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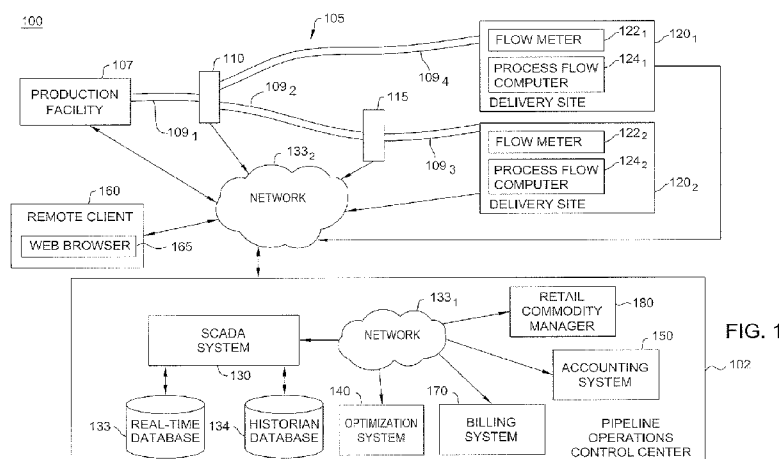
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(54) Title: COMPUTER-IMPLEMENTED METHOD FOR MANAGING COMMODITY CONSUMPTION WITHIN AN INDUSTRIAL PRODUCTION FACILITY



(57) Abstract: Techniques are disclosed for managing certain aspects of a large industrial operation (such as a pipeline). A commodity materials invoice system may allow a user to model a commodity invoice as a template and subsequently use that template to model commodity usage for different periods of time. Costs for a given billing period may be estimated based on actual commodity consumption. For example, data from a SCADA system monitoring different aspects of a pipeline may be used to estimate invoice costs for retail commodity consumption. The commodity materials invoice system may be configured to present both estimated and actualized invoice data side-by-side, allowing users to make a direct comparison of the estimated and actualized invoice data.

Computer-Implemented Method For Managing Commodity Consumption Within An Industrial Production Facility

Cross-Reference to Related Applications

5 This application claims the benefit of U.S. Provisional Application No. 61/321,996, filed April 8, 2010 and US Non-Provisional Application No. 12/969,949, filed December 16, 2010, the entire contents of which are incorporated herein by reference.

Background

10 Generally, a pipeline system provides a continuous pipe conduit that includes a variety of components and equipment, e.g., valves, compressor stations, communications systems, and meters. A pipeline may be used to transport liquid or gaseous materials from one point to another, usually from one point (or points) of production or processing to another, or to points of use. That is, a producer may
15 deliver product to customers through the pipeline. For example, an air separation unit (ASU) may be used to separate atmospheric air into gaseous components (e.g., oxygen gas (O₂), nitrogen gas (N₂), hydrogen gas (H₂), Argon gas (Ar), etc.) delivered to a variety of customers at downstream points along a pipeline. At compressor stations, compressors maintain the pressure of the material in the
20 pipeline as it is transported. Similarly, for a liquid bearing pipeline, pumps may be used to introduce and maintain pressure for a liquid substance transported by the pipeline.

 Obviously, running and maintaining a collection of ASUs used to generate gaseous oxygen (and other substances) delivered through pipeline system is a
25 complex endeavor. To manage this complexity, the operations of a pipeline system may be coordinated and controlled from a central operations control center. At such a control center, an operator may monitor process data related to the operational state of the ASUs, the pipeline and each of its constituent elements using a SCADA (Supervisory Control and Data Acquisition) system. Other complex industrial
30 systems and processes use a similar approach. For example, a petroleum refinery

(at one end of a pipeline) may be monitored from a central control center using a real-time status database configured to receive data collected from the field devices of the refinery. Similarly, electrical generation facilities, chemical production or processing facilities, steel mills, manufacturing plants, assembly lines, etc., are frequently monitored using on a centralized operations control center.

In addition to the operational complexity of these types of large industrial operations, managing the financial side of such an operation presents a substantial challenge. Among other things, e.g., an operator needs to monitor the amount of commodity materials (e.g., electricity, natural gas, etc.) consumed in generating product for delivery customers. The amount (and source) of different commodity materials used in production may greatly impact the profitability of the overall operation. Further, the operator may have a variety of different pricing arrangements with different commodity suppliers (of both the same and different commodities). Some such arrangements may be regulated (e.g., electricity subject to a rate tariff) contractual (e.g., a requirements contract), while others commodities supplies may simply be subject to market forces. Further still, a pipeline operator may have a variety of customers each with a distinct set of contractual requirements that affect how much the pipeline operator may charge or pass on different commodity costs., e.g., for minimum volume delivery, price points for different instantaneous flow rates, force majeure requirements, pass through requirements (what costs of production are passed on to the customer), and price adjustments, etc.

Summary

Embodiments of the invention provide techniques for managing commodity consumption in a large industrial network, such as a pipeline. One embodiment of the invention includes a method for managing commodity consumption within an industrial production facility. The method may generally include receiving a definition of a billing template for each of a plurality of commodity suppliers. Each commodity supplier provides a commodity material consumed by the industrial production facility, and the billing templates each specify a set of line-items modeling an invoice

received from a respective one of the commodity suppliers. The method may also include receiving a request to view an invoice, for a specified billing period, for a selected one of the commodity suppliers and include generating a view of the requested invoice. The view may include a first display area for rendering one or
5 more of the set of line items as estimated invoice data and a second display area for rendering one or more of the set of line items as actualized invoice data. The method may also include displaying, in response to the request to view the invoice, the generated view, including the first display area and the second display area.

Another embodiment of the invention includes a non-transitory computer-
10 readable medium containing a retail commodity manger, which when executed on a processor is configured to perform an operation for managing commodity consumption within an industrial production facility. The operation itself may include receiving a definition of a billing template for each of a plurality of commodity suppliers. Each commodity supplier provides a commodity material consumed by the
15 industrial production facility, and the billing templates each specify a set of line-items modeling an invoice received from a respective one of the commodity suppliers. The operation may further include receiving a request to view an invoice, for a specified billing period, for a selected one of the commodity suppliers generating a view of the requested invoice. The view may include a first display area for rendering one or
20 more of the set of line items as estimated invoice data and a second display area for rendering one or more of the set of line items as actualized invoice data. The operation may also include displaying, in response to the request to view the invoice, the generated view, including the first display area and the second display area.

Still another embodiment of the invention includes a system having a
25 processor and a memory storing a retail commodity manger, which when executed on the processor performs an operation for managing commodity consumption within an industrial production facility. The operation itself may include receiving a definition of a billing template for each of a plurality of commodity suppliers. Each commodity supplier provides a commodity material consumed by the industrial production facility,
30 and the billing templates each specify a set of line-items modeling an invoice

received from a respective one of the commodity suppliers. The operation may further include receiving a request to view an invoice, for a specified billing period, for a selected one of the commodity suppliers generating a view of the requested invoice. The view may include a first display area for rendering one or more of the set of line items as estimated invoice data and a second display area for rendering one or more of the set of line items as actualized invoice data. The operation may also include displaying, in response to the request to view the invoice, the generated view, including the first display area and the second display area.

Brief Description of the Drawings

For a further understanding of the nature and objects of the present invention, reference should be made to the following detailed description, taken in conjunction with the accompanying drawings, in which like elements are given the same or analogous reference numbers and wherein:

Figure 1 is an illustration of a monitored pipeline and an operations control center, according to one embodiment of the invention.

Figure 2 is a more detailed view of one of the computing systems illustrated in Figure 1, according to one embodiment of the invention.

Figure 3 illustrates a method for creating a collection of invoice templates used to model commodity materials costs related to the operations of an industrial system such as a pipeline, according to one embodiment of the invention.

