tag reader being in communication with the database over a communication network for exchanging information with the database, the tag reader having a reading module for reading the identifier stored on the tag of each asset.

15. The system according to any one of claims 1 to 14, wherein the reporting engine is configured to provide a real-time accessibility to the remote device.

16. The system according to any one of claims 1 to 15, further comprising a plurality of the remote devices being further in communication with the database via the communication network.

17. The system according to claim 16, wherein the plurality of remote devices comprises at least one of: a ruggedized laptop computer; a tablet computer; a conventional computer; and a smart phone.

18. The system according to any one of claims 1 to 17, wherein the reporting engine comprises a data retrieval module for retrieving information from the database on the basis of a given unique identifier stored on an identification tag of an asset, the reporting engine further comprising an output module for outputting the report to one of the remote devices via the communication network.

19. The system according to any one of claims 1 to 18, further comprising a tag printer for printing a new identification tag.

20. The system according to any one of claims 1 to 19, wherein the data importation module is in communication with the plurality of entities, each entity being selected from the group consisting of:

a transportation data source;

a storage yard data source;

a construction yard data source;

a pipe cutting data source;

a surveyor data source;

an installation data source including at least one of:

welding data;

x-ray data;

pipe cutting data;

pipe bend data;

coating data;

girth weld coating data;

pre-commissioning test data; and

inspection data; and

operations and maintenance data source including at least one of:

inline inspection data;

cathodic protection data;

pipe quality data;

visual inspections; and

cut-out and replacement data.

21. A method for tracking and managing oil and gas infrastructure assets, the method comprising the steps of:

a) importing into a central database manufacture information on a given asset from a manufacturer data source, the importing step comprising validating the data to be imported based on data integrity rules;

b) associating in the central database, the manufacture information having been imported, to a unique identifier stored in an identification tag mounted on the asset;

c) storing in the central database, history information from a plurality of entities, during a lifecycle of the asset after manufacture and associating the history information to the unique identifier, in order to report information from the central database on a user-interface of a remote device, for tracking and managing the asset, from the remote device, based on the manufacture information and the history information.

22. The method according to claim 21, wherein the importing step (a) further comprises:

identifying a format of the manufacturer information received.

23. The method according to claim 22, wherein the importing step (a) further comprises:

parsing the manufacturer information based on the identified format in order to identify a correspondence between the manufacturer information to be imported and fields of the central database.

24. The method according to any one of claims 21 to 23, wherein the data integrity rules of the validating in step (a) are predefined.

25. The method according to any one of claims 21 to 24, wherein the data integrity rules of the validating in step (a) comprise validating the number of digits in a heat number against an expected number of digits.

26. The method according to any one of claims 21 to 25, wherein the data integrity rules of the validating in step (a) comprise validating a temperature reading against a predefined range of temperatures.

27. The method according to any one of claims 21 to 26, wherein the data integrity rules of the validating in step (a) comprise validating numeric and alphanumeric character requirements in a given pipe number.

28. The method according to any one of claims 21 to 27, wherein the data integrity rules of the validating in step (a) comprise validating a wall thickness against a given range of wall thicknesses.

29. The method according to any one of claims 21 to 28, wherein the data integrity rules of the validating in step (a) comprise validating a coating thickness against a given range of coating thicknesses.

30. The method according to any one of claims 21 to 29, wherein the data integrity rules of the validating in step (a) are defined based on an asset operator's requirements.

31. The method according to any one of claims 21 to 30, wherein the data integrity rules of the validating in step (a) are defined based on regulatory requirements.

32. The method according to any one of claims 21 to 31, wherein the importing step (a) further comprises after the validating step:

receiving an error output from the validating step;

processing the error output; and

receiving data correction instructions.

33. The method according to any one of claims 21 to 32, wherein the importing of the manufacture information of step (a) comprises importing pipe mill information from a pipe mill.

34. The method according to claim 33, wherein the pipe mill information of step (a) comprises at least one of: tally data; mill run data; inspection result data; and work order integration information.

35. The method according to claim 33 or 34, further comprising associating in the central database a new unique identifier stored on a corresponding pipe mill identification tag mounted on the asset at the pipe mill.

36. The method according to any one of claims 21 to 35, wherein the importing of the manufacture information of step (a) comprises importing coating plant information from a coating plant.

37. The method according to claim 36, wherein the coating plant information of step (a) comprises at least one of: tally data; inspection result data; and coating specification data.

38. The method according to claim 36 or 37, wherein the validating of step (a) further comprises validating the pipe mill information based on the manufacturer data stored in the database.

39. The method according to any one of claims 21 to 38, wherein one of the entities of step (c) is a transportation facility and the storing of history information of step (c) comprises storing transportation information.

40. The method according to claim 39, wherein the transportation information comprises at least one of: way bills data; bill of lading data; shipper data; tracking subcontractor data; and receiving information.

41. The method according to claim 39 or 40, wherein storing of step (c) comprises storing the transportation information through batch processing.

42. The method according to any one of claims 21 to 41, wherein one of the entities of step (c) is a storage facility and the storing of history information of step (c) comprises storing storage information.

43. The method according to claim 42, wherein the storage information comprises at least one of: PO number; and vender ID.

44. The method according to claim 42 or 43, wherein storing of step (c) comprises storing the storage information through batch separation.

45. The method according to claim 42 or 43, wherein storing of step (c) comprises storing the storage information through electronic data interchange with ERPs.

46. The method according to any one of claims 21 to 45, wherein one of the entities of step (c) is a construction facility and the storing of history information of step (c) comprises storing construction yard information.

47. The method according to claim 46, wherein the construction yard information comprises at least one of: material testing reports; and asset location data.

48. The method according to claim 46 or 47, further comprising:

storing in the database shipping and receiving information related to the asset; and

validating, at the construction facility, the shipping and receiving information.

49. The method according to any one of claims 21 to 48, wherein one of the entities of step (c) is a pipe cutting facility and the storing of history information of step (c) comprises storing pipe cutting information.

50. The method according to claim 49, wherein the pipe cutting information comprises at least one of: cut and joint information; X-ray testing data; and child and parent association data.

51. The method according to any one of claims 21 to 50, wherein one of the entities of step (c) is a pipe bending facility and the storing of historical information of step (c) comprises storing pipe bending information.

52. The method according to claim 51, wherein the pipe bending information comprises at least one of: bending specification information; and structural integrity impact information.

53. The method according to any one of claims 21 to 52, wherein one of the entities of step (c) is a surveyor entity and the storing of history information of step (c) comprises storing surveyor information.

54. The method according to claim 53, wherein the surveyor information comprises at least one of: pipe latitude, longitude, elevation; and integration with third-party mapping services.

55. The method according to any one of claims 21 to 54, wherein one of the entities of step (c) is an installation facility and the storing of history information of step (c) comprises storing installation information.

56. The method according to claim 55, wherein the installation information comprises at least one of: maintenance data; reporting options data; depth of buried pipe; preventative quality control measures taken; and maintenance related work information.

57. The method according to any one of claims 21 to 56, further comprising:

receiving a reporting request from the remote device, the request comprising the unique identifier of the asset;

retrieving the requested information from the database;

returning a report to the remote device, in response to the request, for presentation on the remote device; and

the report comprising at least one of: manufacturer information and history information retrieved from the database.

58. The method according to claim 57, wherein the reporting request originates from a workspace accessed via the remote device based on login information from a user.

59. The method according to claim 58, wherein the login information comprises a user identifier associated to the user, and wherein the accessing step further comprises:

verifying a user permission based on the user identifier; and

wherein the retrieving step comprises retrieving the requested information for which the user permission allow access to.

60. The method according to any one of claims 57 to 59, wherein the unique identifier of the receiving step originates from a reading of the identification tag of the asset, via a tag reader.

61. The method according to any one of claims 57 to 59, wherein the unique identifier of the receiving step originates from a user entry.

62. The method according to any one of claims 57 to 61, wherein the reporting request comprises a plurality of the unique identifiers associated to a plurality of corresponding one of the assets.

63. The method according to any one of claims 57 to 62, further comprising, sending the reporting request from the remote device.

64. The method according to claim 63, wherein the sending step and the retrieving step are executed in real-time.

65. The method according to any one of claims 21 to 64, further comprising:

providing the identification tag having the unique identifier stored thereon;

mounting the identification tag on the asset; and

if the tagging process is not completed:

i) generating a new unique identifier in the database;

ii) providing a new identification tag having the new unique identifier stored thereon;

iii) mounting the new identification tag on the asset; and

iv) if the tagging process is not completed, repeating steps (i) to (iii).

66. The method according to any one of claims 21 to 65, further comprising:

storing, in the database, operational procedures relative to an asset;

generating a procedure message for presenting the operational procedures on the user-interface of the remote device;

receiving status information from the remote device, relative to the operational procedures; and

associating a completion status in the database, to each of the operational procedures based on the status information received.

67. The method according to claim 66, wherein the completion status represents a completed task or a non-completed task, the method further comprising:

if one of the procedure is identified as having a status representing a non-completed task, generating an exception report identifying the asset and the procedure.

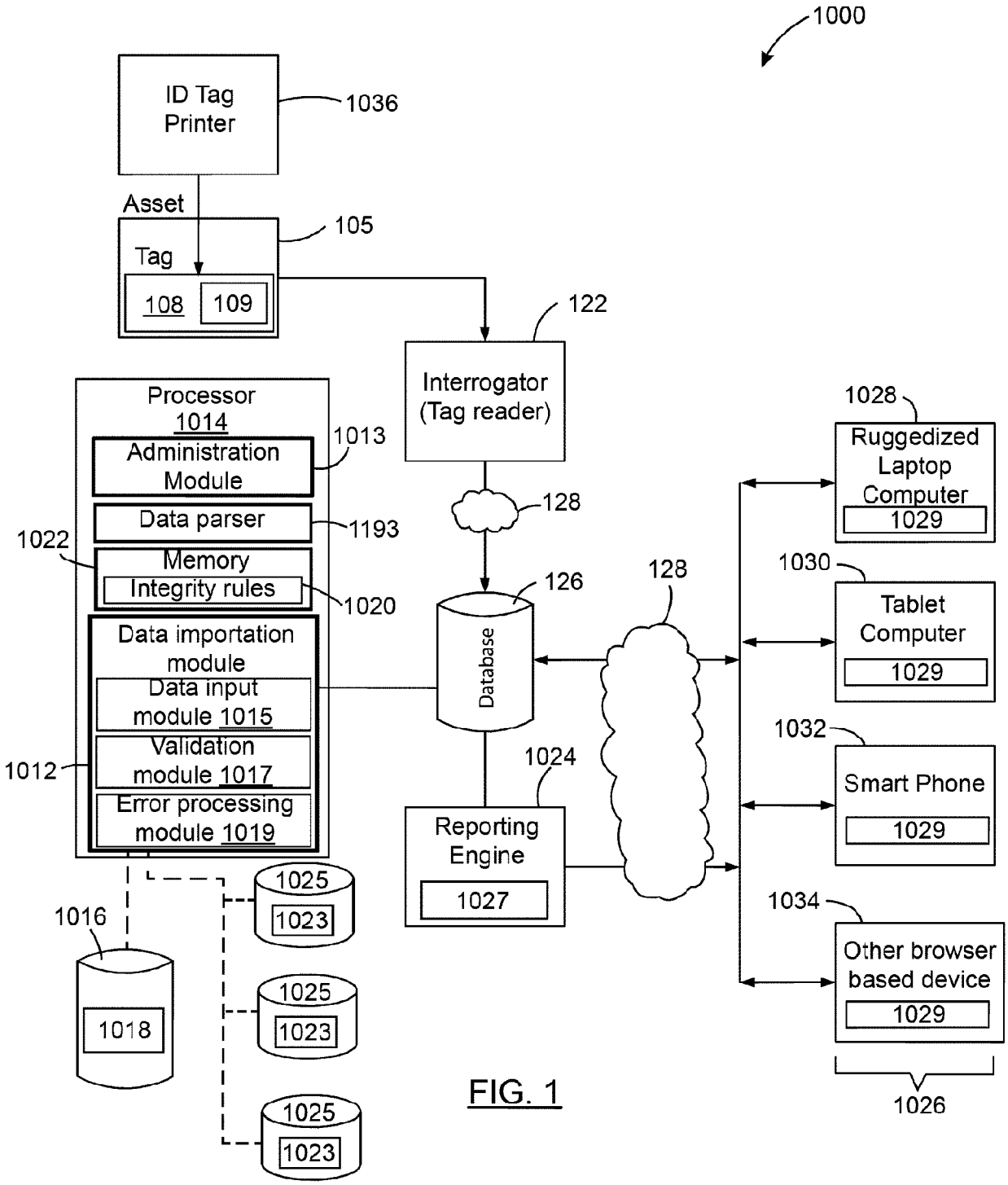

1000
ID Tag Printer
1036
Asset
Tag
105
108
109
122
Interrogator (Tag reader)
Processor 1014
1013
Administration Module
Data parser
1193
1022
Memory
Integrity rules
1020
Data importation module
Data input module 1015
Validation module 1017
1012
Error processing module 1019
128
126
Database
128
1024
Reporting Engine
1027
1028
Ruggedized Laptop Computer
1029
1030
Tablet Computer
1029
1032
Smart Phone
1029
1034
Other browser based device
1029
1026
1016
1018
1025
1023
1025
1023
1025
1023

FIG. 1

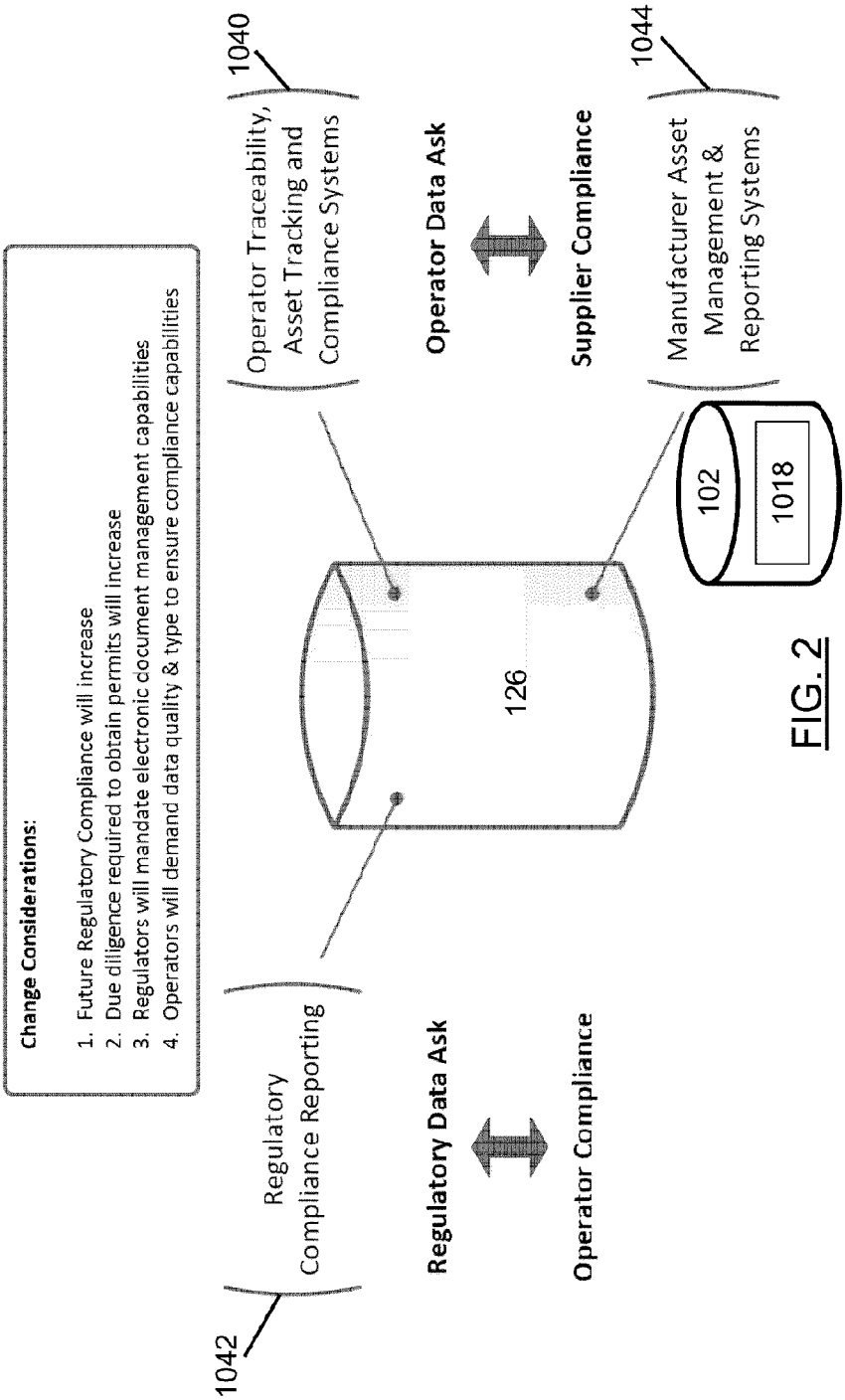

Change Considerations:
1. Future Regulatory Compliance will increase
2. Due diligence required to obtain permits will increase
3. Regulators will mandate electronic document management capabilities
4. Operators will demand data quality & type to ensure compliance capabilities
1042
Regulatory Compliance Reporting
1040
Operator Traceability, Asset Tracking and Compliance Systems
1044
Manufacturer Asset Management & Reporting Systems
Regulatory Data Ask
Operator Compliance
Operator Data Ask
Supplier Compliance
126
102
1018