Figure 4 illustrates a method for modeling an invoice of commodity material consumption within an industrial network such as a pipeline, according to one embodiment of the invention.

Figure 5 illustrates an example user interface for a commodity invoice designer, according to one embodiment of the invention.

Figure 6 illustrates an example user interface for a commodity invoice rate designer, according to one embodiment of the invention.

Figure 7 illustrates an example user interface for a commodity invoice manager, according to one embodiment of the invention.

Description of Preferred Embodiments

Embodiments of the invention include a commodity materials invoice system used to manage certain aspects of a large industrial operation (such as a pipeline). In a particular embodiment, the commodity materials invoice system allows users to manage and track costs associated with retail commodities such as electricity, natural gas, third party purchases, as well as other commodities. The commodity materials invoice system allows a pipeline operator to estimate and actualize retail commodity costs in real-time for a broad variety of different commodities. That is, the commodity materials invoice system allows the pipeline operator to estimate costs (e.g., based on estimates of a commodity used during a billing period) and actualize them at a later date (e.g., based on an invoice from a commodity supplier). The estimated (and actualized) costs may model a broad variety of retail commodity costs including the ability to model percentage based calculations (e.g., taxes), on- and off-peak demand pricing, block pricing, and the like.

In one embodiment, a user composes a commodity invoice as a billing template and subsequently uses that template to model commodity usage for different periods of time, i.e., for a given billing period. Costs for a given billing period may be estimated based on actual commodity consumption. For example, data from a SCADA system monitoring different aspects of a pipeline may be used to estimate invoice costs for retail commodity consumption. In one embodiment, the SCADA system may provide a real-time status database (which reflects the current process data of the industrial system) and a historian database (which archives the process data from the industrial system as it changes over time). For example, the real-time database may provide the current commodity consumption rates for each ASU, the demand-pull from the pipeline by each customer, and the like. Similarly, the historian database may include each real-time volumetric accumulation previously received.

Using this information, estimates of commodity usage may be used to populate the fields of the template for a given period.

Importantly, the estimated invoice costs represented in the billing template may be modeled on the actual invoice form (and rate structure) used by the provider of a given commodity. Thus, in contrast to currently available products, the commodity materials invoice system provides an operator with the ability to model invoices from different suppliers and to track counter parties costs in a retail-based structure that mirrors the actual invoices from each counter party. Further, a user may attach documents to an invoice generated for a given billing period, providing users with instant access to the cost data pertaining to a specific counterparty, product and/or period of time, all in one system. Thus, the commodity materials invoice system provides a centralized collection of commodity invoice data (both actualized and estimated) that may facilitate profit and loss sheet reporting as well as facilitate a billing system configured to invoice customers for the pass-through costs of certain commodity costs incurred by the pipeline operator. Further still, data from the commodity materials invoice system may be used to optimize the operations of the pipeline. For example, an optimization process may evaluate the estimated commodity costs to determine a recommended solution to where to obtain commodity products from during a given billing period.

In the following, reference is made to embodiments of the invention. However, it should be understood that the invention is not limited to specific described embodiments. Instead, any combination of the following features and elements, whether related to different embodiments or not, is contemplated to implement and practice the invention. Furthermore, although embodiments of the invention may achieve advantages over other possible solutions and/or over the prior art, whether or not a particular advantage is achieved by a given embodiment is not limiting of the invention. Thus, the following aspects, features, embodiments and advantages are merely illustrative and are not considered elements or limitations of the appended claims except where explicitly recited in a claim(s). Likewise, reference to "the invention" shall not be construed as a generalization of any inventive subject matter

disclosed herein and shall not be considered to be an element or limitation of the appended claims except where explicitly recited in a claim(s).

One embodiment of the invention is implemented as a program product for use with a computer system. The program(s) of the program product defines
5 functions of the embodiments (including the methods described herein) and can be contained on a variety of computer-readable storage media. Illustrative computer-readable storage media include, but are not limited to: (i) non-writable storage media (e.g., read-only memory devices within a computer such as CD-ROM disks readable by a CD-ROM drive) on which information is permanently stored; (ii) writable storage
10 media (e.g., floppy disks within a diskette drive or hard-disk drive) on which alterable information is stored. Such computer-readable storage media, when carrying computer-readable instructions that direct the functions of the present invention, are embodiments of the present invention. Other media include communications media through which information is conveyed to a computer, such as through a computer or
15 telephone network, including wireless communications networks. The latter embodiment specifically includes transmitting information to/from the Internet and other networks. Such communications media, when carrying computer-readable instructions that direct the functions of the present invention, are embodiments of the present invention. Broadly, computer-readable storage media and communications
20 media may be referred to herein as computer-readable media.

In general, the routines executed to implement the embodiments of the invention, may be part of an operating system or a specific application, component, program, module, object, or sequence of instructions. The computer program of the present invention typically is comprised of a multitude of instructions that will be
25 translated by the native computer into a machine-readable format and hence executable instructions. Also, programs are comprised of variables and data structures that either reside locally to the program or are found in memory or on storage devices. In addition, various programs described hereinafter may be identified based upon the application for which they are implemented in a specific
30 embodiment of the invention. However, it should be appreciated that any particular

program nomenclature that follows is used merely for convenience, and thus the invention should not be limited to use solely in any specific application identified herein.

A particular embodiment of the invention is described using a pipeline as an example of a large industrial operation managed using the commodity materials invoice application and system described herein. However, it should be understood that embodiments of the invention may be adapted for use with a broad variety of industrial systems with complex billing requirements including, e.g., electrical generation facilities, chemical production or processing facilities, steel mills, manufacturing plants, assembly lines, etc. Accordingly, references to a pipeline system are merely illustrative and not limiting.

Figure 1 is an illustration of a system **100** that includes a monitored pipeline **105** and an operations control center **102**, according to one embodiment of the invention. As shown, a pipeline **105** connects a production/processing facility **107** and two product delivery sites **120₁₋₂**. Production facility **107** may represent, for example, a molecular gas generation plant that includes one or more air separation units (ASUs) used to purify gaseous substances from the atmosphere. The resulting product is delivered to stations **120₁₋₂** over the pipeline **105**. Illustratively, pipeline **105** includes pipeline segments **109₁₋₄**. Pipeline segments **109₁**, **109₂**, and **109₃**, provide a path from production facility **107** to delivery site **120₂** and pipeline segments **109₁** and **109₄** provide a path from production facility **107** to delivery station **120₁**. Additionally, pipeline **105** includes compressor stations **110** and **120** used to maintain the pressure of gaseous substances as it is transported over pipeline **105** from the production facility **107** to the delivery sites **120₁₋₂**.

The production facility **107** and the compressor stations **110** and **115** may include sensor equipment used to monitor aspects of the operational state of the pipeline **105**. For a pressurized gas pipeline, for example, a wide variety of field devices and parameters may be monitored including, for example, inlet gas pressure, outlet gas pressure, gas temperature, cooling liquid temperature, flow rates, and power consumption, among others. Similarly, the operational state of various field

devices, air separation units, and equipment at production facility **107** and delivery stations **120₁₋₂** may be monitored by sensor equipment. For example, the amount of electricity, natural gas, or other retail commodity consumed by the ASU may be monitored by sensor equipment. Of course, for other industrial networks and systems, the sensors and monitoring equipment may be selected to suit the needs of a particular case. Illustratively, delivery sites **120₁₋₂** each include a respective flow meter **122₁₋₂** and a process flow computer **124₁₋₂**. In one embodiment, the flow meters **122₁₋₂** may be configured to sample the instantaneous flow rates of product taken from the pipeline **105** by the delivery stations **120₁₋₂** at a specified interval (e.g., once every second). Similarly, sensors at the production facility **107** and compressor stations **110**, **115** may monitor the instantaneous rates of commodity consumption.