FIG. 2

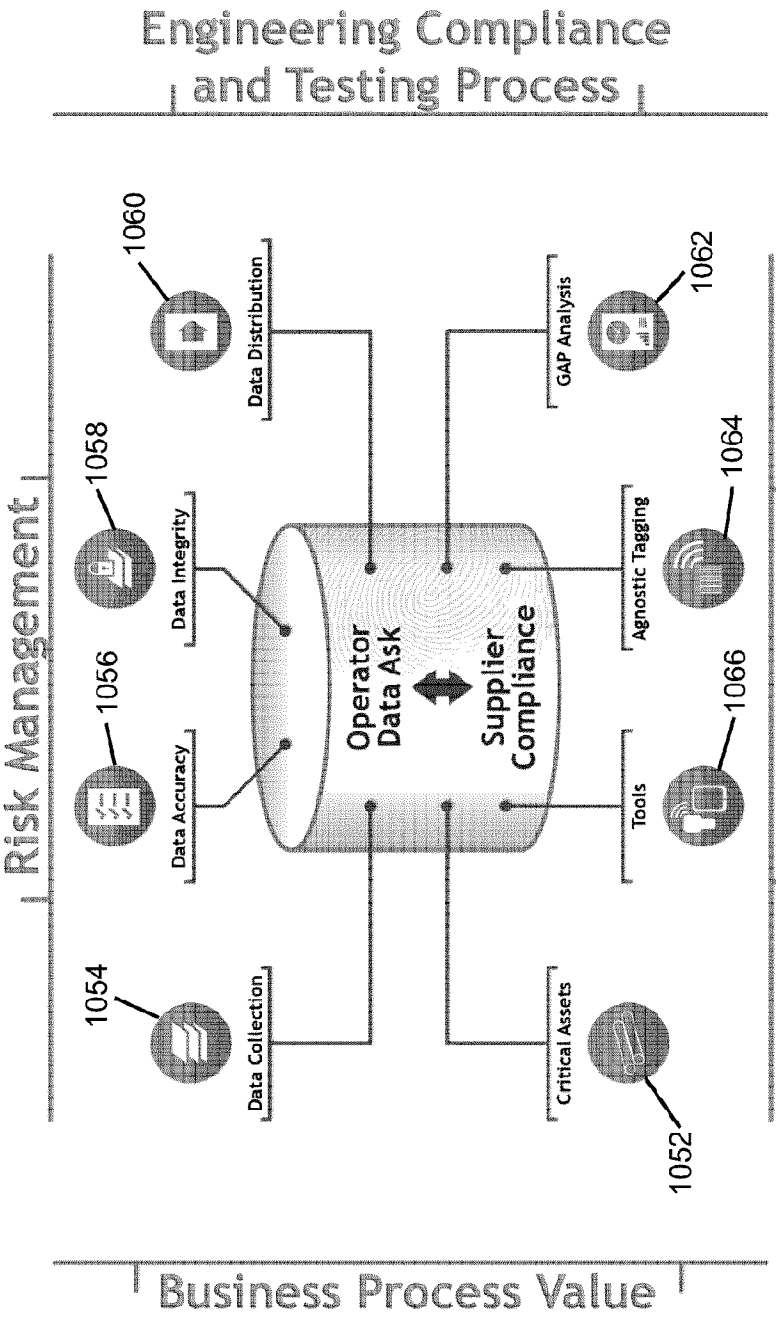

Engineering Compliance
and Testing Process
Risk Management
Lifecycle Model
Business Process Value
Operator
Data Ask
Supplier
Compliance
Data Distribution
Data Integrity
Data Accuracy
Data Collection
GAP Analysis
Agnostic Tagging
Tools
Critical Assets
1060
1058
1056
1054
1062
1064
1066
1052

FIG. 3

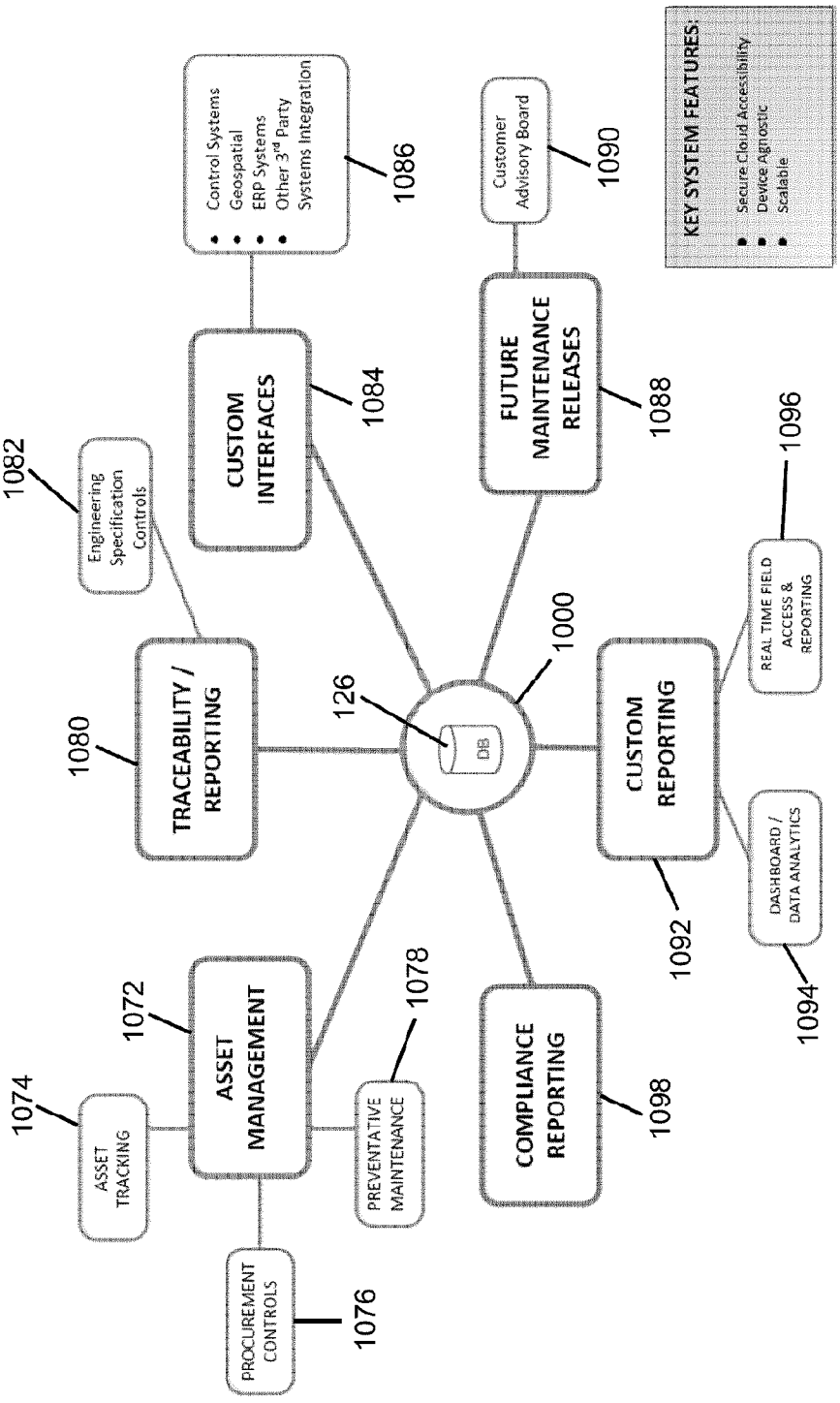

KEY SYSTEM FEATURES:
Secure Cloud Accessibility
Device Agnostic
Scalable
DB
1000
126
TRACEABILITY / REPORTING
1080
Engineering Specification Controls
1082
ASSET MANAGEMENT
1072
ASSET TRACKING
1074
PROCUREMENT CONTROLS
1076
PREVENTATIVE MAINTENANCE
1078
CUSTOM INTERFACES
1084
Control Systems
Geospatial
ERP Systems
Other 3rd Party Systems Integration
1086
FUTURE MAINTENANCE RELEASES
1088
Customer Advisory Board
1090
CUSTOM REPORTING
1092
REAL TIME FIELD ACCESS & REPORTING
1096
DASHBOARD / DATA ANALYTICS
1094
COMPLIANCE REPORTING
1098

FIG. 4

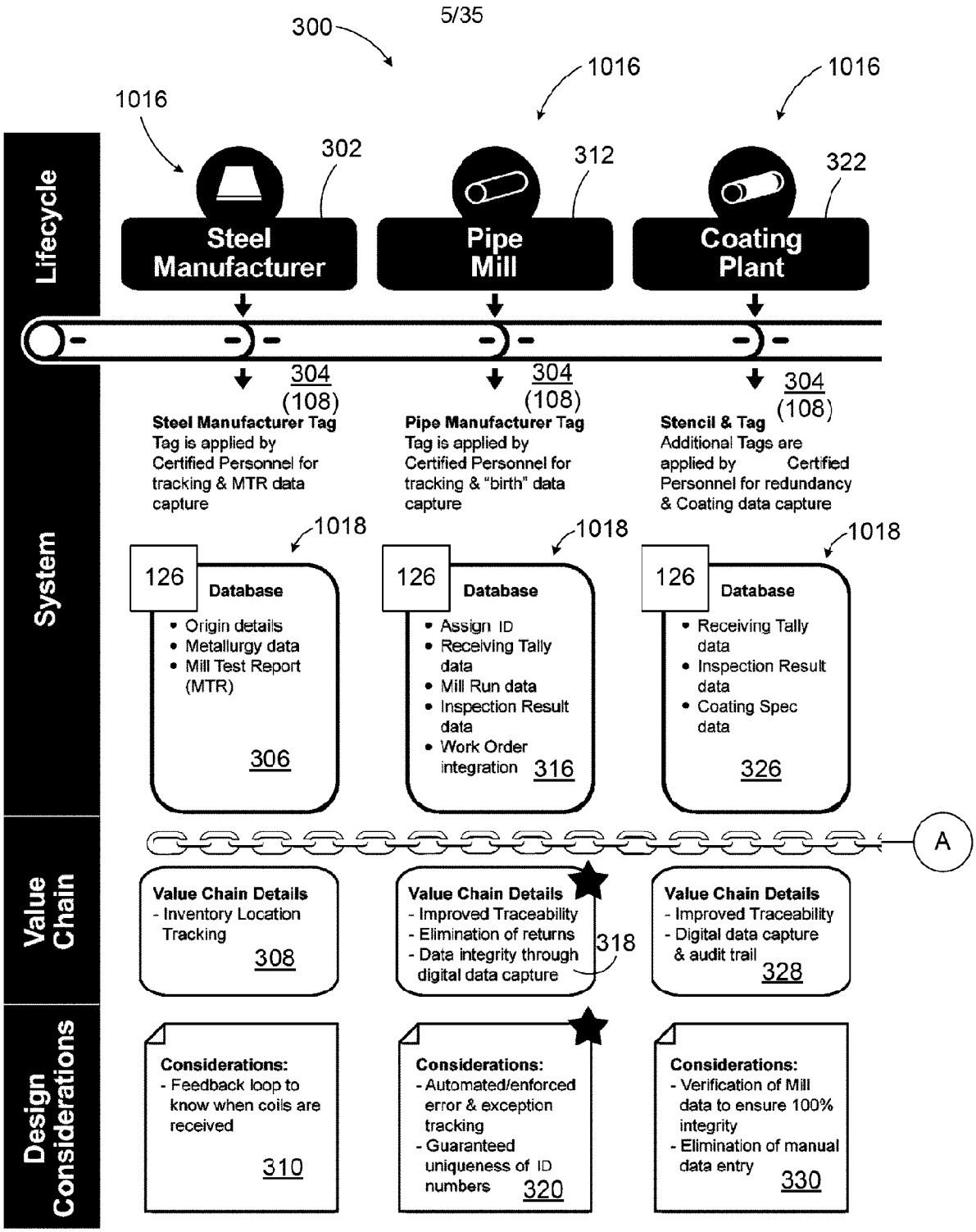

300
1016
1016
1016
Lifecycle
System
Value Chain
Design Considerations
302
312
322
Steel Manufacturer
Pipe Mill
Coating Plant
304 (108)
304 (108)
304 (108)
Steel Manufacturer Tag
Tag is applied by Certified Personnel for tracking & MTR data capture
Pipe Manufacturer Tag
Tag is applied by Certified Personnel for tracking & "birth" data capture
Stencil & Tag
Additional Tags are applied by Certified Personnel for redundancy & Coating data capture
1018
1018
1018
126
Database
• Origin details
• Metallurgy data
• Mill Test Report (MTR)
306
126
Database
• Assign ID
• Receiving Tally data
• Mill Run data
• Inspection Result data
• Work Order integration
316
126
Database
• Receiving Tally data
• Inspection Result data
• Coating Spec data
326
A
Value Chain Details
- Inventory Location Tracking
308
Value Chain Details
- Improved Traceability
- Elimination of returns
- Data integrity through digital data capture
318
Value Chain Details
- Improved Traceability
- Digital data capture & audit trail
328
Considerations:
- Feedback loop to know when coils are received
310
Considerations:
- Automated/enforced error & exception tracking
- Guaranteed uniqueness of ID numbers
320
Considerations:
- Verification of Mill data to ensure 100% integrity
- Elimination of manual data entry
330

FIG. 5A

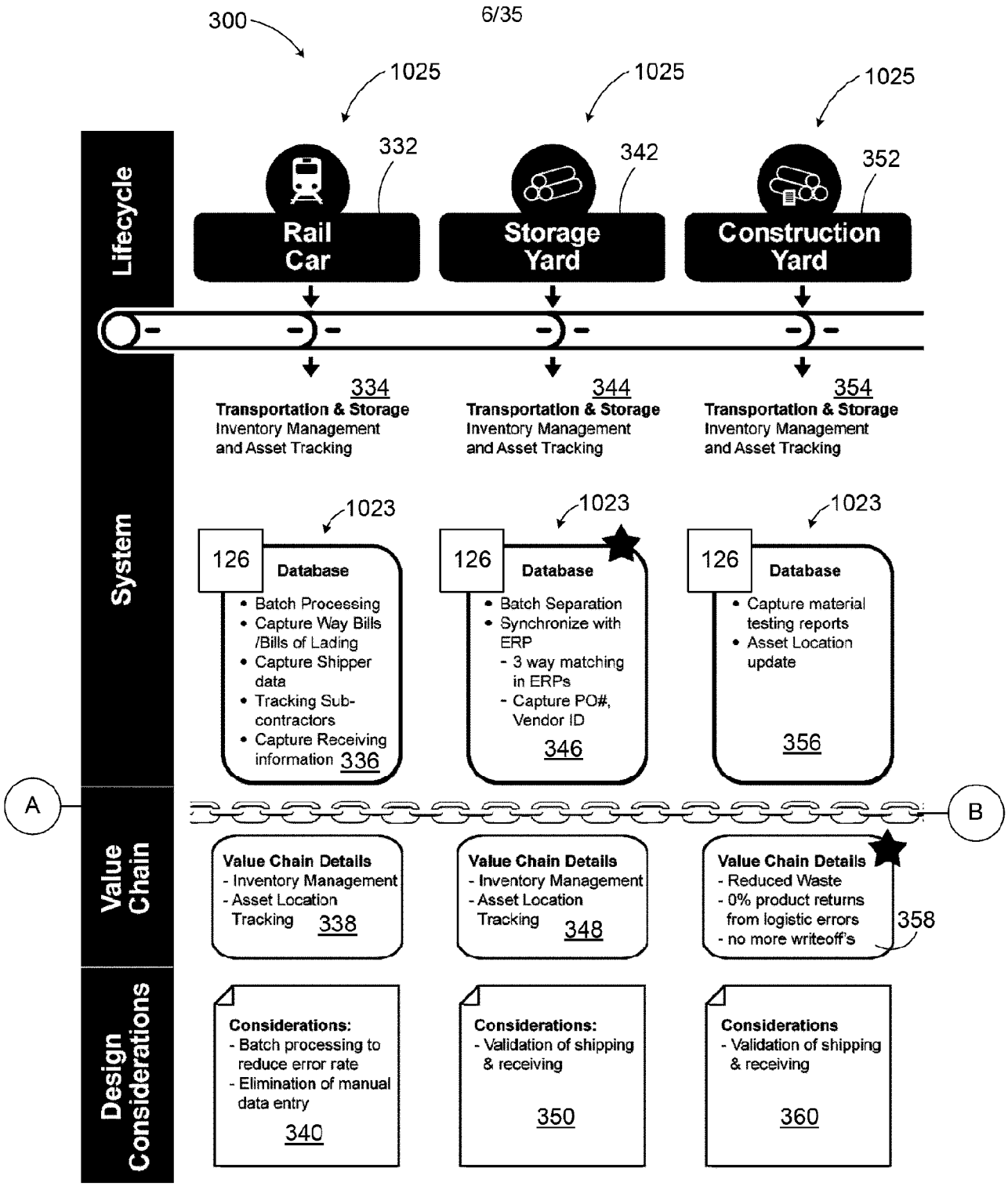

300
1025
1025
1025
Lifecycle
332
342
352
Rail Car
Storage Yard
Construction Yard
334
344
354
Transportation & Storage
Inventory Management
and Asset Tracking
Transportation & Storage
Inventory Management
and Asset Tracking
Transportation & Storage
Inventory Management
and Asset Tracking
System
1023
1023
1023
126
Database
• Batch Processing
• Capture Way Bills /Bills of Lading
• Capture Shipper data
• Tracking Sub-contractors
• Capture Receiving information 336
126
Database
• Batch Separation
• Synchronize with ERP
- 3 way matching in ERPs
- Capture PO#, Vendor ID
346
126
Database
• Capture material testing reports
• Asset Location update
356
A
B
Value Chain
Value Chain Details
- Inventory Management
- Asset Location Tracking 338
Value Chain Details
- Inventory Management
- Asset Location Tracking 348
Value Chain Details
- Reduced Waste
- 0% product returns from logistic errors
- no more writeoff's
358
Design Considerations
Considerations:
- Batch processing to reduce error rate
- Elimination of manual data entry
340
Considerations:
- Validation of shipping & receiving
350
Considerations
- Validation of shipping & receiving
360

FIG. 5B

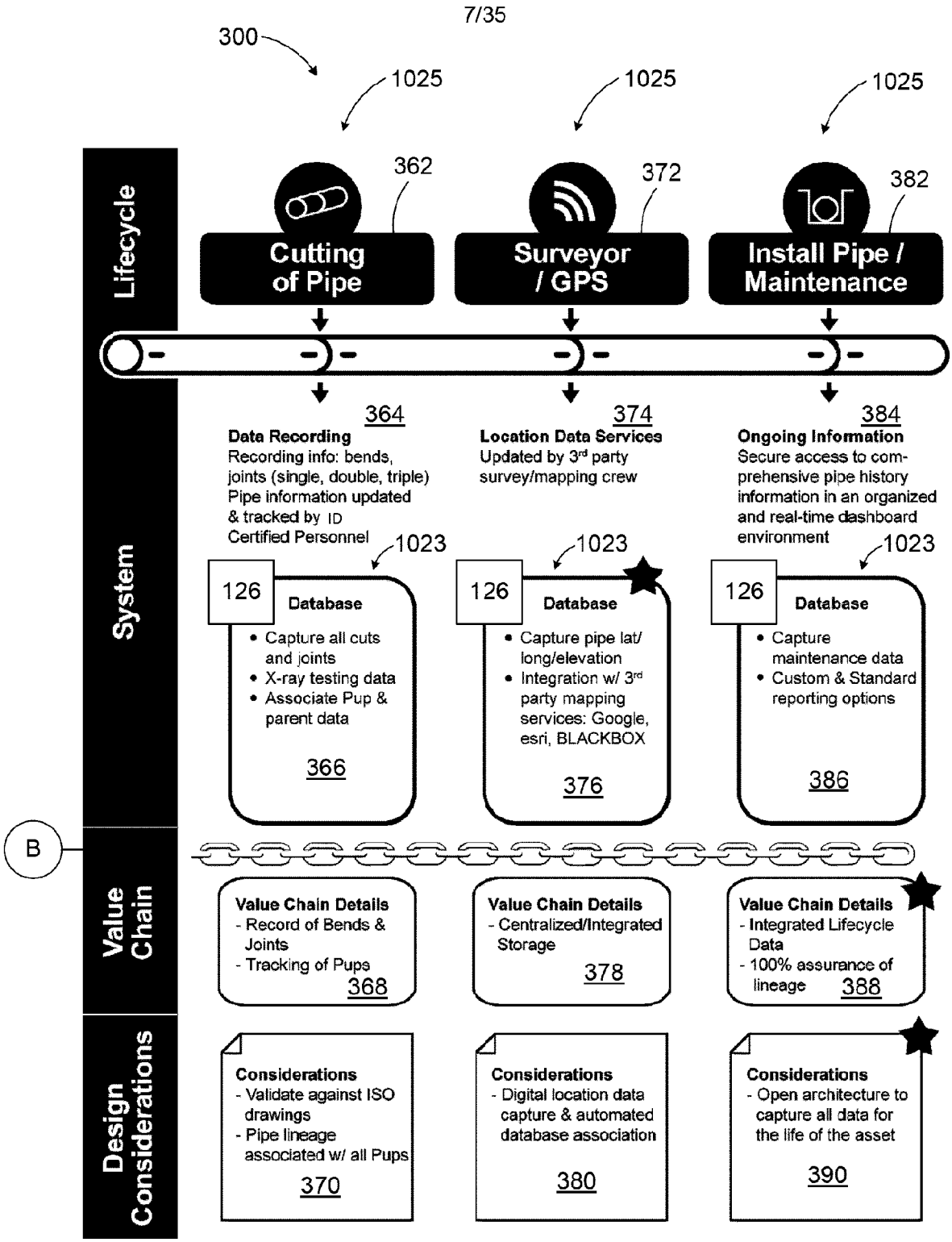

300
1025
1025
1025
Lifecycle
362
372
382
Cutting of Pipe
Surveyor / GPS
Install Pipe / Maintenance
364
374
384
Data Recording
Recording info: bends, joints (single, double, triple)
Pipe information updated & tracked by ID
Certified Personnel
Location Data Services
Updated by 3rd party survey/mapping crew
Ongoing Information
Secure access to comprehensive pipe history information in an organized and real-time dashboard environment
System
1023
1023
1023
126
Database
• Capture all cuts and joints
• X-ray testing data
• Associate Pup & parent data
366
126
Database
• Capture pipe lat/long/elevation
• Integration w/ 3rd party mapping services: Google, esri, BLACKBOX
376
126
Database
• Capture maintenance data
• Custom & Standard reporting options
386
B
Value Chain
Value Chain Details
- Record of Bends & Joints
- Tracking of Pups
368
Value Chain Details
- Centralized/Integrated Storage
378
Value Chain Details
- Integrated Lifecycle Data
- 100% assurance of lineage
388
Design Considerations
Considerations
- Validate against ISO drawings
- Pipe lineage associated w/ all Pups
370
Considerations
- Digital location data capture & automated database association
380
Considerations
- Open architecture to capture all data for the life of the asset
390

FIG. 5C

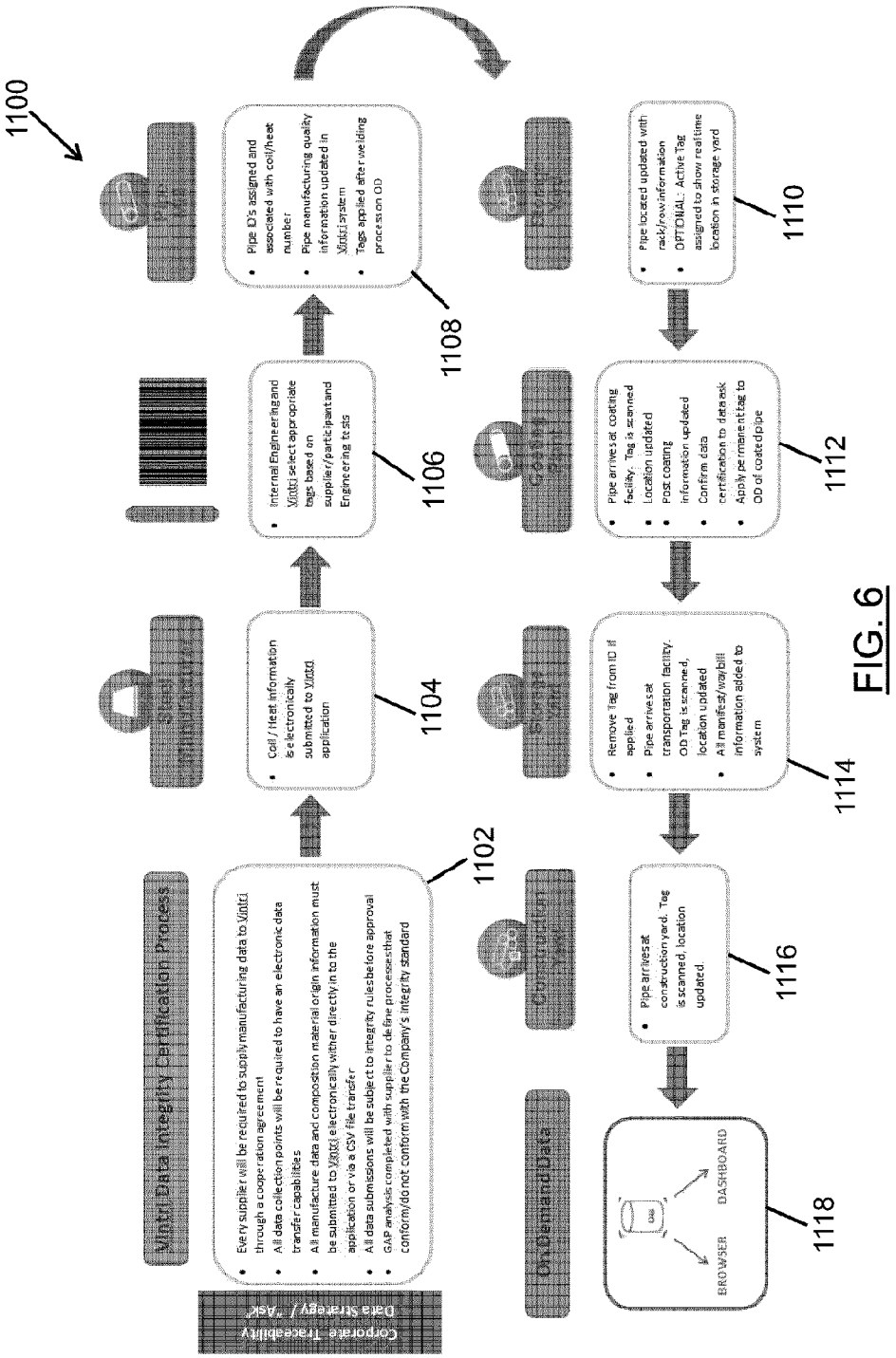

1100
Vintri Data Integrity Certification Process
Every supplier will be required to supply manufacturing data to Vintri through a cooperation agreement
All data collection points will be required to have an electronic data transfer capabilities
All manufacture data and composition material origin information must be submitted to Vintri electronically wither directly in to the application or via a CSV file transfer
All data submissions will be subject to integrity rules before approval
GAP analysis completed with supplier to define processes that conform/do not conform with the Company's integrity standard
1102
Coil / Heat information is electronically submitted to Vintri application
1104
Internal Engineering and Vintri select appropriate tags based on supplier/participant and Engineering tasks
1106
Pipe ID's assigned and associated with coil/heat number
Pipe manufacturing quality information updated in Vintri system
Tags applied after welding procession OD
1108
Pipe located updated with rack/row information
OPTIONAL: Active Tag assigned to show realtime location in storage yard
1110
Pipe arrives at coating facility. Tag is scanned
Location updated
Post coating information updated
Confirm data certification to data ask
Apply permanent tag to OD of coated pipe
1112
Remove Tag from ID if applied
Pipe arrives at transportation facility. OD Tag is scanned, location updated
All manifest/waybill information added to system
1114
Pipe arrives at construction yard. Tag is scanned, location updated
1116
On Demand Data
BROWSER
DASHBOARD
1118
Corporate Traceability Data Strategy / "Ask"

FIG. 6

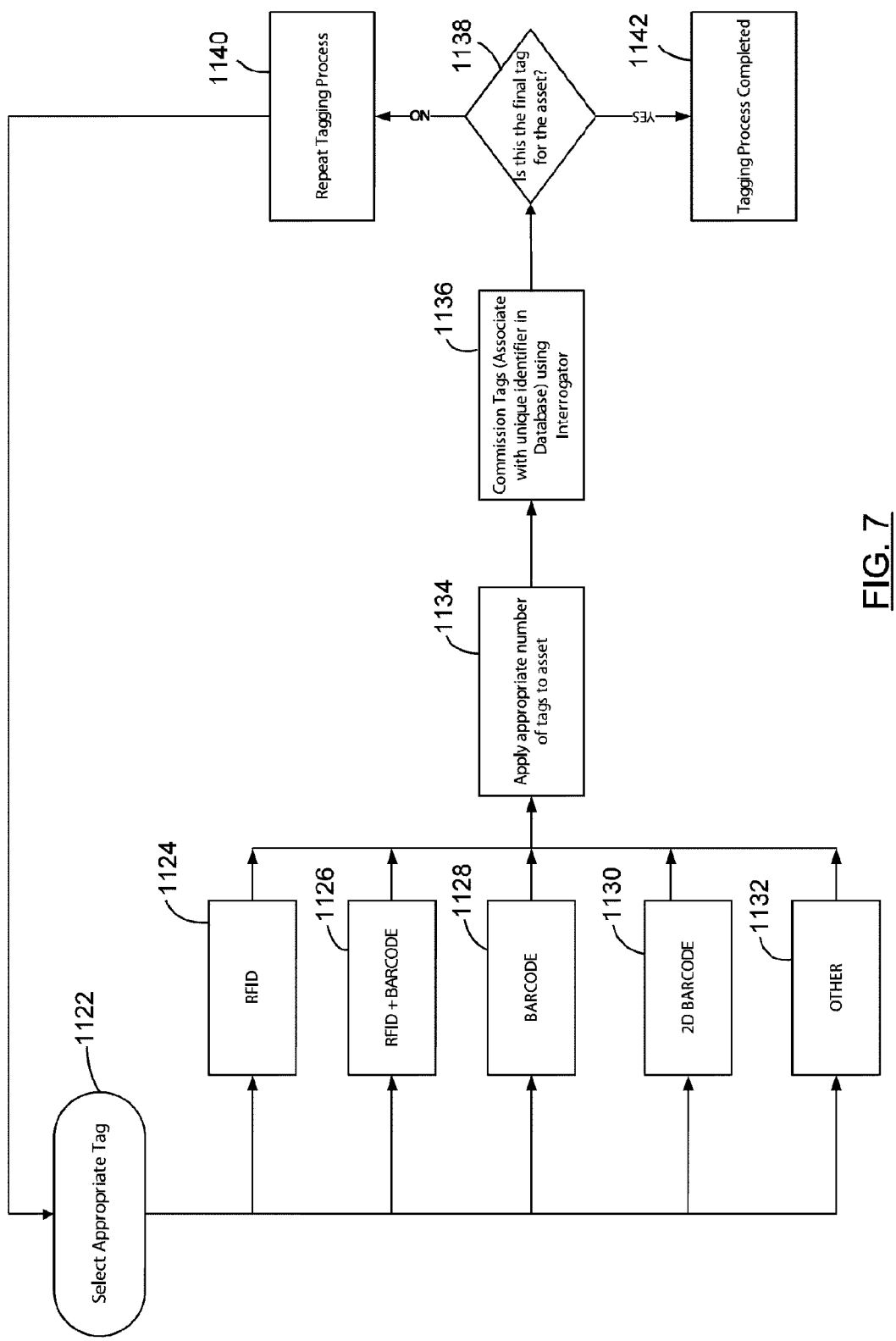

1120
1140
Repeat Tagging Process
1138
Is this the final tag for the asset?
NO
1142
YES
Tagging Process Completed
1136
Commission Tags (Associate with unique identifier in Database) using Interrogator
1134
Apply appropriate number of tags to asset
1124
RFID
1126
RFID + BARCODE
1128
BARCODE
1130
2D BARCODE
1132
OTHER
1122
Select Appropriate Tag

FIG. 7

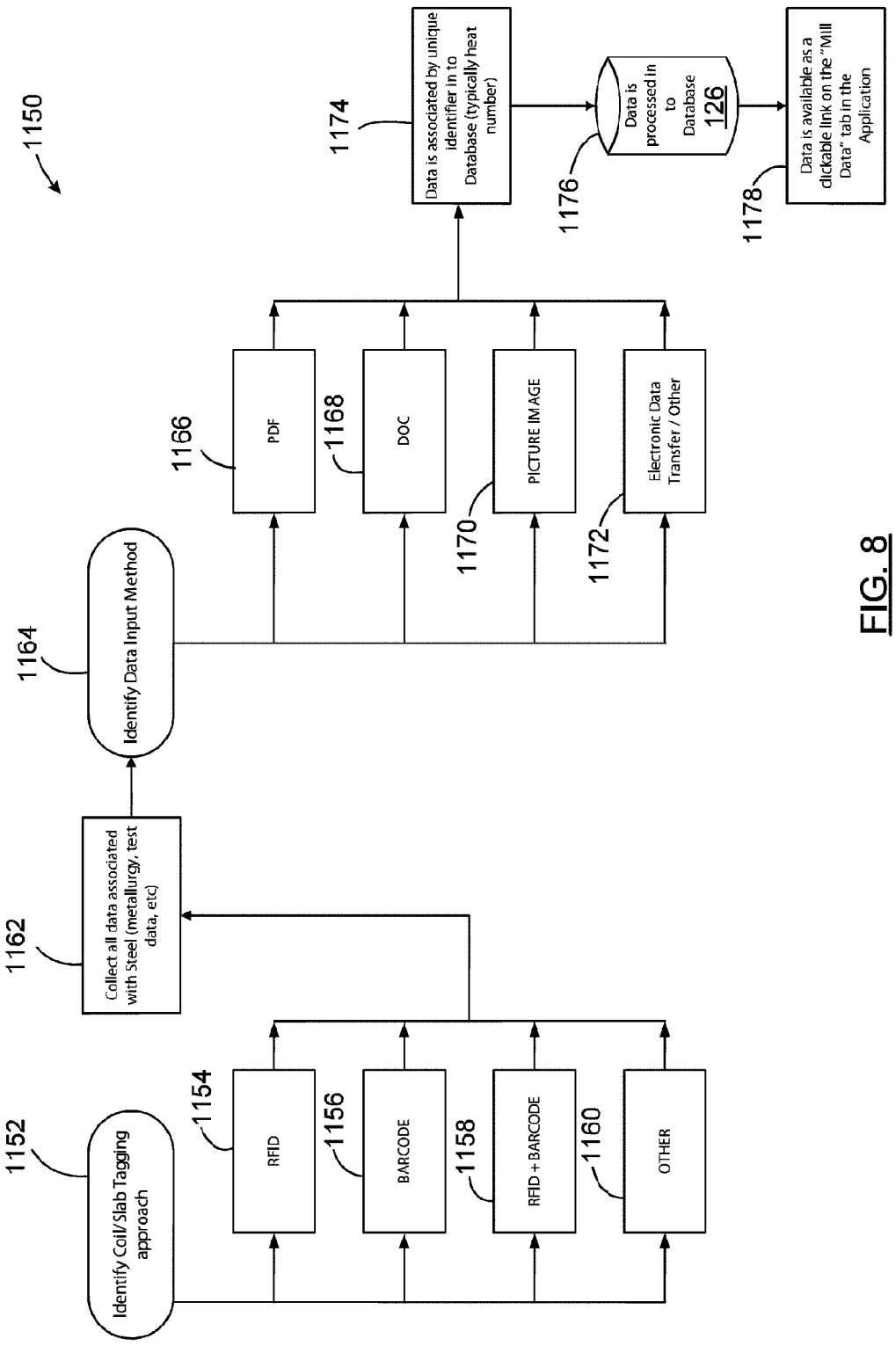

1150
1152
Identify Coil/Slab Tagging approach
1154
RFID
1156
BARCODE
1158
RFID + BARCODE
1160
OTHER
1162
Collect all data associated with Steel (metallurgy, test data, etc)
1164
Identify Data Input Method
1166
PDF
1168
DOC
1170
PICTURE IMAGE
1172
Electronic Data Transfer / Other
1174
Data is associated by unique identifier in to Database (typically heat number)
1176
Data is processed in to Database 126
1178
Data is available as a clickable link on the "Mill Data" tab in the Application