The rates determined by the flow meter **122₁₋₂** may be transmitted to the respective process flow computer **124₁₋₂**. In turn, the process flow computer **124₁₋₂** receives the sampled flow rate and updates the volume accumulated in one or more volume groups. In one embodiment, the volumes accumulated by the process flow computers **124** may be transmitted to the operation control center **102** over network **133₂** at periodic intervals, e.g., once an hour. Sensors at a variety of points in the pipeline **105** may also transmit information regarding the operational state of pipeline **105** to the operation control center **102** over network **133₂**, as represented by the arrows connecting the production facility **107**, compressor stations **110** and **115**, and delivery sites **120₁₋₂** to network **133₂**. The pipeline operation control center **102** may employ a number of computer systems running application programs used to coordinate, monitor, and control the operations of pipeline **105**, including a retail commodity manger **180** configured to manage and track costs associated with retail commodities such as electricity, natural gas, third party purchases, and any other commodity used in generating and/or delivering product to the delivery sites **120₁₋₂**.

Illustratively, the pipeline operations control center **102** includes a SCADA (Supervisory Control and Data Acquisition) system **130**, a real-time database **133** and a historian database **134** an accounting system **150**, a billing system **170**, and the retail commodity manger **180**, each communicating over a network **133₁**.

Additionally, a computing system may provide a remote interface to the computing systems at the operations control center **102**. Thus, as shown, the remote client **160** communicates over network **133₁** with the computer systems of the operations control center **102**. For example, a user may interact with a web-browser **165** to
5 access SCADA data over the network **133₁**. The computer systems **130**, **133**, **134**, **150**, **160**, **170**, and **180** are included to be representative of existing computer systems, e.g., desktop computers, server computers, laptop computers, tablet computers and the like. However, embodiments of the invention are not limited to any particular computing system, application, device, architecture or network, and
10 instead, may be adapted to take advantage of new computing systems and platforms as they become available. Additionally, one skilled in the art will recognize that the illustrations of computer systems **130**, **133**, **134**, **150**, **160**, and **170** are simplified to highlight aspects of the present invention and that computing systems and networks typically include a variety of components not shown in Figure 1.

15 In one embodiment, the SCADA **130** system is configured to gather data in real-time from sensors on the pipeline **105**, the production facility **107**, and from the process flow computers **124₁₋₂** at the delivery sites **120₁₋₂** in order to control equipment and monitor conditions in the pipeline **105**. As noted above, e.g., in context of this disclosure, the SCADA system **130** may receive volumetric
20 accumulations of retail commodity consumption, such as electricity, natural gas, third party purchases, and any other commodity used in generating and/or delivering product to the delivery sites **120₁₋₂**, as well as receive accumulations of product delivered to each delivery site **120₁₋₂**. In one embodiment, commodity consumption data may be tied to the product delivered to one of the delivery sites **120₁₋₂**.
25 Alternatively, however, the commodity consumption data may reflect commodity usage without being differentiated for multiple customers.

Monitored data received from sensors in the pipeline **105** may be stored in real-time database **133**. In one embodiment, the real-time database **133** generally stores the last known value for each element or component of an industrial system
30 (e.g., pipeline **105**) monitored using system **100**. That is, the real-time database **133**

may store data values each representing a monitored parameter of pipeline **105** and the current operational value of that parameter, e.g., the most recent rate of electricity consumption used by an ASU at the production facility **107**. Such a parameter could be updated, e.g., each minute in order to continually reflect a then current electricity
5 consumption of the ASU.

The data may be written into real-time database **133** periodically, where values are updated at regular intervals, or exception based, where a new values are written into real-time database **133** only when the monitored value changes more than a predetermined value. In turn, the retail commodity manager **180** may use the
10 commodity accumulation data to estimate retail invoice values for commodities consumed from each of multiple suppliers. Similarly, the billing system **170** may be configured to estimate customer invoices based on the accumulated volumes, external factors (e.g., pass through amounts such as the cost of electricity), and on any billing adjustments specified in an agreement between the producer and
15 consumer of product delivered through pipeline **105**. The historian database **134** may be configured to retrieve (or receive) the values for monitored parameters from real-time database **133**. Thus, the historian database **134** provides an archive of values from the real-time database **133**. The retail commodity manager **180** could use such data to create an estimated invoice for a billing period – tracking the cost of
20 the electricity based on (1) the actual consumption data and (2) the rate tariff of the electricity provider. That is, the retail commodity manager **180** may query the real-time database **133** and the historian database **134** to populate the billing template composed for a particular commodity provider. Further, such data may be used, e.g., to compare an estimate of commodity consumption for a given billing period with an
25 actual invoice of commodity consumption for that same period when it is subsequently received from a commodity vendor.

Of course, the appearance, behavior, and capabilities of interfaces made available by the retail commodity manager **180** and the billing system **170** may be tailored to suit the needs of a particular case. Further, although SCADA system **130**,
30 real-time database **133**, historian system **134**, accounting system **150**, billing system

170, and the retail commodity manager **180** are shown as separate components, one of ordinary skill in the art will recognize that these components may be applications running on a single computer system, or on multiple computer systems, and further, that these components may be configured in a variety of ways.

5 Figure **2** is a more detailed view of a computer system **200** which includes the retail commodity manager of Figure **1**, according to one embodiment of the invention. As shown, the computer system **200** includes, without limitation, a central processing unit (CPU) **205**, a network interface **215**, an interconnect **220**, a memory **225**, and storage **230**. The computer system **200** may also include an I/O device interface **210**
10 connecting I/O devices **212** (e.g., keyboard, display and mouse devices) to the computer system **200**.

 In general, the CPU **205** retrieves and executes programming instructions stored in the memory **225**. Similarly, the CPU **205** stores and retrieves application data residing in the memory **225**. The interconnect **220** facilitates transmission of
15 programming instructions and application data between the CPU **205**, I/O devices interface **210**, storage **230**, network interface **215**, and memory **225**. CPU **205** is included to be representative of a single CPU, multiple CPUs, a single CPU having multiple processing cores, and the like. And the memory **225** is generally included to be representative of a random access memory. The storage **230** may be a disk drive
20 storage device. Although shown as a single unit, the storage **230** may be a combination of fixed and/or removable storage devices, such as fixed disc drives, floppy disc drives, tape drives, removable memory cards, optical storage, network attached storage (NAS), or a storage area-network (SAN).

 Illustratively, the memory **225** contains the retail commodity manager **180**, and
25 the storage **230** contains a collection of rate schedules **238**, estimated invoice data **240**, and actualized invoice data **242**. In one embodiment, the retail commodity manager **180** provides a software application which allows a pipeline operator to model invoices from a plurality of different commodity suppliers, based on the particular invoice, agreement, tariff, or other arrangement between the pipeline
30 operator and supplier.

As shown, the retail commodity manager **180** includes a bill designer **232**, a bill manager **234** and a rate calculator **236**. In one embodiment, the bill designer **232** provides a user with a graphical user interface used to compose a collection of billing templates **244**. Each billing template **244** may be modeled on an invoice format used by a given commodity supplier. For example, for an electrical supplier, the billing template **244** may include a set of line items for kilowatt hours of electricity consumed, for off-peak and on-peak demand amounts, for taxes and excise charges, etc. Note, the pipeline operator may have supply contracts with multiple electricity providers, and the bill designer **232** may be used to compose a distinct billing template **244** for each one. The rate calculator **226**, may provide a graphical user interface which allows the user to specify the appropriate formula for calculating an estimated invoice amounts for any given field or line item within a billing template **244**. As another example, for a natural gas supplier, the billing template **244** may include a set of line items for MMTBUs of gas delivered to the operator, and for a materials supplier, a mass or volume of commodities delivered to the operator. More generally, each billing template **244** may include a set of fields or line items tailored to correspond to the invoices format used by a particular commodity supplier.

Once a billing template **244** is specified for a given commodity supplier, the pipeline operator may use that billing template **244** to model invoices corresponding to commodity product obtained from that supplier using the bill manager **234**. In one embodiment, the bill manager **234** provides a user with a graphical user interface used to generate (or supply) estimated invoice data **240** and actualized invoice data **242**. For example, the user may specify a given billing period for a selected billing template **244**, i.e., the user may specify what commodity supplier's invoice to model for a given billing period. Returning to the example of electricity consumption for an ASU, the bill manager **234** would populate the fields of the billing template **244** using data obtained from the SCADA system – providing an estimate of amounts of commodity materials consumed by the pipeline operator for that billing period. Further, the rate calculator **236** may calculate an invoice amount for each line item of the invoice based on the rate schedules **238** for the selected commodity supplier and

the data from the SCADA system. Importantly, the estimated invoice data **240** for the selected commodity supplier is presented using the invoice format of that commodity supplier. Alternatively, the user may enter estimates of commodity materials consumption and the rate calculator **236** may calculate the corresponding invoice amounts. This latter approach may be used by the pipeline operator to model different scenarios for commodity consumption. Further, if an actual invoice is available from the commodity supplier for the given period, the user may enter actualized invoice data **242** into the line items of the selected billing template **244**. Alternatively, if the actual invoice data is supplied in a machine readable form (e.g., as a structured markup document processed by the bill manager), the bill manager **234** may parse the invoice data and populate the selected billing template **244** automatically.

Figure 3 illustrates a method **300** for creating a collection of invoice templates used to model commodity materials costs related to the operations of an industrial system such as a pipeline, according to one embodiment of the invention. Although the method steps are described in conjunction with the systems of Figures 1 and 2, persons skilled in the art will understand that any system configured to perform the method steps, in any order, is within the scope of the invention.

As shown, the method **300** begins at step **305**, where the retail commodity manager **180** receives a definition of a billing template **244** for each of a plurality of commodity suppliers. As noted above, the billing template **244** for each commodity supplier may include a set of fields or line items modeled on the actual invoice format used by a given commodity supplier. Further, the rate calculator **236** may be used to specify a formula for computing an invoice amount corresponding to a given field or line item of an invoice. Once completed, the retail commodity manager **180** may store the billing templates **244** and corresponding line item definitions (step **310**). In one embodiment, a the billing template **244** may include two corresponding sets of fields, one set of fields for estimates of commodity consumption populated, e.g., using SCADA data, and a second set of fields for actual invoice amounts populated, e.g., using invoices received from a given commodity supplier. This allows a user to

compare the estimated amounts with an actual invoice, when it is received. Further, because the estimates are presented in the billing template **244** using the invoice format of that commodity supplier, a direct side-by-side comparison is possible.

At step **315**, the retail commodity manager **180** receives a request to view an invoice for one of the commodity providers. For example, the user may interact with the bill manager **234** to request to view an invoice for the current month for the electricity obtained from a particular commodity supplier. In response, the retail commodity manager **180** retrieves the selected billing template **244** and displays the fields or line items to the user. Further, as described in greater detail below, the retail commodity manager **180** may populate the fields or line items of the selected billing template **244** using any available SCADA data (as estimated invoice data **240**), and any available actual invoice amounts (as actualized invoice data **242**), or user supplied data, as well as combinations thereof.

For example, Figure **4** illustrates a method **400** for modeling an invoice of commodity material consumption within an industrial network such as a pipeline, according to one embodiment of the invention. As shown, the method **400** begins at step **405**, where the retail commodity manager **180** populates fields of a selected billing template **244** using actualized invoice data (if available). At step **410**, the retail commodity manager **180** populates fields of the billing template using estimated invoice data (if available). At step **415**, the retail commodity manager **180** renders a display of the selected billing template where one set of fields is populated using the available estimated invoice data (if any) and another set of fields is populated using the available actualized data (if any).

Once the selected billing template is used to render an image of an invoice for a particular commodity supplier, the user may provide estimates for one or more of the line item values or fields of an invoice. Further, if the actual invoice data has not been previously entered (or parsed from a markup language document), the user may enter actual invoice data stored by the retail commodity manager **180** (step **420**). Once entered, the user may have an electronic copy (e.g., a PDF file) of the actual invoice stored along with the actualized invoice data. The user may also

change or update any of the estimated commodity consumption amounts. In response, the retail commodity manager **180** may use the rate calculator to update the line item amounts corresponding to any changed commodity consumption amounts.

5 At step **425**, once the retail commodity manager **180** generates an invoice for the selected billing period – based on estimated data, actualized data, or combinations of both, the resulting invoice may be published to a database and accessed by a variety of systems at an operations control center. For example, as noted above, the invoices modeled using the retail commodity manager **180** may
10 facilitate profit and loss sheet reporting as well as facilitate a billing system configured to invoice customers for the pass-through costs of certain commodity costs incurred by the pipeline operator. Further still, data from the commodity materials invoice system may be used to optimize the operations of the pipeline. In one embodiment, an optimization process may evaluate the estimated commodity costs to determine a
15 recommended solution to where to obtain commodity products from during a given billing period. For example, the optimization process may be used to select from competing commodity suppliers. As another example, in the case of an ASU at a production facility, if the estimated invoice data indicated that the electricity consumption of the ASU was likely to exceed a contracted amount of electricity from
20 a given supplier, leading to a premium being paid for additional consumption, the optimization process could shift production from that ASU to another, change to another commodity supplier, or otherwise change how the ASU is operating to avoid exceeding the contract amount of electricity.

 Figures **5-7** illustrate examples of user interfaces provided by the retail
25 commodity manager **180**, according to one embodiment of the invention. First, Figure **5** shows an example of the bill designer **232** being used to compose a bill template modeling an invoice from an electric utility. As shown, the interface of the retail commodity manager **180** includes a tree view **500** that allows the user to select between different bill templates (or to create a new template). Illustratively, the user
30 has expanded the tree view **500** to select an electricity supplier labeled “electricity

supplier #1," resulting in sub element of "locations" being displayed. In this case, the user has selected "production facility #1."

Additionally, the retail commodity manager **180** shows the bill designer **232**, along with a line items pane **505**, a bill template preview pane **510**, and a formula entry field **515**. In this example, the bill designer **232** allows the user to specify a name, vendor, account, and type fields, etc., for a particular bill template **244**. The line items pane **505** allows the user to specify each field to include in the billing template **244**. Further, the formula entry field **515** allows a user to specify how an invoice amount should be calculated from one or more of the line item fields. As noted above, the line items specified in the line items pane **505** may correspond to the line items from an actual invoice from a given commodity supplier; in this example, an invoice from "electricity supplier #1" for electricity consumed at the "production facility #1." The bill template preview pane **510** allows a user to specify whether a given line item is included in a display of a given bill template or used as data in calculating one of the included line item fields.

Figure **6** illustrates an example user interface for a commodity invoice rate designer, according to one embodiment of the invention. In particular, Figure **6** shows an example of the rate calculator **236**. As shown, the rate calculator **236** includes a display area **615** displaying a rate calculation **620** composed for a charge type named "off peak demand charge." Additionally, the rate calculator includes a set of rate calculation functions **605**, and time periods **610**, along with buttons used for numeric and arithmetic input. Of course, one of ordinary skill in the art will recognize that the particular assortment of rate calculation functions, and time periods, or other operations that may be specified using the rate calculator **236** may be tailored to suit the needs of a particular case.