FIG. 8

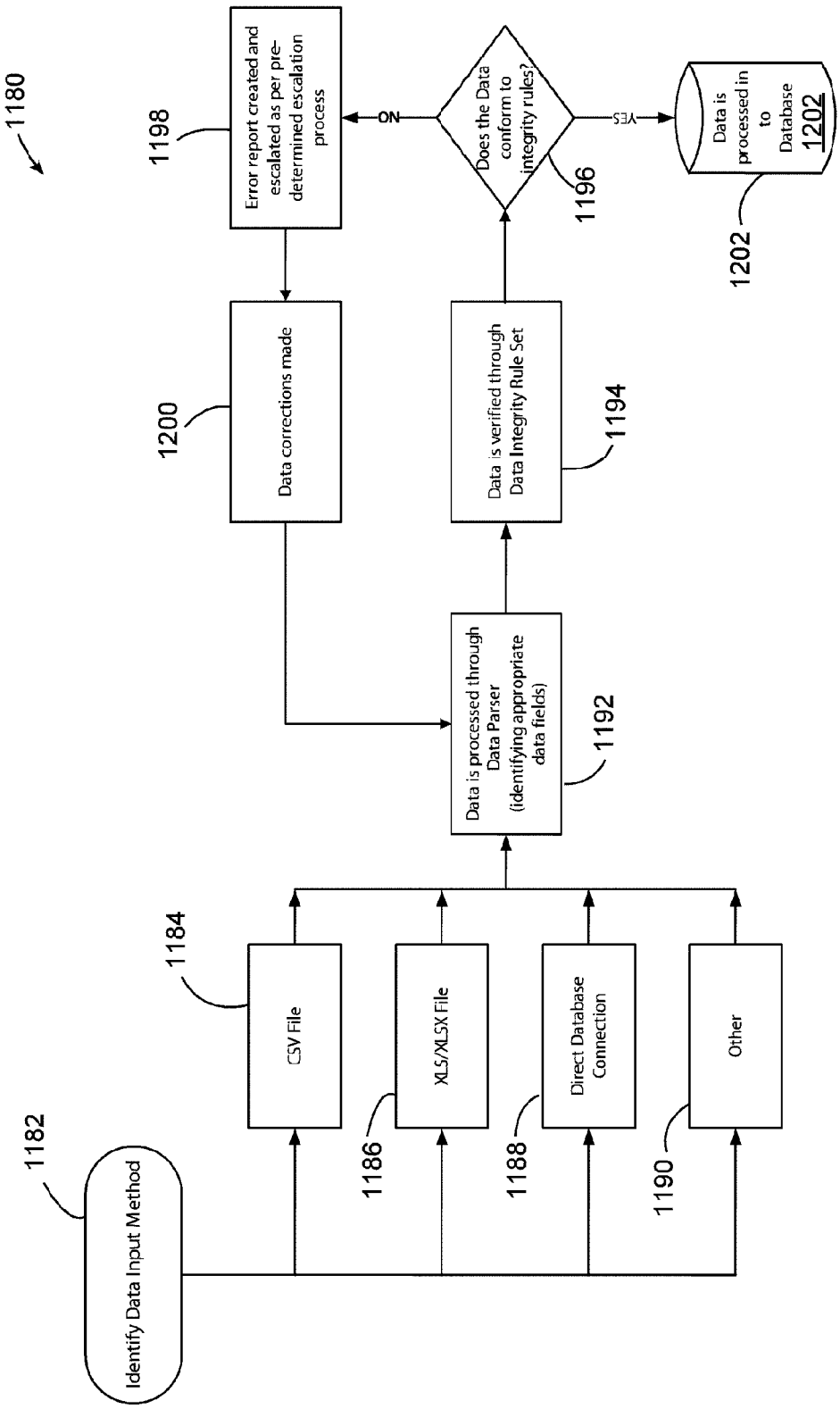

1180
1182
Identify Data Input Method
1184
CSV File
1186
XLS/XLSX File
1188
Direct Database Connection
1190
Other
1192
Data is processed through Data Parser (identifying appropriate data fields)
1194
Data is verified through Data Integrity Rule Set
1196
Does the Data conform to integrity rules?
NO
YES
1198
Error report created and escalated as per pre-determined escalation process
1200
Data corrections made
1202
Data is processed in to Database 1202

FIG. 9

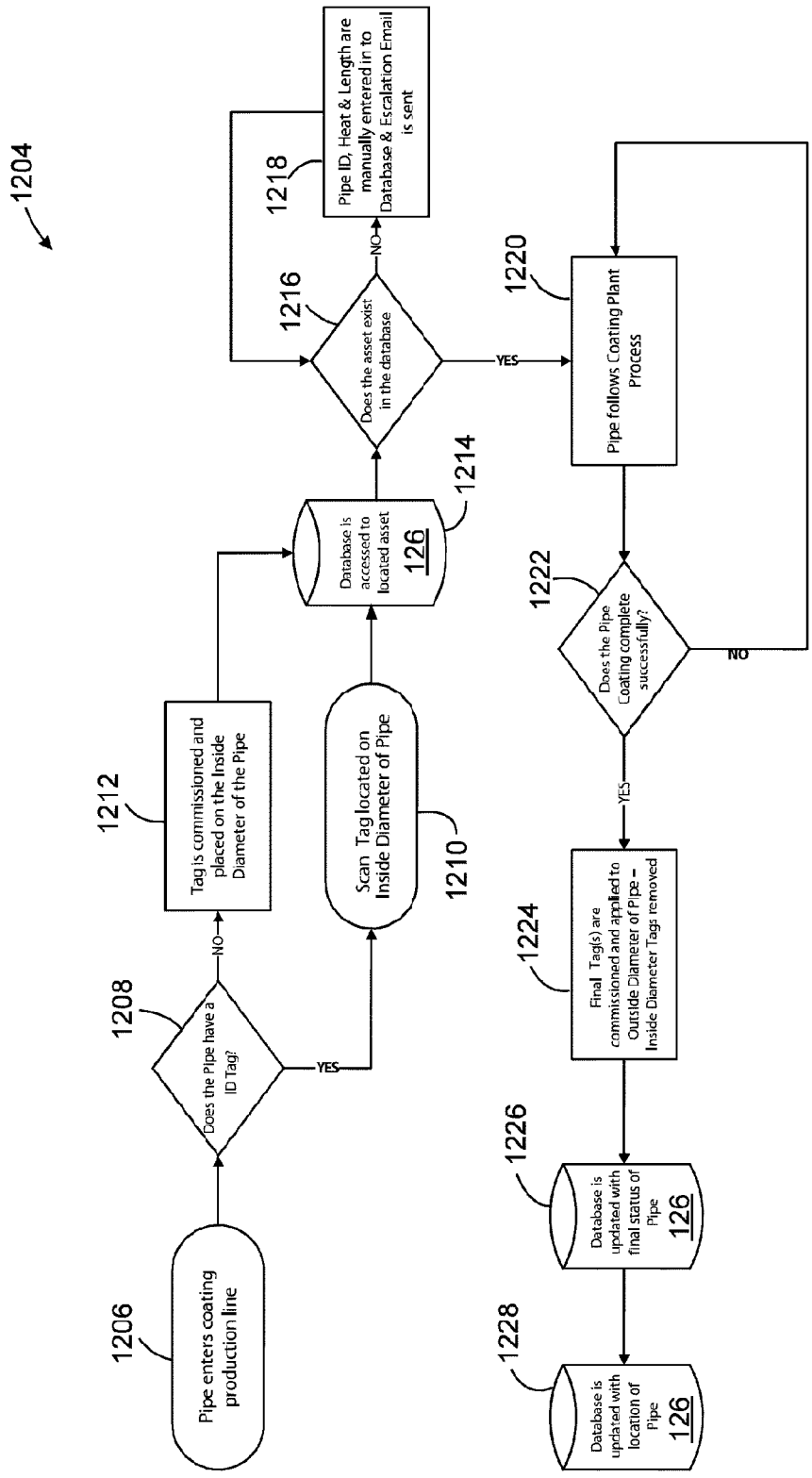

1204
1206
Pipe enters coating production line
1208
Does the Pipe have a ID Tag?
NO
YES
1210
Scan Tag located on Inside Diameter of Pipe
1212
Tag is commissioned and placed on the Inside Diameter of the Pipe
1214
Database is accessed to located asset 126
1216
Does the asset exist in the database
NO
YES
1218
Pipe ID, Heat & Length are manually entered in to Database & Escalation Email is sent
1220
Pipe follows Coating Plant Process
1222
Does the Pipe Coating complete successfully?
NO
YES
1224
Final Tag(s) are commissioned and applied to Outside Diameter of Pipe – Inside Diameter Tags removed
1226
Database is updated with final status of Pipe 126
1228
Database is updated with location of Pipe 126

FIG. 10

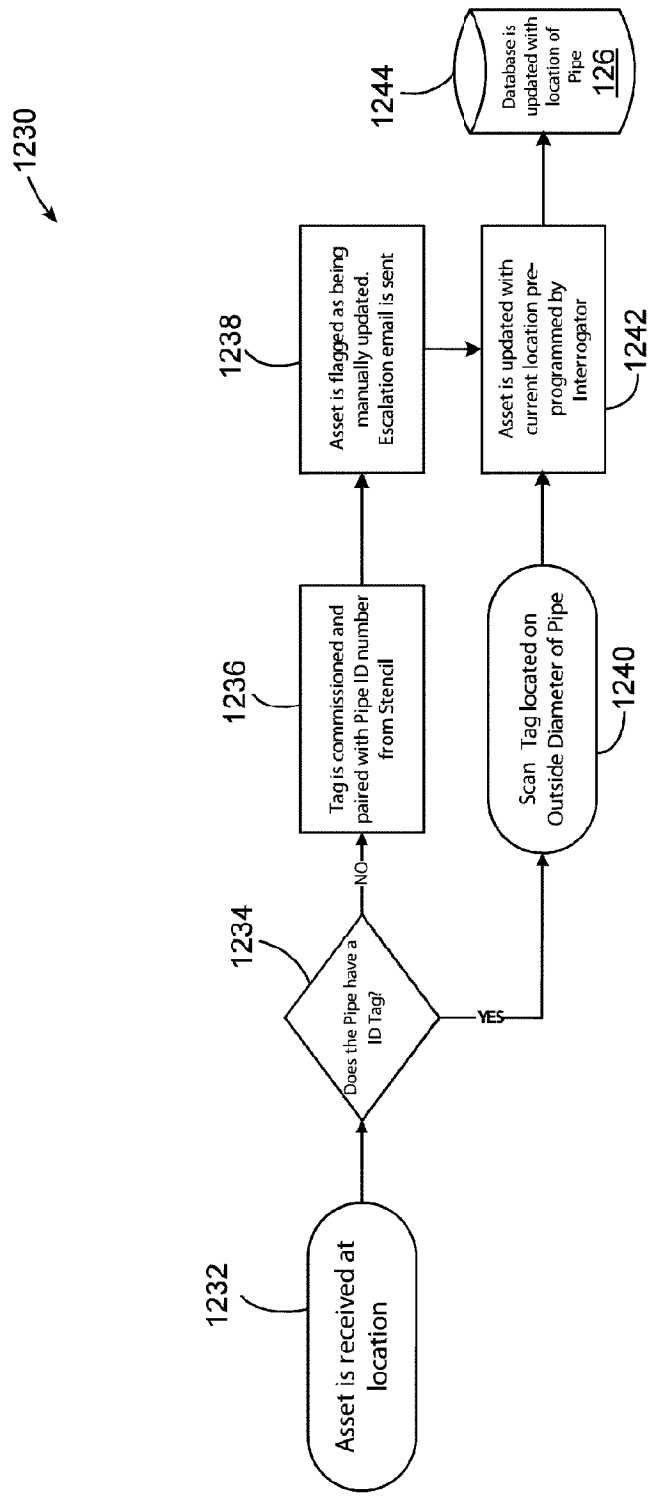

1230
1232
Asset is received at location
1234
Does the Pipe have a ID Tag?
NO
YES
1236
Tag is commissioned and paired with Pipe ID number from Stencil
1238
Asset is flagged as being manually updated. Escalation email is sent
1240
Scan Tag located on Outside Diameter of Pipe
1242
Asset is updated with current location pre-programmed by Interrogator
1244
Database is updated with location of Pipe 126

FIG. 11

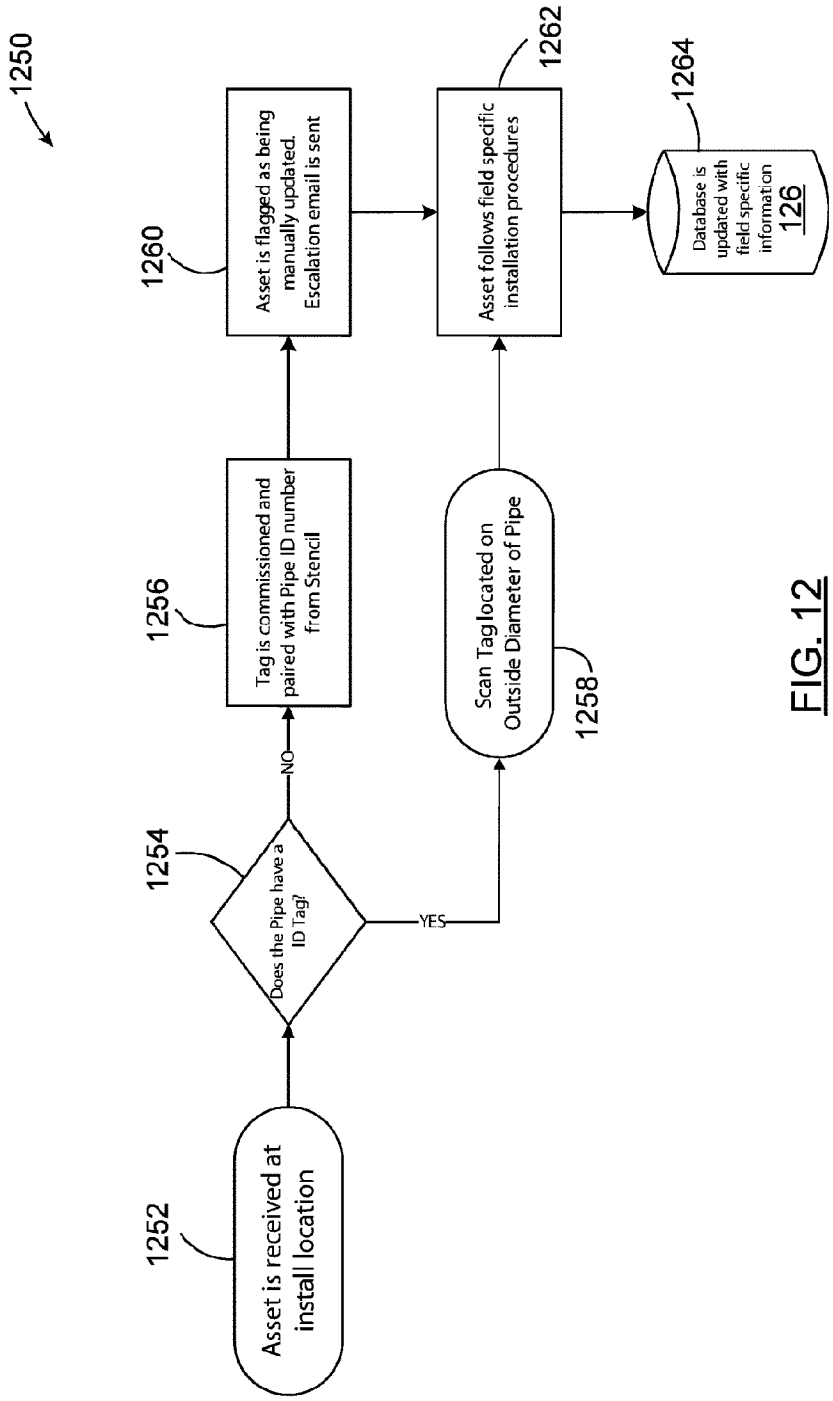

1250
1252
Asset is received at install location
1254
Does the Pipe have a ID Tag?
NO
YES
1256
Tag is commissioned and paired with Pipe ID number from Stencil
1258
Scan Tag located on Outside Diameter of Pipe
1260
Asset is flagged as being manually updated. Escalation email is sent
1262
Asset follows field specific installation procedures
1264
Database is updated with field specific information 126