Figure **7** illustrates an example user interface for the retail commodity manager **180**, according to one embodiment of the invention. Specifically, Figure **7** shows an example of the bill manager **234** being used to view a bill template modeling an invoice from an electric utility. In this example, the view of the bill manager **234** corresponds to the bill template **244** composed using the interface to

the bill designer **232** shown in Figure 5. Thus, the view of the bill manager **234** includes the name, vendor, account, and type fields specified for the "electricity supplier #1" providing energy to the "production facility #1," along with information specifying a billed amount, an account number, a bill number, etc. Additionally, the
5 view of the bill manager **234** also includes a billing period **725** with a starting and ending date.

As shown, the interface of the retail commodity manager **180** includes a tree view **705** that allows the user to select between different commodity suppliers and locations. For the selected location and commodity supplier, the bill manager **234**
10 includes a set of line items **720**, corresponding to each line item expected to be present in an invoice from the selected commodity supplier. Further, a set of estimated columns **710** is used to show the estimated invoice data **240** for each line item and a set of actualized columns **715** is used to show the actualized invoice data **242** for the selected commodity provider, location, and billing period. Thus, the view
15 of the bill manager **234** allows a user to make a direct side-by-side comparison of the estimated and actualized invoice data.

Advantageously, embodiments of the invention provide techniques for managing aspects of a large industrial operation (such as a pipeline). As disclosed, a commodity materials invoice system allows a user to model a commodity invoice as a
20 template and subsequently use that template to model commodity usage for different periods of time. Costs for a given billing period may be estimated based on actual commodity consumption. For example, data from a SCADA system monitoring different aspects of a pipeline may be used to estimate invoice costs for retail commodity consumption. The commodity materials invoice system may be
25 configured to present both estimated and actualized invoice data side-by-side, allowing users to make a direct comparison of the estimated and actualized invoice data.

It will be understood, however, that many additional changes in the details, materials, steps, and arrangement of parts, which have been herein described and
30 illustrated in order to explain the nature of the invention, may be made by those

skilled in the art within the principle and scope of the invention as expressed in the appended claims. Thus, the present invention is not intended to be limited to the specific embodiments in the examples given above and/or the attached drawings.

WHAT IS CLAIMED IS:

1. A method for managing commodity consumption within an industrial production facility, the method being computer implemented and characterized in that the steps including:

5 receiving a definition of a billing template for each of a plurality of commodity suppliers, wherein each commodity supplier provides a commodity material consumed by the industrial production facility, and wherein the billing templates each specify a set of line-items modeling an invoice received from a respective one of the commodity suppliers;

10 receiving a request to view an invoice, for a specified billing period, for a selected one of the commodity suppliers;

generating a view of the requested invoice, wherein the view includes a first display area for rendering one or more of the set of line items as estimated invoice data and a second display area for rendering one or more of the set of line items as
15 actualized invoice data; and

displaying, in response to the request to view the invoice, the generated view, including the first display area and the second display area.

2. The method of claim 1, further comprising, populating at least one of the set of line items in the first display area with an estimate of commodity consumption for the
20 billing period.

3. The method of claim 2, wherein the estimate of commodity consumption is obtained from a SCADA system configured to monitor commodity consumption within the industrial production facility.

4. The method of claim 2, wherein the estimate of commodity consumption is
25 obtained in response to user input specifying a value for the at least one line item.

5. The method of claim 1, further comprising, populating at least one of the set of line items in the second display area with an actualized value of commodity consumption for the billing period.

6. The method of claim 5, further comprising, storing, with the requested invoice, an electronic copy of an actual invoice received from the selected commodity supplier, for the billing period.

7. The method of claim 1, storing the view of the requested invoice in a
5 database, wherein the database is accessed by at least one of an accounting system, a billing system, and an optimizing system.

8. The method of claim 1, wherein the industrial production facility includes one or more air separation units used to generate product delivered through a pipeline.

9. The method of claim 8, wherein the commodity material is electrical power.

10 10. A non-transitory computer-readable medium containing a retail commodity manager, which when executed on a processor is configured to perform an operation for managing commodity consumption within an industrial production facility according to any one of claims 1 to 9.

11. A system, comprising:

15 a processor; and

a memory storing a retail commodity manager, which when executed on the processor performs an operation for managing commodity consumption within an industrial production facility, the operation comprising:

20 identifying one or more volumetric accumulation splits for a process flow receiving a definition of a billing template for each of a plurality of commodity suppliers, wherein each commodity supplier provides a commodity material consumed by the industrial production facility, and wherein the billing templates each specify a set of line-items modeling an invoice received from a respective one of the commodity suppliers,

25 receiving a request to view an invoice, for a specified billing period, for a selected one of the commodity suppliers,

generating a view of the requested invoice, wherein the view includes a first display area for rendering one or more of the set of line items as

estimated invoice data and a second display area for rendering one or more of the set of line items as actualized invoice data, and

displaying, in response to the request to view the invoice, the generated view, including the first display area and the second display area.

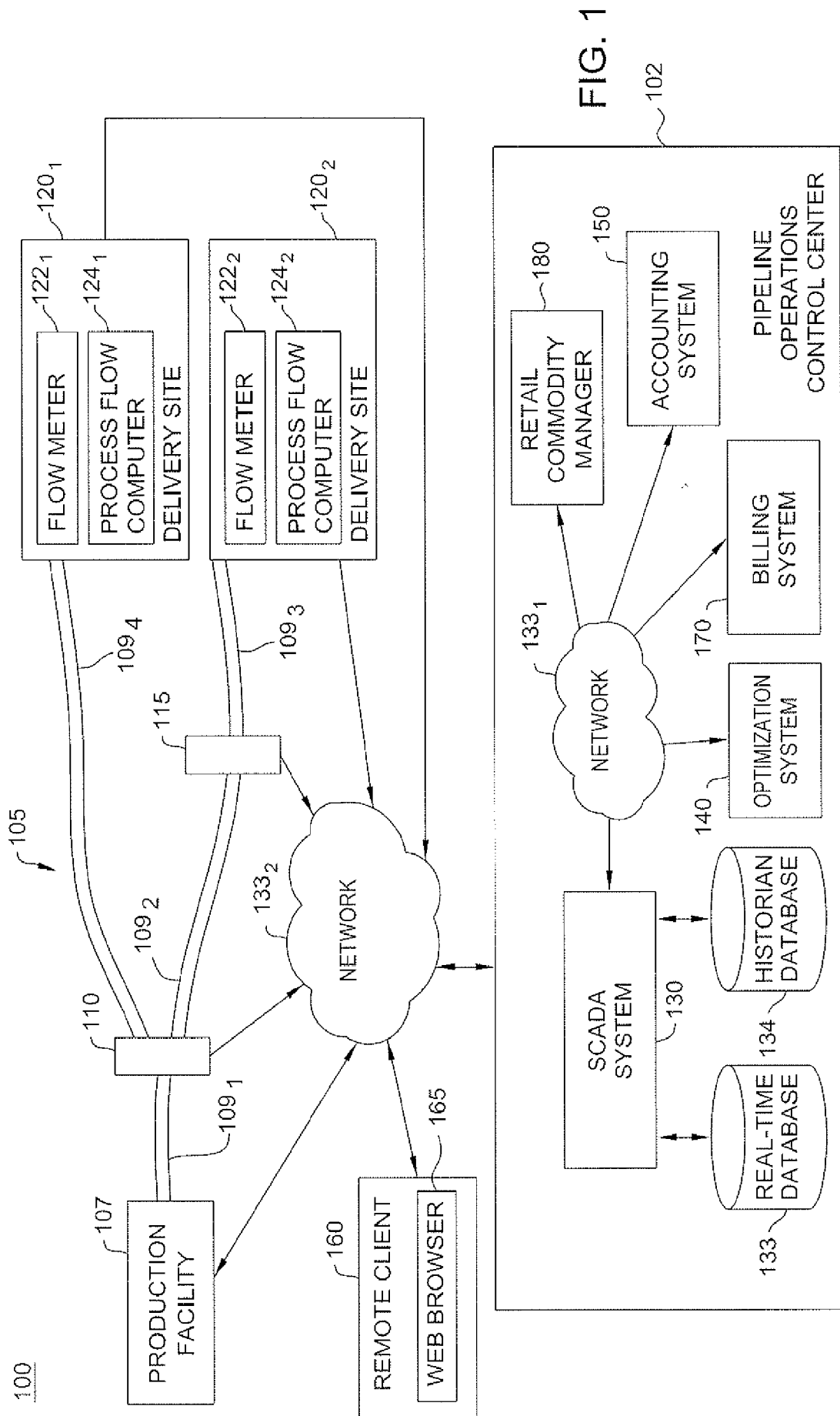
5 12. The system of claim 11, wherein the operation further comprises, populating at least one of the set of line items in the first display area with an estimate of commodity consumption for the billing period.

13. The system of claim 12, wherein the estimate of commodity consumption is obtained from a SCADA system configured to monitor commodity consumption within
10 the industrial production facility.

14. The system of claim 12, wherein the estimate of commodity consumption is obtained in response to user input specifying a value for the at least one line item.

15. The system of claim 11, wherein the operation further comprises, populating at least one of the set of line items in the second display area with an actualized value
15 of commodity consumption for the billing period.

16. The system of claim 15, wherein the operation further comprises, storing, with the requested invoice, an electronic copy of an actual invoice received from the selected commodity supplier, for the billing period.



2/7

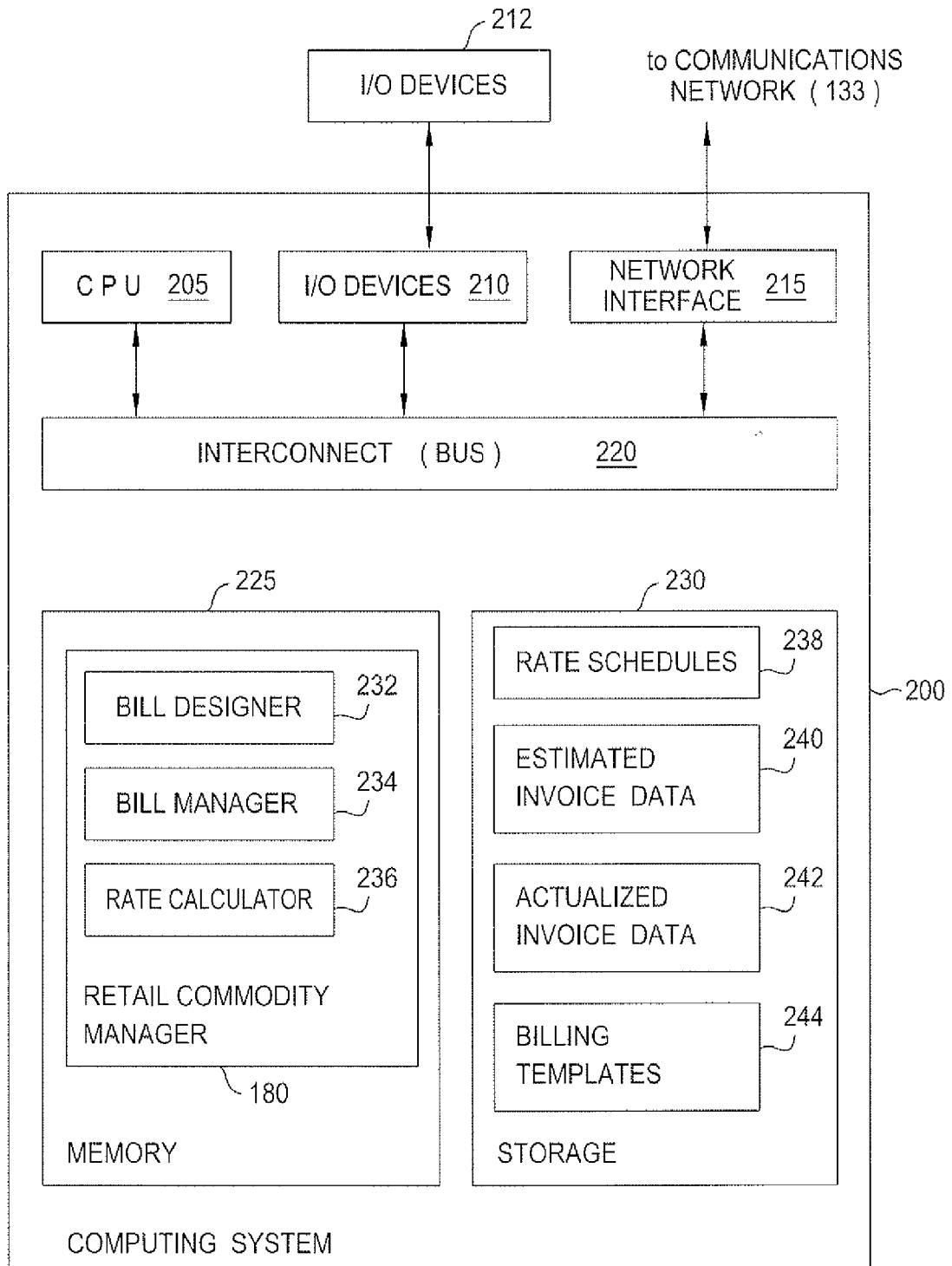


FIG. 2

3/7

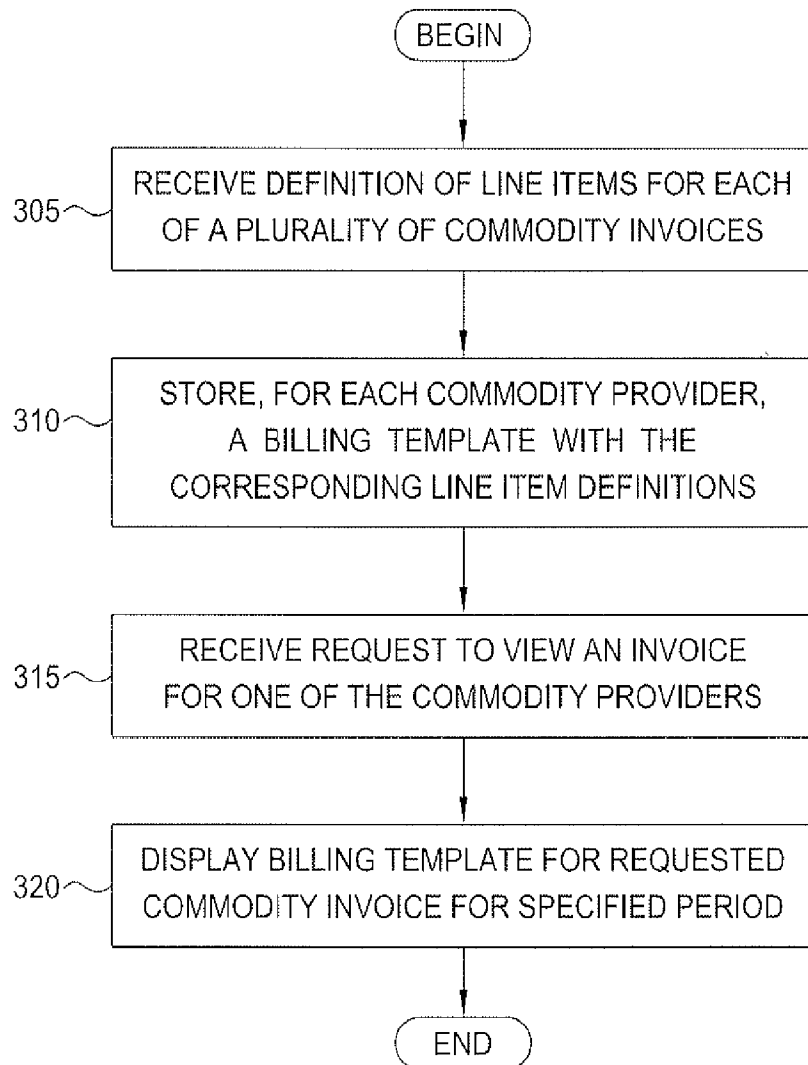
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FIG. 3