FIG. 12

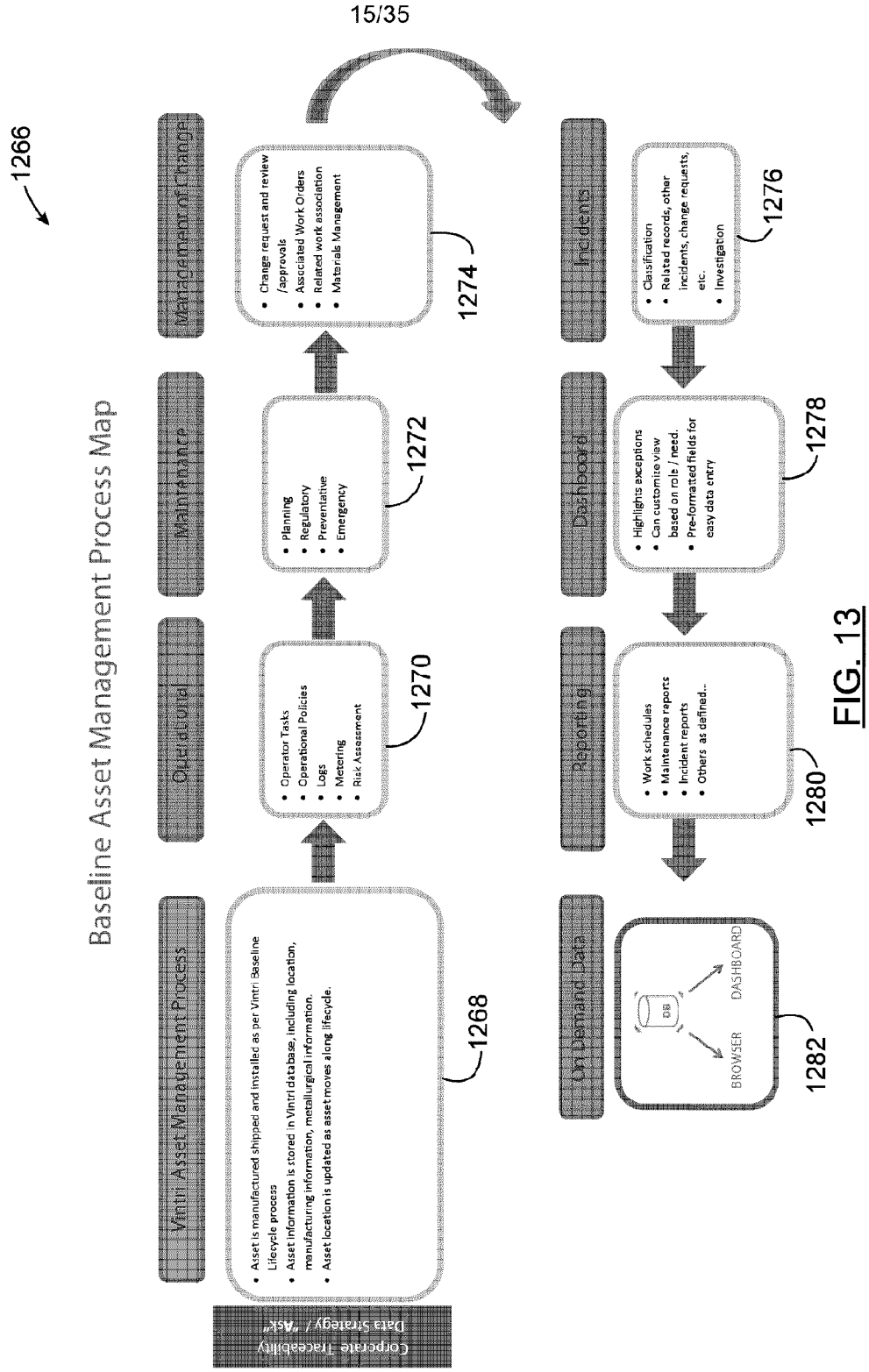

1266
Baseline Asset Management Process Map
Vintri Asset Management Process
Operational
Maintenance
Management of Change
Incidents
Dashboard
Reporting
On Demand Data
Corporate Traceability
Data Strategy / "Ask"
• Asset is manufactured shipped and installed as per Vintri Baseline Lifecycle process
• Asset information is stored in Vintri database, including location, manufacturing information, metallurgical information.
• Asset location is updated as asset moves along lifecycle.
1268
• Operator Tasks
• Operational Policies
• Logs
• Metering
• Risk Assessment
1270
• Planning
• Regulatory
• Preventative
• Emergency
1272
• Change request and review /approvals
• Associated Work Orders
• Related work association
• Materials Management
1274
• Classification
• Related records, other incidents, change requests, etc.
• Investigation
1276
• Highlights exceptions
• Can customize view based on role / need.
• Pre-formatted fields for easy data entry
1278
• Work schedules
• Maintenance reports
• Incident reports
• Others as defined...
1280
DB
BROWSER
DASHBOARD
1282

FIG. 13

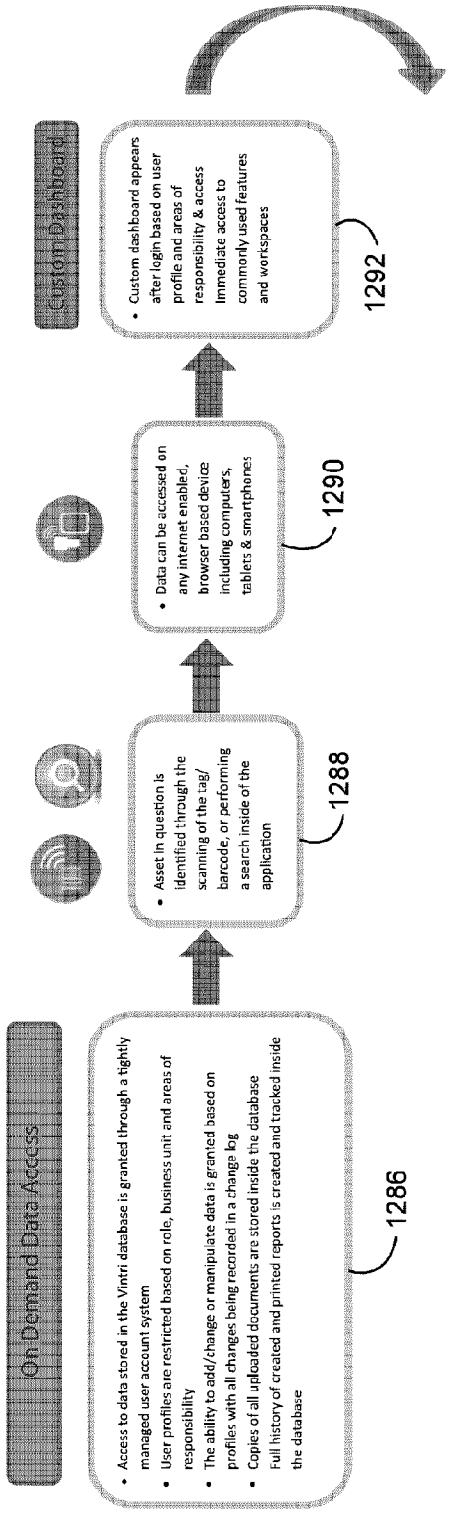

1284
Enterprise Reporting Process Map
On Demand Data Access
• Access to data stored in the Vintri database is granted through a tightly managed user account system
• User profiles are restricted based on role, business unit and areas of responsibility
• The ability to add/change or manipulate data is granted based on profiles with all changes being recorded in a change log
• Copies of all uploaded documents are stored inside the database Full history of created and printed reports is created and tracked inside the database
1286
• Asset in question is identified through the scanning of the tag/ barcode, or performing a search inside of the application
1288
• Data can be accessed on any internet enabled, browser based device including computers, tablets & smartphones
1290
Custom Dashboard
• Custom dashboard appears after login based on user profile and areas of responsibility & access Immediate access to commonly used features and workspaces
1292
Custom Reporting & Interfaces
• Custom interface in to client management systems including SAP, JD Edwards, Etc.
1299
Field Data Reporting
• On Demand reporting directly from the field using a tablet, smartphone or laptop
1298
Regulatory Reporting
• Specific regulatory reporting through customized regulator dashboard
1296
Traceability Reporting
• Access to asset specific information including metallurgy, manufacturing and coating information
1294

FIG. 14

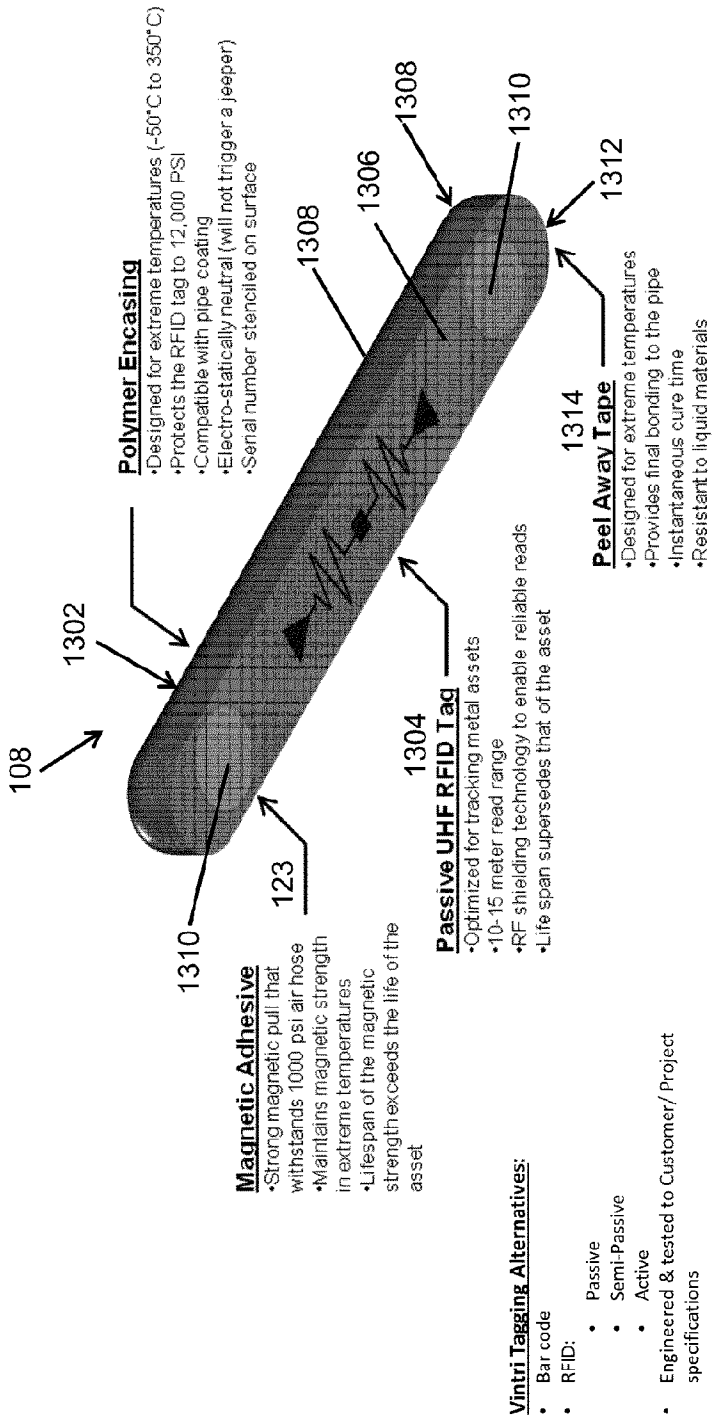

108
1302
Polymer Encasing
•Designed for extreme temperatures (-50°C to 350°C)
•Protects the RFID tag to 12,000 PSI
•Compatible with pipe coating
•Electro-statically neutral (will not trigger a jeeper)
•Serial number stenciled on surface
1308
1306
1308
1310
1310
123
Magnetic Adhesive
•Strong magnetic pull that withstands 1000 psi air hose
•Maintains magnetic strength in extreme temperatures
•Lifespan of the magnetic strength exceeds the life of the asset
1304
Passive UHF RFID Tag
•Optimized for tracking metal assets
•10-15 meter read range
•RF shielding technology to enable reliable reads
•Life span supersedes that of the asset
1314
1312
Peel Away Tape
•Designed for extreme temperatures
•Provides final bonding to the pipe
•Instantaneous cure time
•Resistant to liquid materials
Vintri Tagging Alternatives:
• Bar code
• RFID:
• Passive
• Semi-Passive
• Active
• Engineered & tested to Customer/ Project specifications

FIG. 15

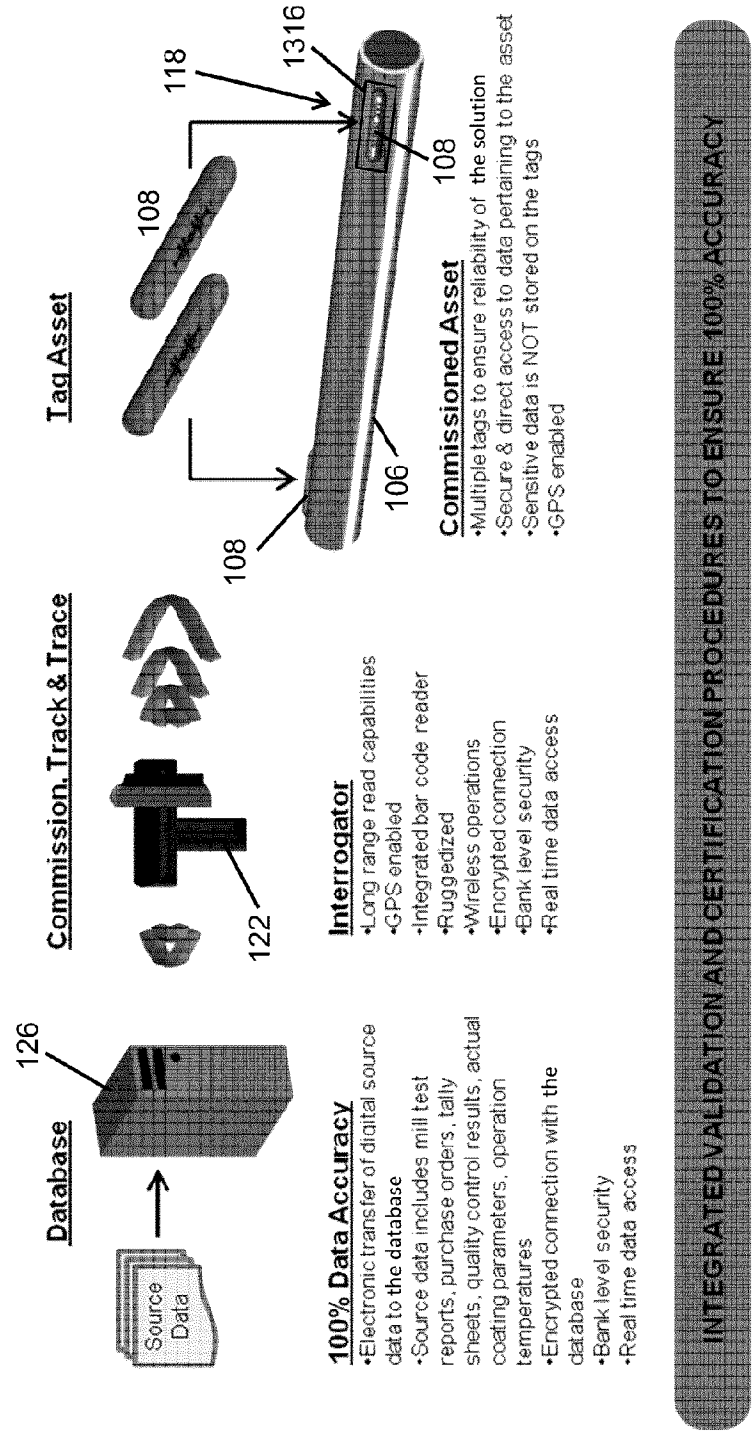

Database
126
Source Data
100% Data Accuracy
•Electronic transfer of digital source data to the database
•Source data includes mill test reports, purchase orders, tally sheets, quality control results, actual coating parameters, operation temperatures
•Encrypted connection with the database
•Bank level security
•Real time data access
Commission, Track & Trace
122
Interrogator
•Long range read capabilities
•GPS enabled
•Integrated bar code reader
•Ruggedized
•Wireless operations
•Encrypted connection
•Bank level security
•Real time data access
Tag Asset
108
118
1316
108
106
108
Commissioned Asset
•Multiple tags to ensure reliability of the solution
•Secure & direct access to data pertaining to the asset
•Sensitive data is NOT stored on the tags
•GPS enabled
INTEGRATED VALIDATION AND CERTIFICATION PROCEDURES TO ENSURE 100% ACCURACY

FIG. 16

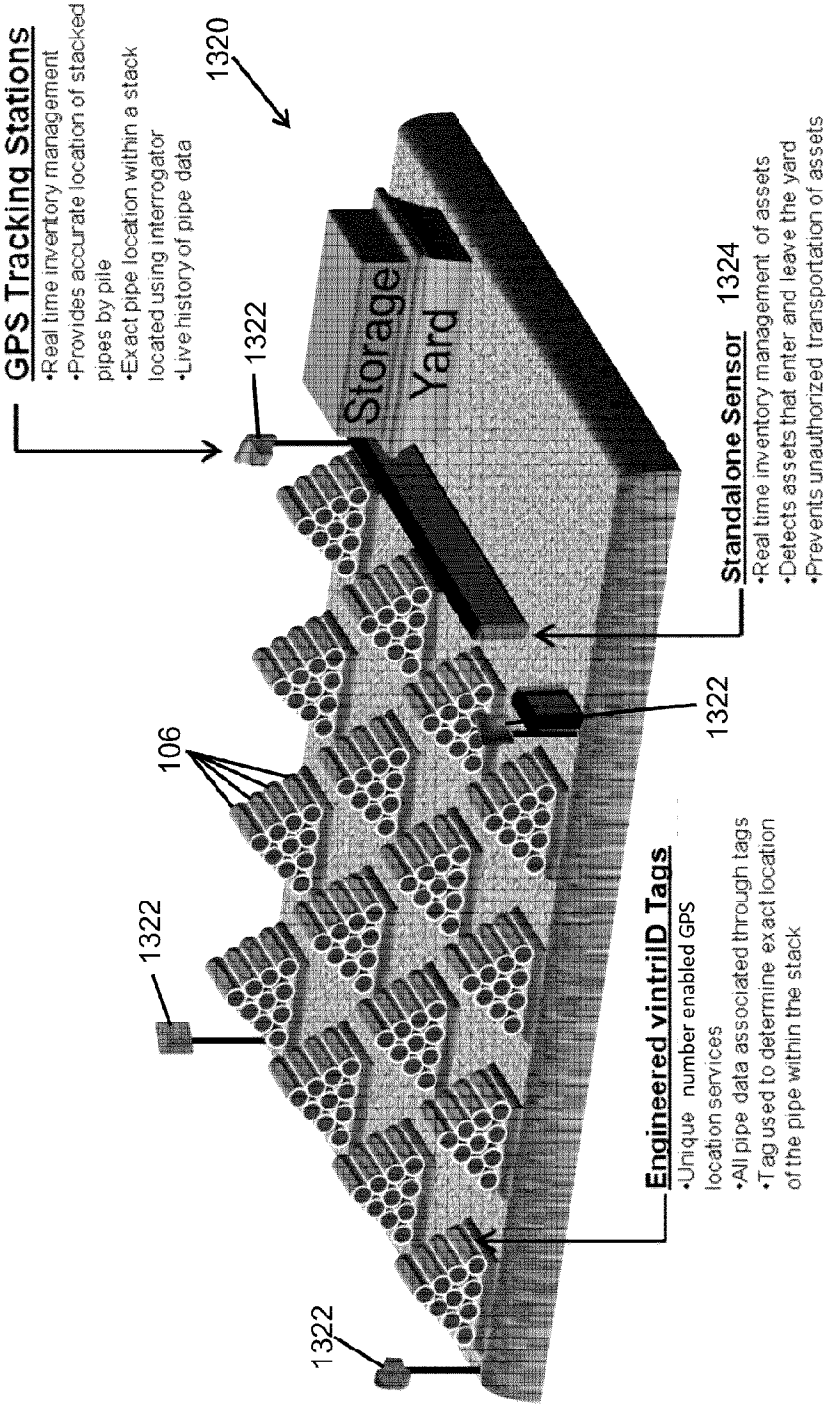

GPS Tracking Stations
•Real time inventory management
•Provides accurate location of stacked pipes by pile
•Exact pipe location within a stack located using interrogator
•Live history of pipe data
1320
1322
Storage Yard
Standalone Sensor 1324
•Real time inventory management of assets
•Detects assets that enter and leave the yard
•Prevents unauthorized transportation of assets
106
1322
1322
1322
Engineered vintriID Tags
•Unique number enabled GPS location services
•All pipe data associated through tags
•Tag used to determine exact location of the pipe within the stack