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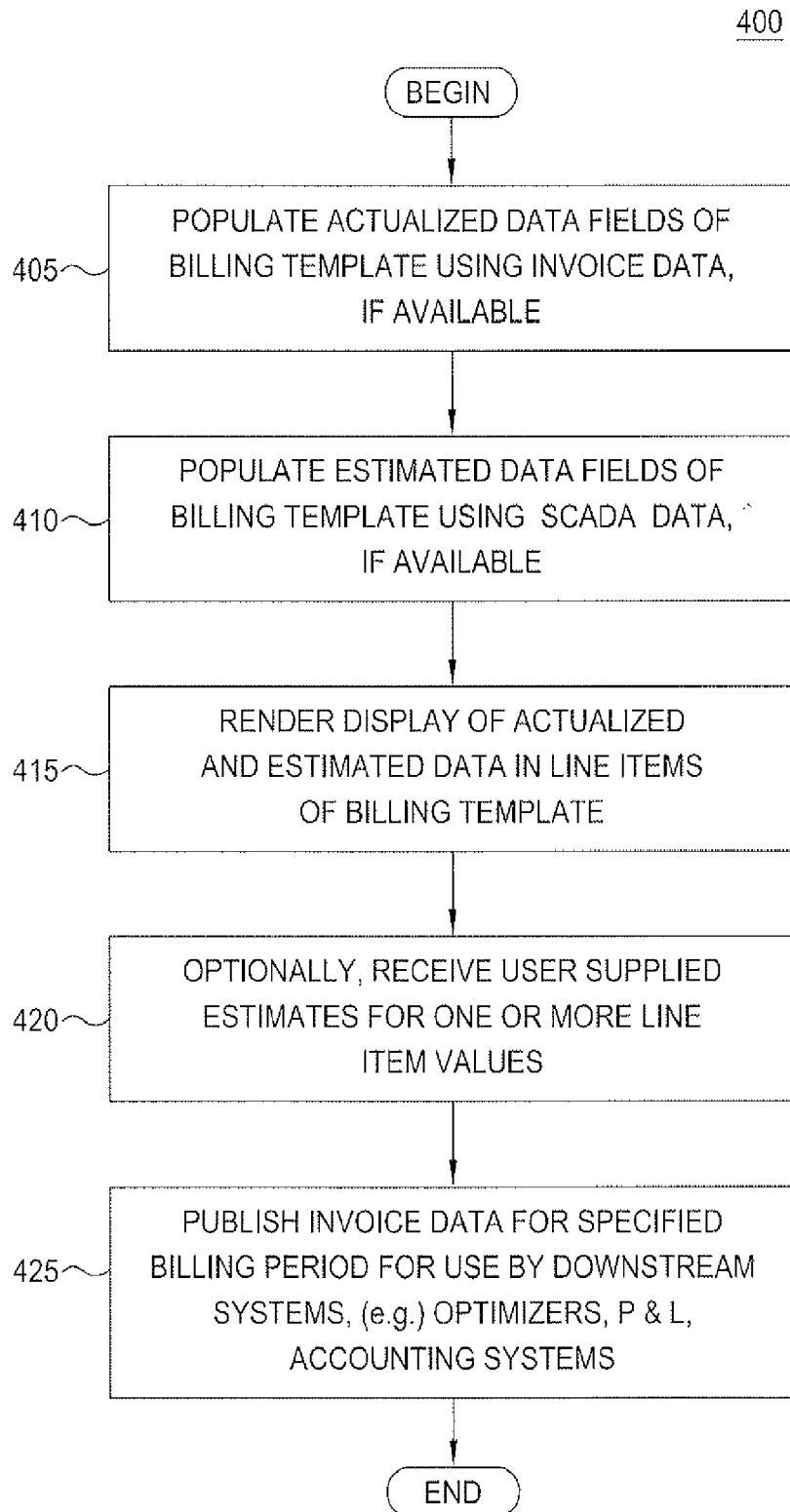


FIG. 4

56E

Bill Designer																																																																																																			
* Template Code:		Electric Supplier #1		Commodity: Power		Account: 03780689703																																																																																													
Vendor:		Electric Supplier #1		Location: Production Facility #1		* Effective: 12/01/2009																																																																																													
232 Vendors + Admin Area - AEP_KY Locations + Electricity Supplier - Production Facility #1 Bill Designer + Steel Supplier - Natural Gas																																																																																																			
Line Items <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Charge #</th> <th>Charge Name</th> <th>Charge Type</th> <th>Unit</th> <th>Rate</th> <th>Formula</th> </tr> </thead> <tbody> <tr><td>1</td><td>Energy Usage</td><td>Energy</td><td>KWH</td><td>0</td><td></td></tr> <tr><td>2</td><td>On Peak Demand</td><td>Demand</td><td>KW</td><td>0</td><td></td></tr> <tr><td>3</td><td>Off Peak Demand</td><td>Demand</td><td>KW</td><td>0</td><td></td></tr> <tr><td>4</td><td>...</td><td>Usage</td><td>103M3</td><td>0</td><td></td></tr> <tr><td>5</td><td>Energy Charge</td><td>Energy</td><td>KWH</td><td>0.02829</td><td>[Energy Usage] * [Rate]</td></tr> <tr><td>6</td><td>On Peak Demand Charge</td><td>Demand</td><td>KW</td><td>9.35</td><td>[Rate] * [On Peak Demand]</td></tr> <tr><td>7</td><td>Off Peak Demand Charge</td><td>Demand</td><td>KW</td><td>0.84</td><td>[Rate] * [Off Peak Demand]</td></tr> <tr><td>8</td><td>Customer Charge</td><td>Charge</td><td>USD</td><td>1,353</td><td>[Rate] * 1</td></tr> </tbody> </table>										Charge #	Charge Name	Charge Type	Unit	Rate	Formula	1	Energy Usage	Energy	KWH	0		2	On Peak Demand	Demand	KW	0		3	Off Peak Demand	Demand	KW	0		4	...	Usage	103M3	0		5	Energy Charge	Energy	KWH	0.02829	[Energy Usage] * [Rate]	6	On Peak Demand Charge	Demand	KW	9.35	[Rate] * [On Peak Demand]	7	Off Peak Demand Charge	Demand	KW	0.84	[Rate] * [Off Peak Demand]	8	Customer Charge	Charge	USD	1,353	[Rate] * 1																																				
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Bill Template Preview 510 <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Include</th> <th>Charge Name</th> <th>Charge Type</th> <th>Cost Type</th> <th>Sort Order</th> <th>Unit</th> <th>Est Value</th> <th>Est Cost</th> <th>Act Cost</th> <th>Billed Cost</th> </tr> </thead> <tbody> <tr><td>☒</td><td>Energy Usage</td><td>Energy</td><td>N</td><td></td><td>1 KWH</td><td>0</td><td>\$0</td><td>\$0</td><td>\$0</td></tr> <tr><td>☒</td><td>On Peak Demand</td><td>Demand</td><td>N</td><td></td><td>2 KW</td><td>0</td><td>\$0</td><td>\$0</td><td>\$0</td></tr> <tr><td>☒</td><td>Off Peak Demand</td><td>Demand</td><td>N</td><td></td><td>3 KW</td><td>0</td><td>\$0</td><td>\$0</td><td>\$0</td></tr> <tr><td>☒</td><td>...</td><td>Usage</td><td>N</td><td></td><td>4 103M3</td><td>0</td><td>\$0</td><td>\$0</td><td>\$0</td></tr> <tr><td>☒</td><td>Energy Charge</td><td>Energy</td><td>Y</td><td></td><td>5 KWH</td><td>0</td><td>\$0</td><td>\$0</td><td>\$0</td></tr> <tr><td>☒</td><td>On Peak Deman...</td><td>Demand</td><td>Y</td><td></td><td>6 KW</td><td>0</td><td>\$0</td><td>\$0</td><td>\$0</td></tr> <tr><td>☒</td><td>Off Peak Deman...</td><td>Demand</td><td>Y</td><td></td><td>7 KW</td><td>0</td><td>\$0</td><td>\$0</td><td>\$0</td></tr> <tr><td>☒</td><td>Customer Charge</td><td>Charge</td><td>Y</td><td></td><td>8 USD</td><td>0</td><td>\$0</td><td>\$0</td><td>\$0</td></tr> </tbody> </table>										Include	Charge Name	Charge Type	Cost Type	Sort Order	Unit	Est Value	Est Cost	Act Cost	Billed Cost	☒	Energy Usage	Energy	N		1 KWH	0	\$0	\$0	\$0	☒	On Peak Demand	Demand	N		2 KW	0	\$0	\$0	\$0	☒	Off Peak Demand	Demand	N		3 KW	0	\$0	\$0	\$0	☒	...	Usage	N		4 103M3	0	\$0	\$0	\$0	☒	Energy Charge	Energy	Y		5 KWH	0	\$0	\$0	\$0	☒	On Peak Deman...	Demand	Y		6 KW	0	\$0	\$0	\$0	☒	Off Peak Deman...	Demand	Y		7 KW	0	\$0	\$0	\$0	☒	Customer Charge	Charge	Y		8 USD	0	\$0	\$0	\$0
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Rate Calculator