FIG. 17

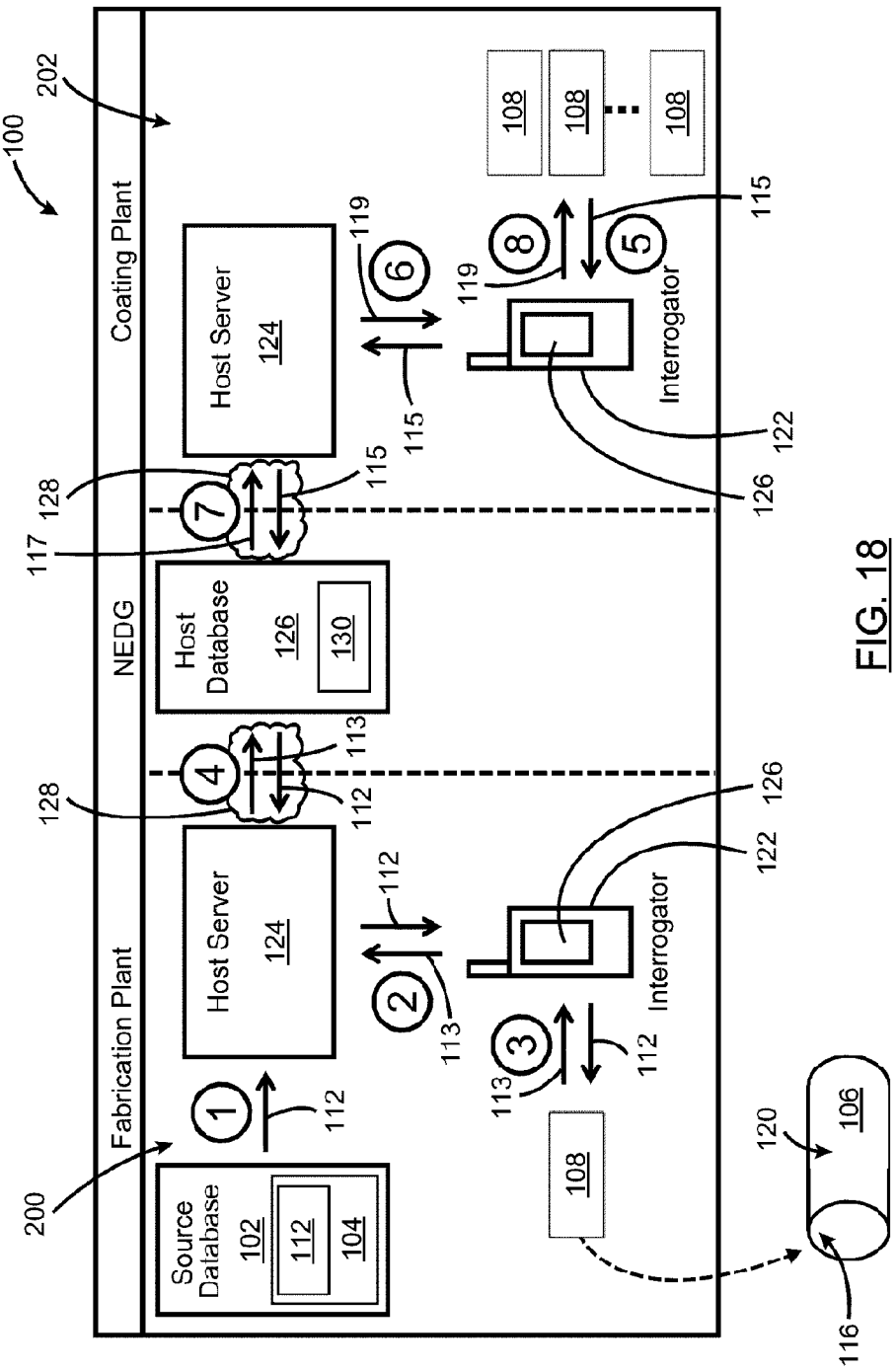

100
202
Fabrication Plant
NEDG
Coating Plant
200
Source Database
102
112
104
Host Server
124
Host Database
126
130
Host Server
124
Interrogator
Interrogator
108
108
108
108
106
116
120
1
2
3
4
5
6
7
8
112
113
115
117
119
122
126
128

FIG. 18

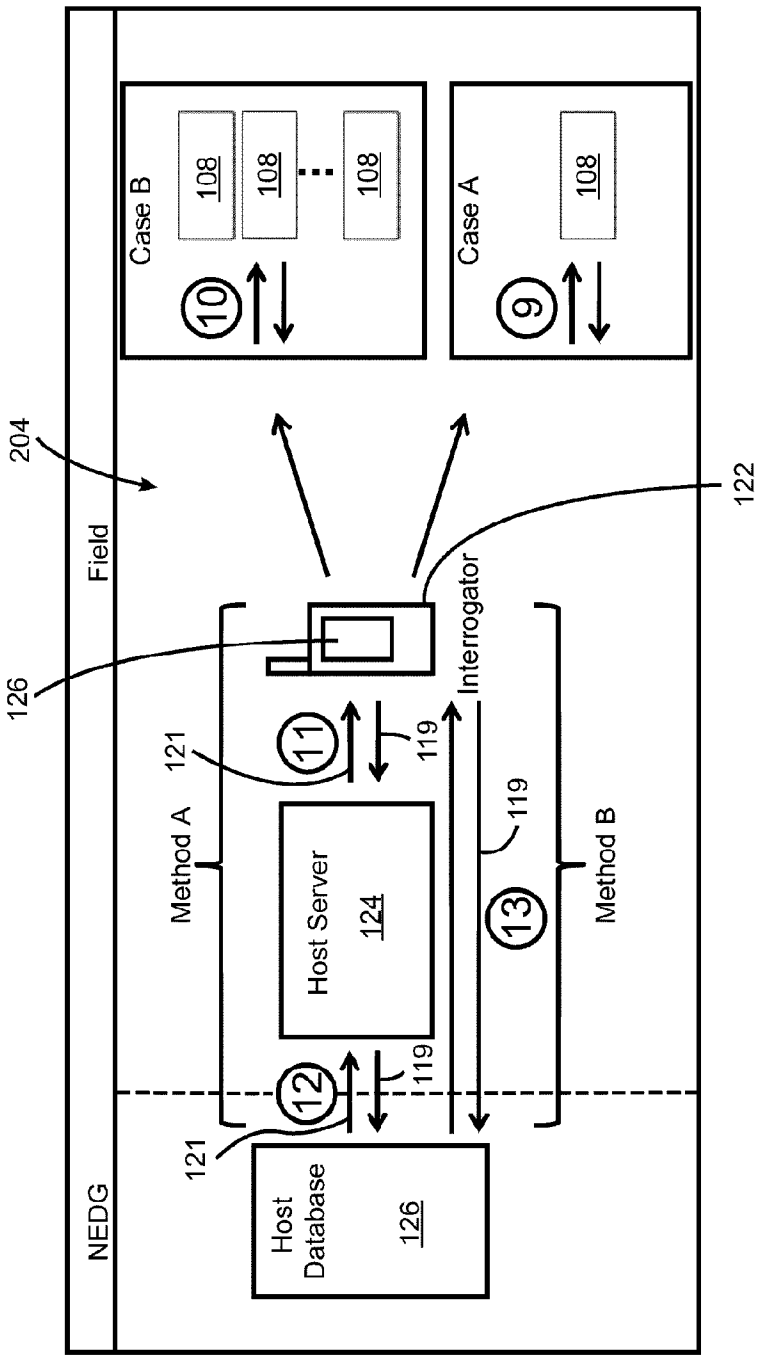

NEDG
Field
204
126
122
Case B
108
108
108
10
Case A
108
9
Interrogator
11
121
119
Method A
Host Server
124
119
13
Method B
12
119
121
Host Database
126

FIG. 19

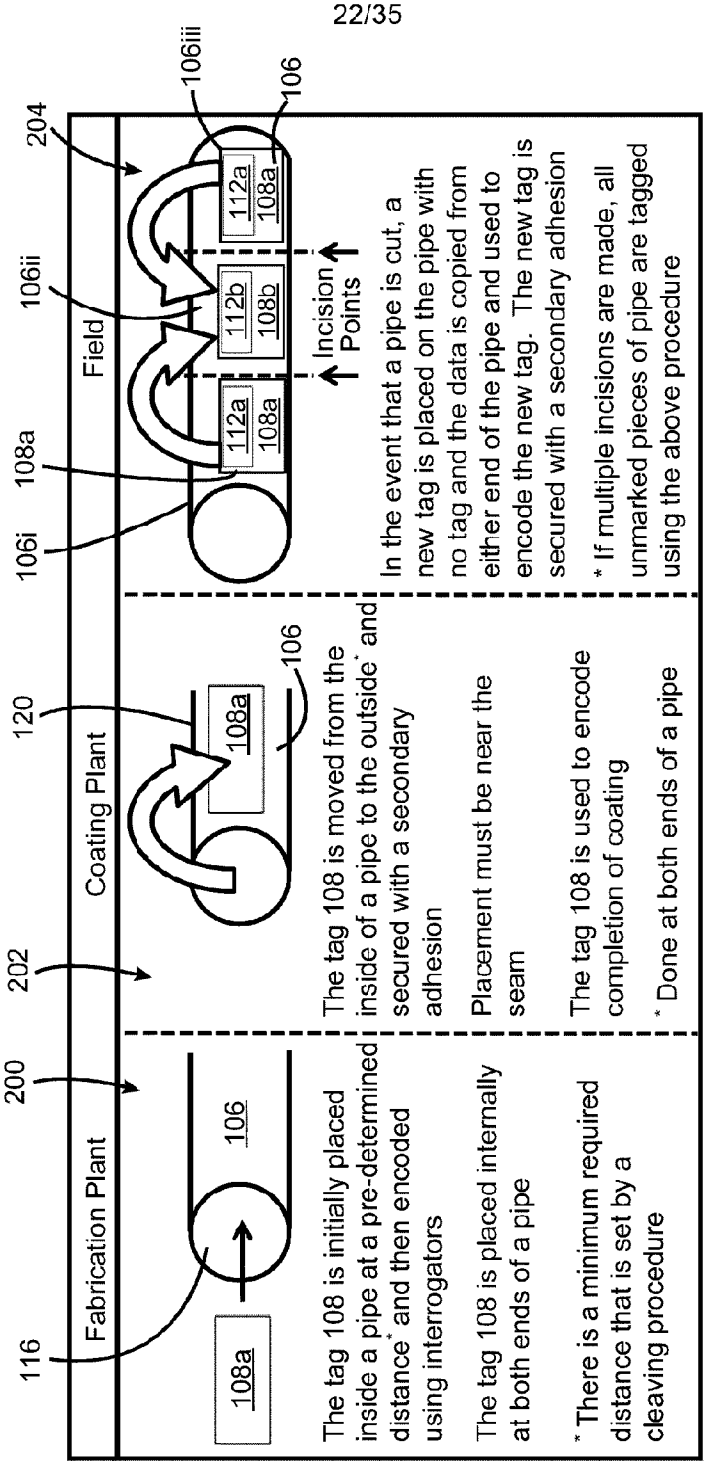
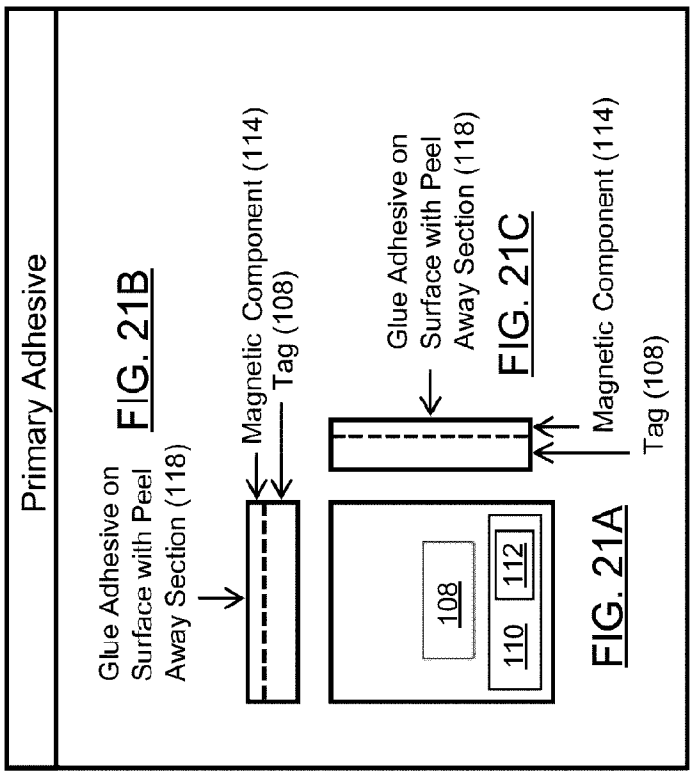
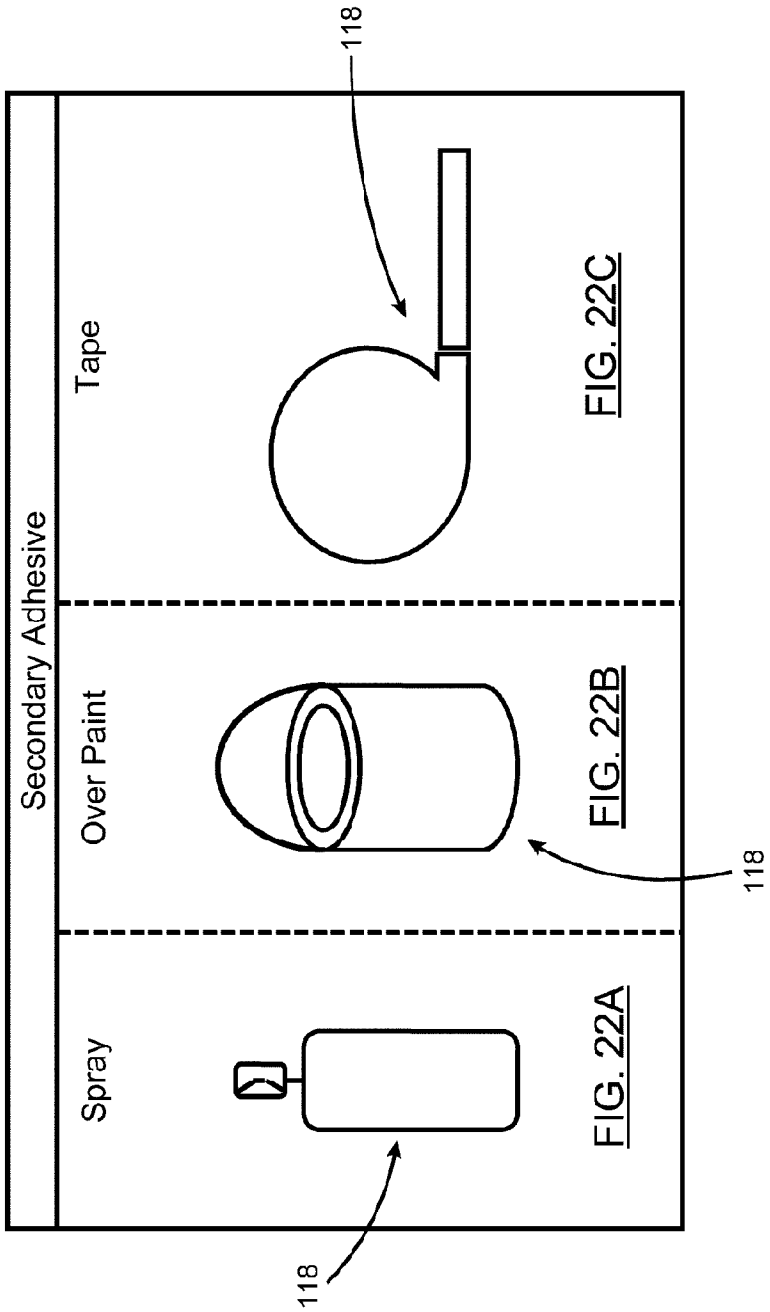


FIG. 20A FIG. 20B FIG. 20C


Primary Adhesive
Glue Adhesive on Surface with Peel Away Section (118)
Magnetic Component (114)
Tag (108)
FIG. 21B
Glue Adhesive on Surface with Peel Away Section (118)
108
110
112
FIG. 21C
Magnetic Component (114)
Tag (108)
FIG. 21A


Secondary Adhesive
Spray
Over Paint
Tape
118
118
118
FIG. 22A
FIG. 22B
FIG. 22C

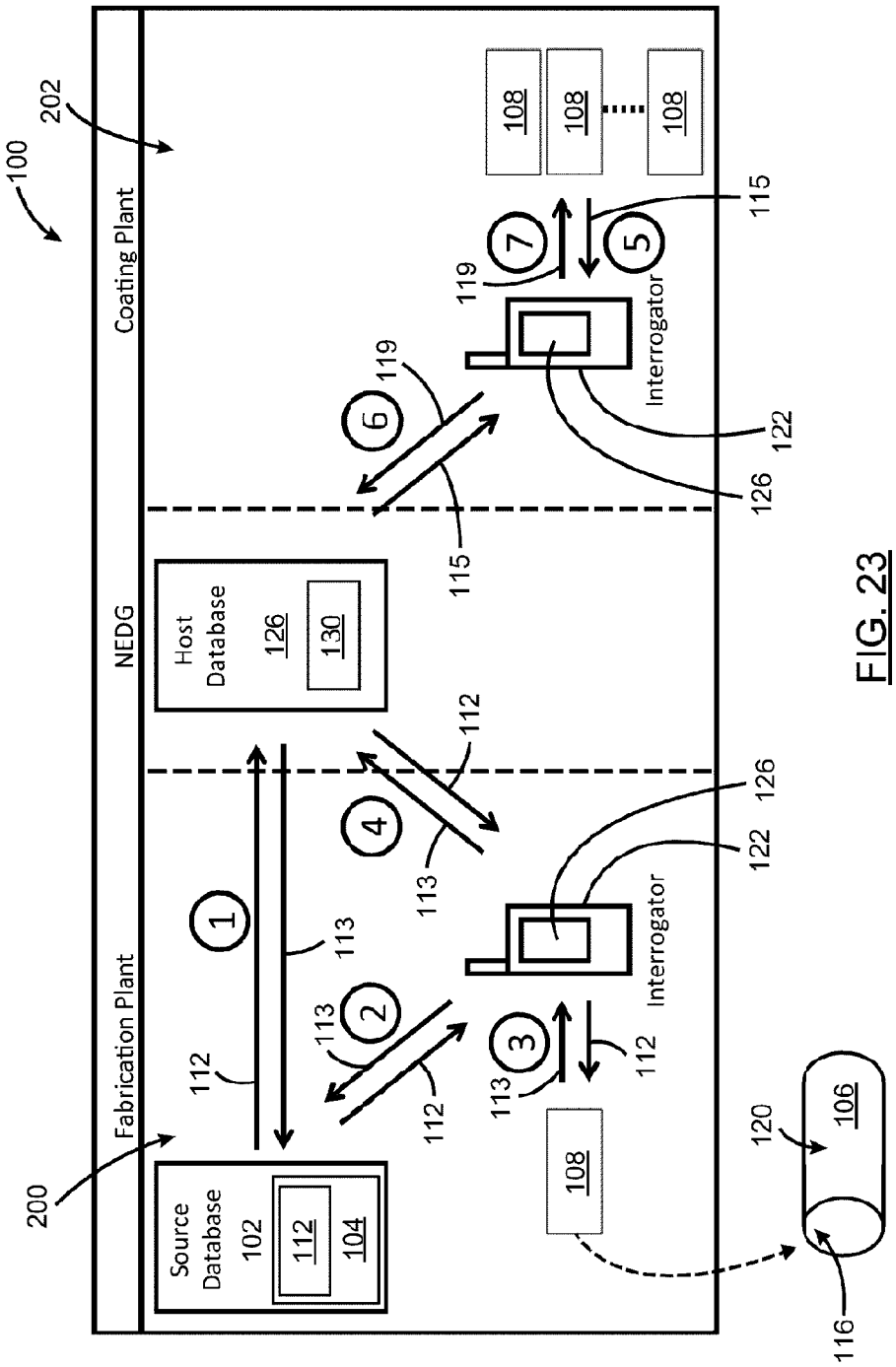

100
202
Coating Plant
NEDG
Fabrication Plant
200
Source Database
102
112
104
Host Database
126
130
108
108
108
Interrogator
Interrogator
106
116
120
1
2
3
4
5
6
7
112
113
115
119
122
126

FIG. 23

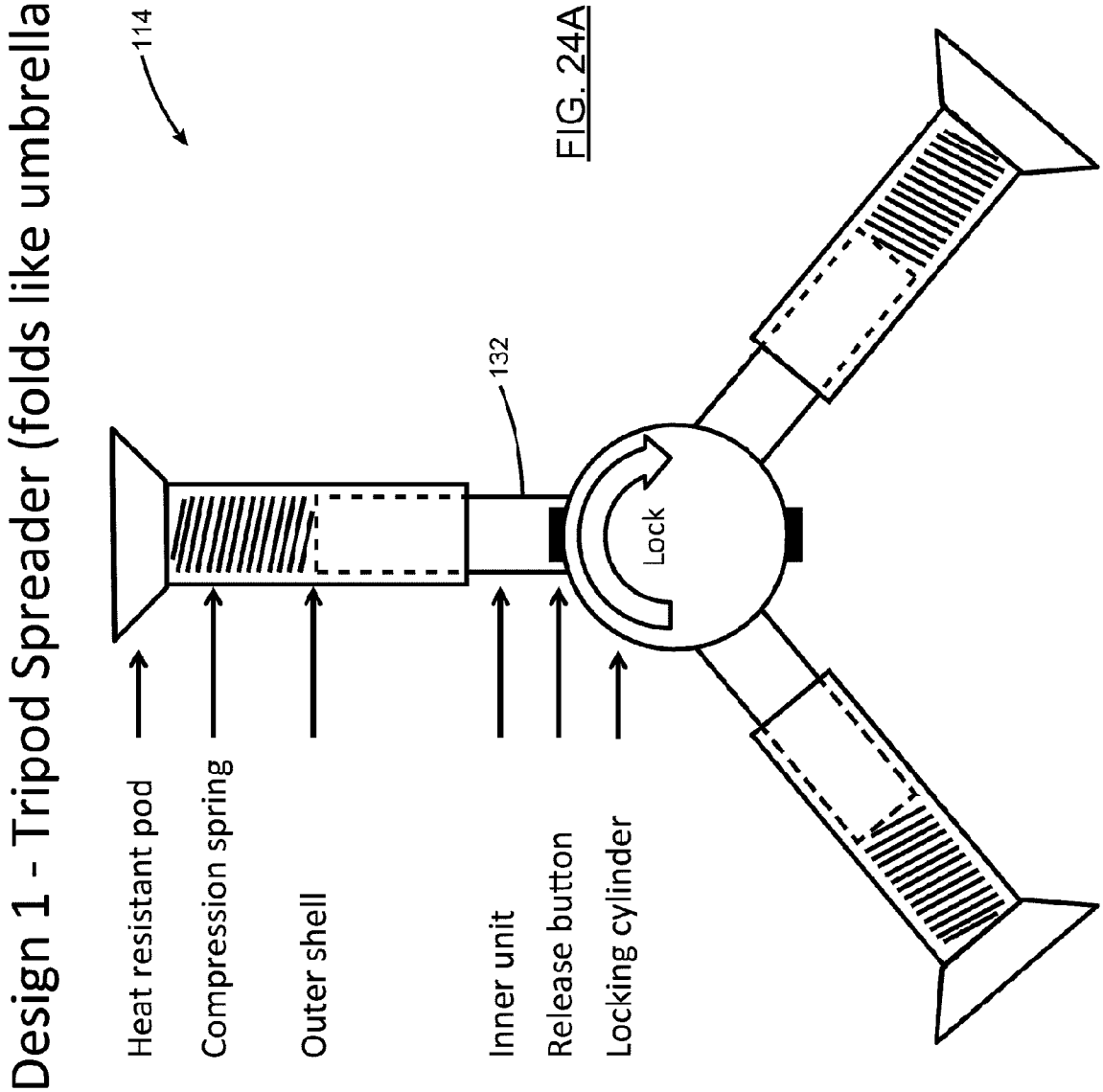

Design 1 - Tripod Spreader (folds like umbrella)
114
132
Lock
Heat resistant pod
Compression spring
Outer shell
Inner unit
Release button
Locking cylinder