Charge Name: Off Peak Demand Charge

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[Rate] * [Off - Peak Demand

620

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610

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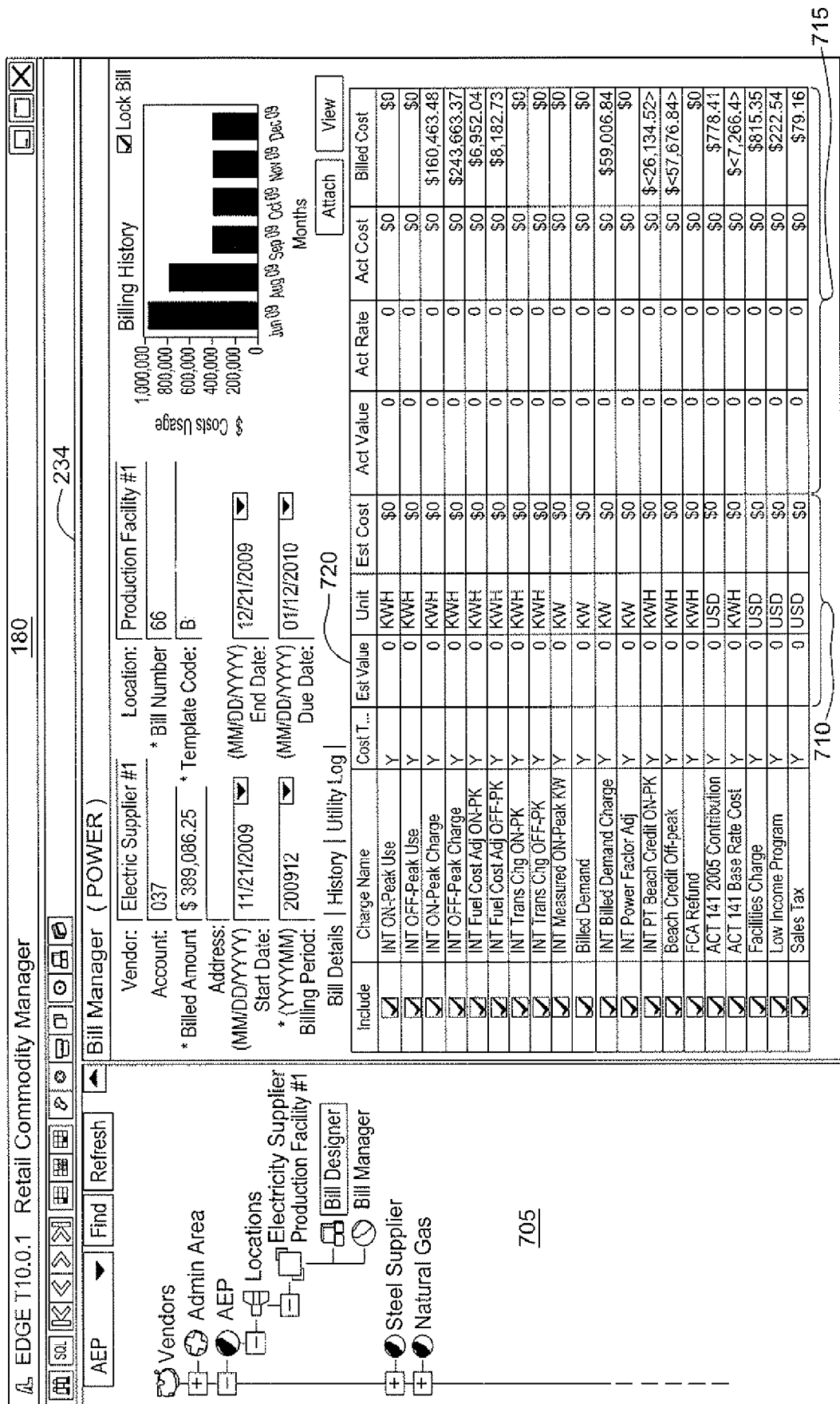
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OK

FIG. 6

FIG. 7



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 11/31547

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - G06Q 40/00 (2011.01)

USPC - 705/40

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)

USPC - 705/40

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC - 705/1.1; 705/301 (keyword limited; terms below)

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

Dialog; GooglePatents; GoogleScholar

commodit, utility, consum, usage, utiliz, cost, generat, materials, control, center, manager, liquid, gaseous, SCADA, supervis, data, acquisition, invoice, billing, bill, period, cycle, pipeline, point, node, estimat, theoretic, approx

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2008/0082215 A1 (MCDOWELL) 03 April 2008 (03.04.2008), Fig. 7B; Para [0025]-[0026], [0028], [0032]-[0035], [0043]-[0044], [0051], [0082], [0084]-[0085], [0090]	1-16
Y	US 2002/0010666 A1 (WRIGHT) 24 January 2002 (24.01.2002), Para [0022], [0028], [0035]-[0037], [0042], [0044]	1-16
A	US 2003/0018490 A1 (MAGERS et al.) 23 January 2003 (23.01.2003)	1-16

☐ Further documents are listed in the continuation of Box C.


* Special categories of cited documents:

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search

23 May 2011 (23.05.2011)

Date of mailing of the international search report

13 JUN 2011

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
P.O. Box 1450, Alexandria, Virginia 22313-1450

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