FIG. 24A

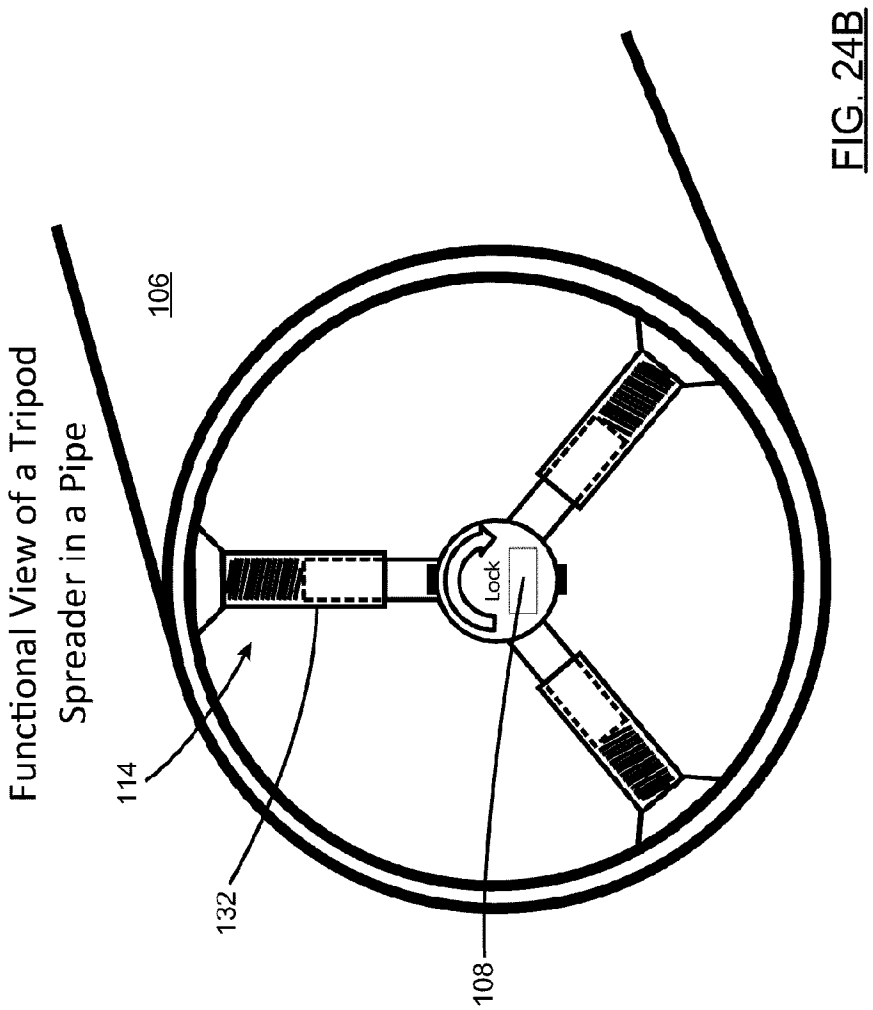

Functional View of a Tripod
Spreader in a Pipe
106
114
132
108
Lock

FIG. 24B

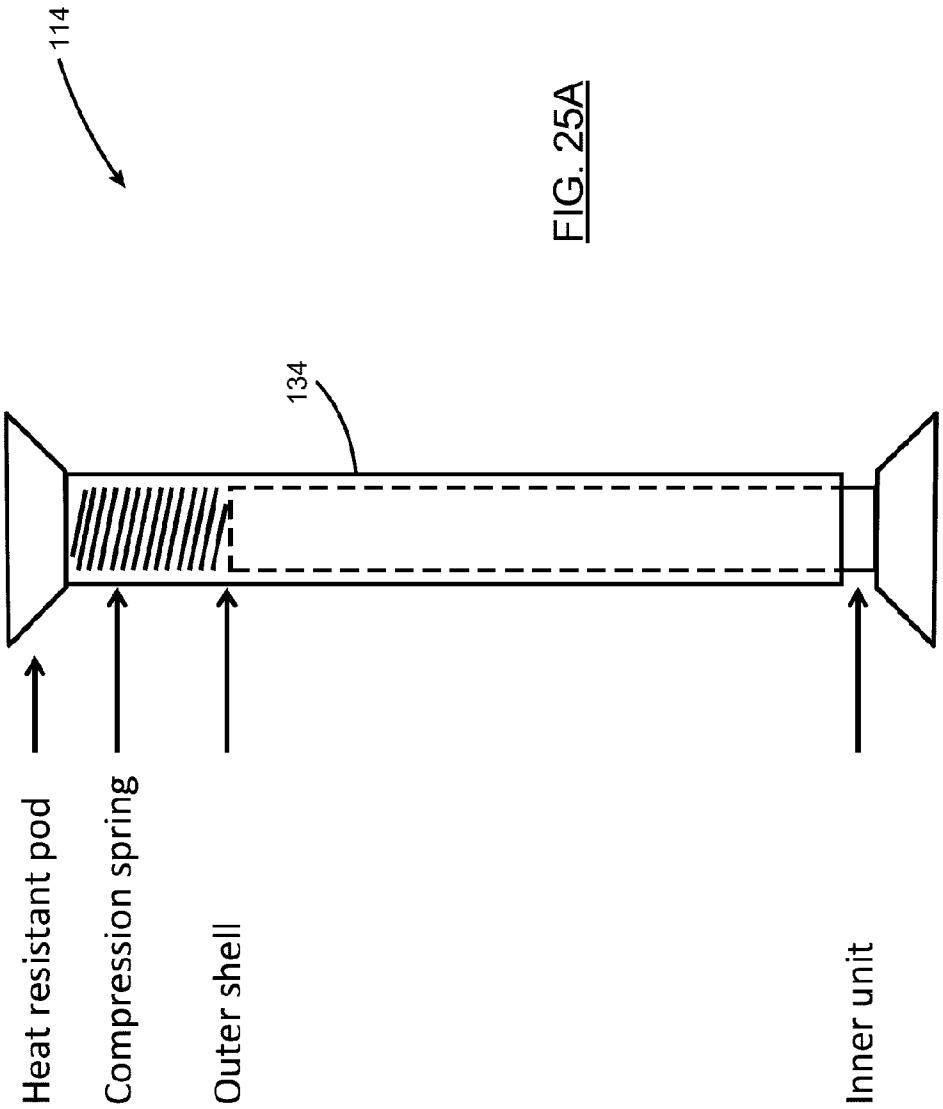

114
134
Heat resistant pod
Compression spring
Outer shell
Inner unit

FIG. 25A

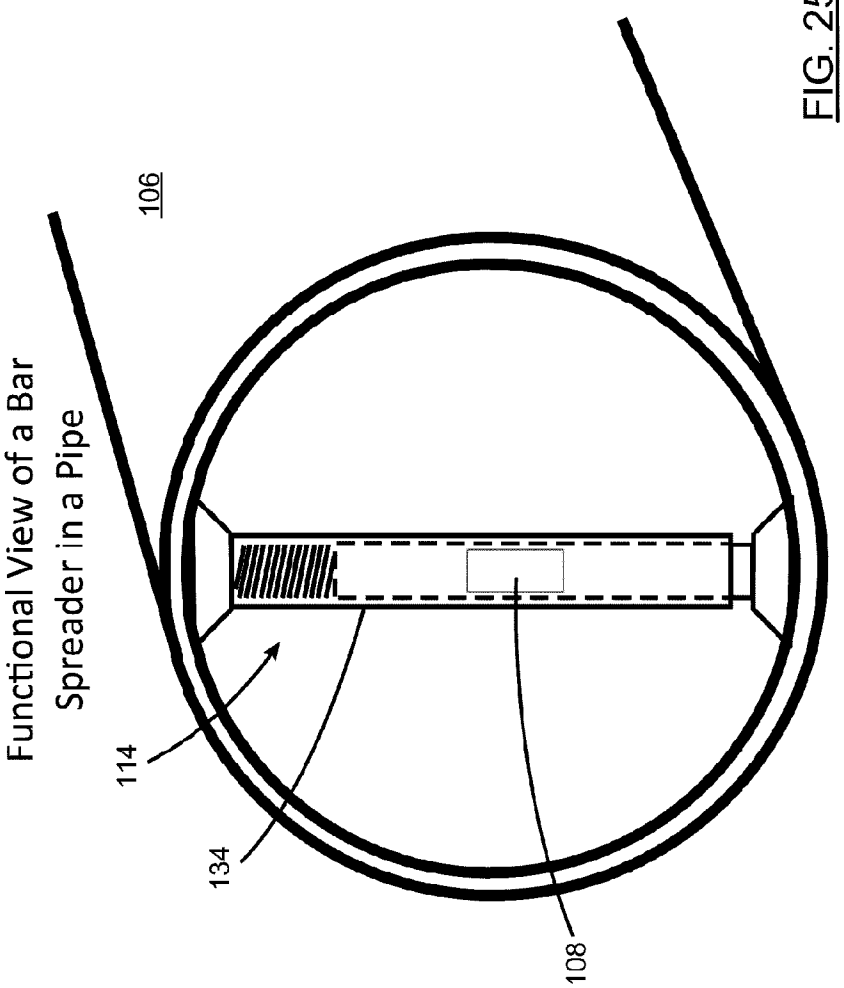


FIG. 25B

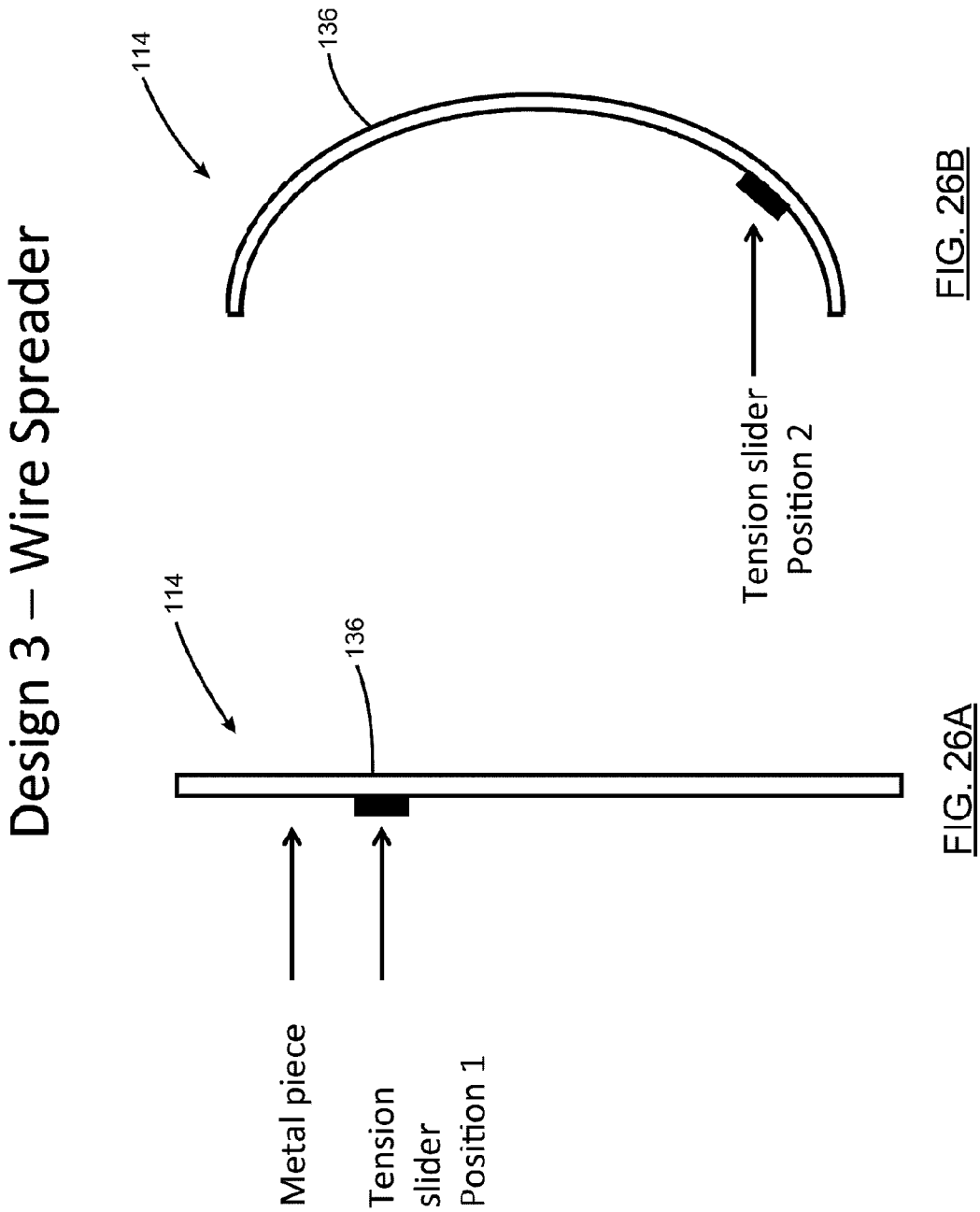


FIG. 26A

FIG. 26B

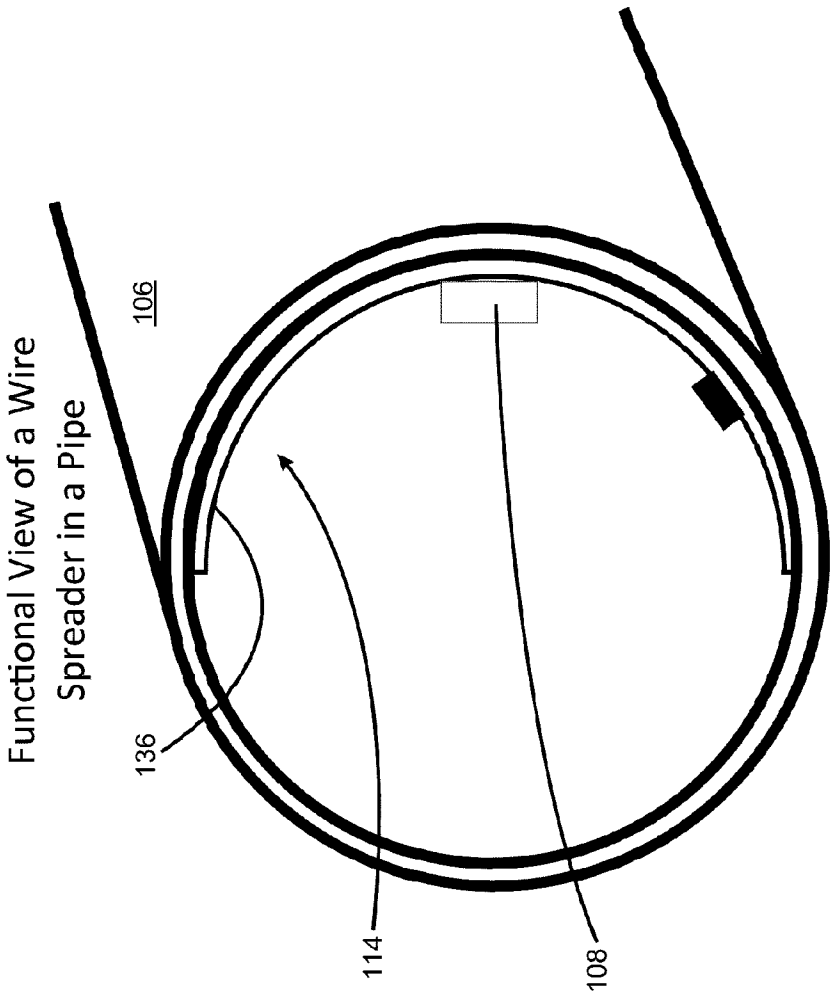


FIG. 26C

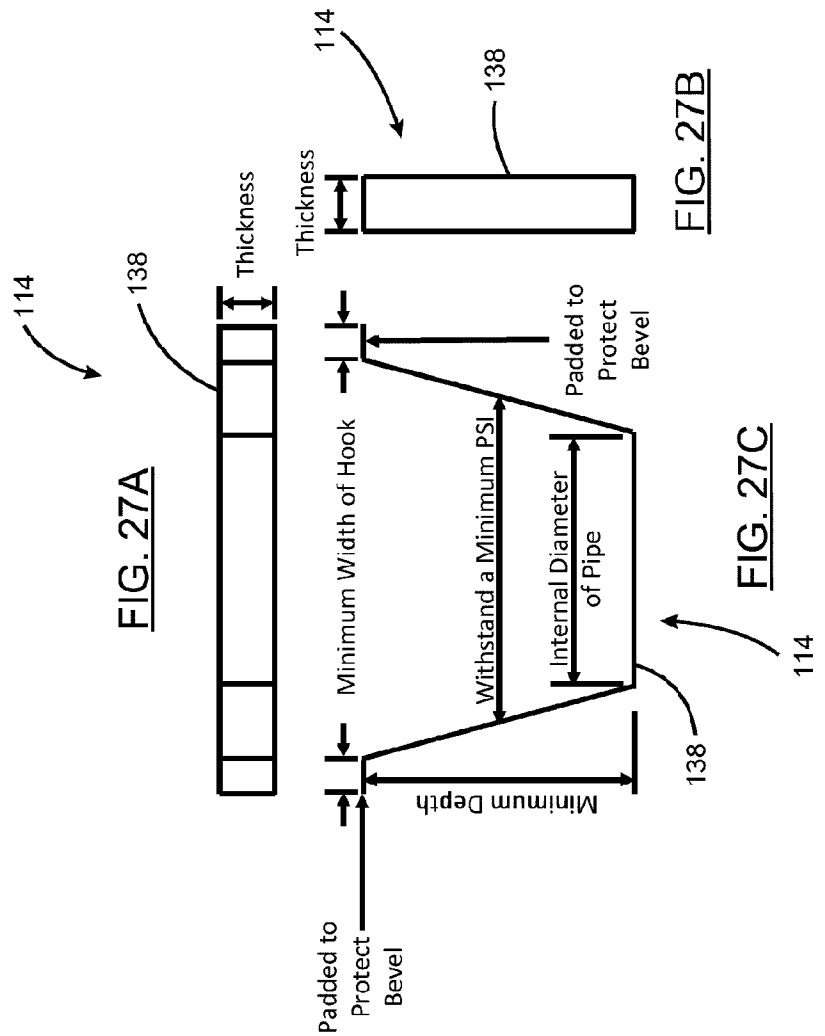


FIG. 27A

FIG. 27B

FIG. 27C

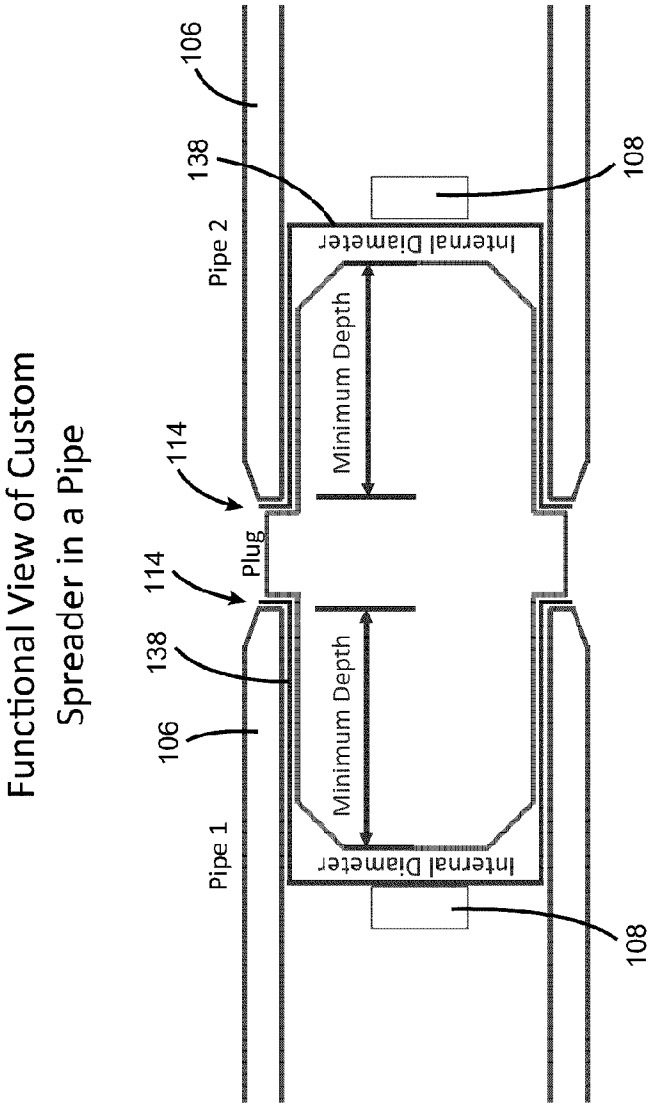

Functional View of Custom Spreader in a Pipe
106
138
108
Pipe 2
Internal Diameter
Minimum Depth
114
Plug
114
138
Minimum Depth
106
Pipe 1
Internal Diameter
108

FIG. 27D

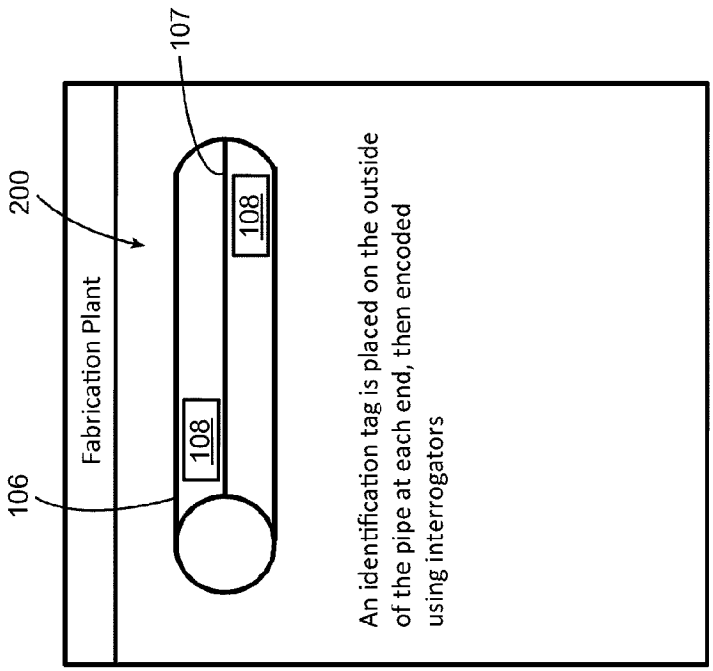

107
200
Fabrication Plant
108
108
106
An identification tag is placed on the outside of the pipe at each end, then encoded using interrogators

FIG. 28

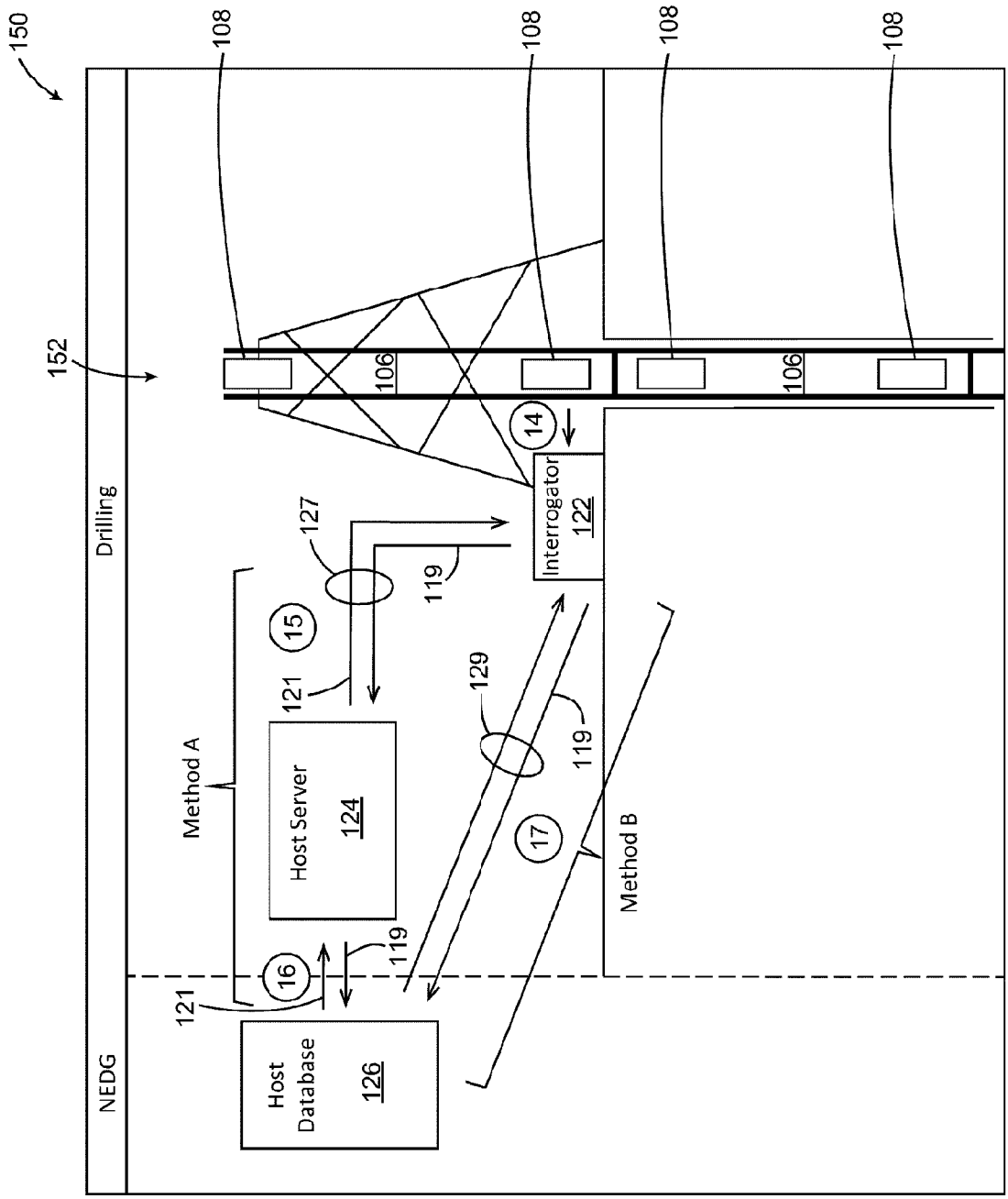

150
108
108
108
108
152
106
106
14
Interrogator
122
127
119
15
121
129
119
Method A
Host Server
124
17
Method B
119
16
121
Host
Database
126
Drilling
NEDG

FIG. 29

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2013/050126

A. CLASSIFICATION OF SUBJECT MATTER
IPC: ***G06Q 10/06*** (2012.01) , ***G06Q 10/08*** (2012.01)
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)
IPC: G06Q 10/06 (2012.01), G06Q 10/08 (2012.01)

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

Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used)
Epoque™ (Epodoc, X Full), Canadian database, and Google Scholar™ (Keywords: tracking, RFID or barcode, tag, identifier, lifecycle, asset, reporting, history, data validation, data integrity and similar terms).

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X ------ Y	Publication : "Lifecycle ID and Lifecycle Data Management"(HARRISON et al.), Auto-ID Labs White Paper WP- BIZAPP-032, University of Cambridge, UK, 14 June 2006 (14- 06 -2006). Retrieved from the internet on 16 May 2013 (16-05-2013) at URL: :<http://222.autoidlabs.org/uploads/media/AUTOIDLABS-WP-BIZAPP-032.pdf> * entire document and particularly, Sections 1.1, 1.2, 2.2, 3.2, 3.3, 3.4.2, 4, 4.1.2;* *Sections 4.3 and 5.2; Fig. 2, 3, 5 and 6*	1,2, 4, 13 - 18, 21,22, 24, 57 - 60, 63 and 64 ---------- 3, 5 - 12, 19 - 20, 23, 25 - 56, 61 - 62 and 65 - 67
Y	EP 2 362 061 A2 (MACKENZIE et al.), 31 August 2011(31-08-2011). * entire document and particularly, para 0004, 0006 - 0010, 0015, 0021- 0029; * * para 0032 and 0034; Fig. 1 and 4*	3, 5 - 12, 19 - 20, 23, 25 - 56, 61 - 62 and 65 - 67
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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
21 May 2013 (21-05-2013)	23 May 2013 (23-05-2013)

Name and mailing address of the ISA/CA	Authorized officer
Canadian Intellectual Property Office Place du Portage I, C114 - 1st Floor, Box PCT 50 Victoria Street Gatineau, Quebec K1A 0C9 Facsimile No.: 001-819-953-2476	Veeresh Nadarajan (819) 953-1575

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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International application No.
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