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(71) Applicant *(for all designated States except US)*: **ACS ENGINEERING TECHNOLOGIES INC.** [CA/CA]; 200, 1144-29th Street NE, Calgary, Alberta T2E 7P1 (CA).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **SARKAR, Sujit, K.** [CA/CA]; Box 27, Site 15, RR 1, DeWinton, Alberta T0L 0X0 (CA). **MITCHELL, David, J.** [CA/CA]; 3103 43rd St. S.W., Calgary, Alberta T3E 3N9 (CA).

(74) Agents: **KINSMAN, L. Anne** et al.; Borden Ladner Gervais LLP, World Exchange Plaza, 100 Queen Street, Suite 1100, Ottawa, Ontario K1P 1J9 (CA).

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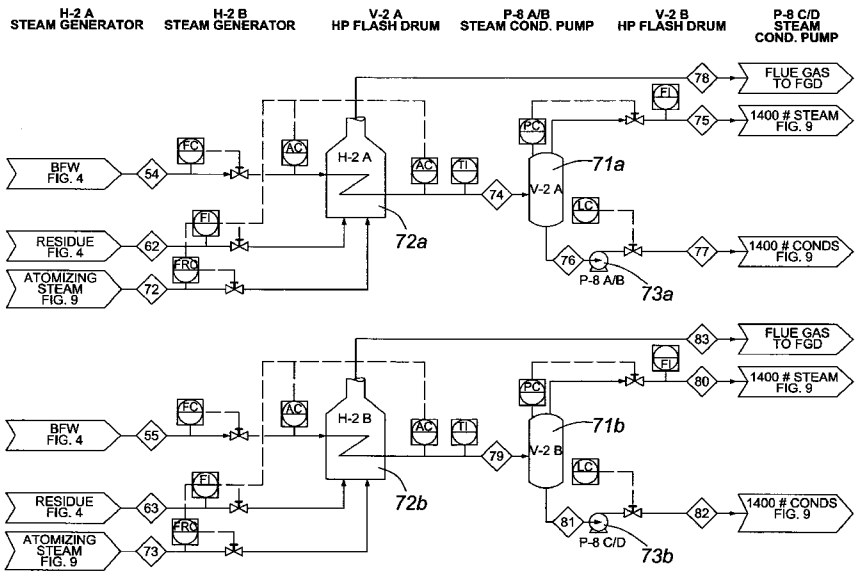

(57) Abstract: The present invention provides for steam generation replacing natural gas with a selected refined product of a feedstock of bitumen, asphaltines or heavy oil using locally produced surplus bitumen, asphaltine or heavy oil, separating the asphaltines and other components of the feedstock for use in providing a liquid fuel for steam generation. The lighter products from the separation equipment not used for liquid fuel may be blended into the produced bitumen, asphaltines or heavy oil, to increase its API gravity and reduce the diluent required for transportation. This technology may be employed in open pit mining operations for the generation of steam and power. The refined components of the feedstock used to provide liquid fuel are selected to optimize energy output balancing planned energy demand against the value of the components of the feedstock used.

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STEAM GENERATION APPARATUS AND METHOD

FIELD OF THE INVENTION

The present invention relates to a steam generator and in particular to a steam generation apparatus and method replacing natural gas as fuel with a selected portion of bitumen, asphaltines or heavy oil optimized for desired energy or steam production.

BACKGROUND OF THE INVENTION

Steam is often used in industrial processes. For example, steam can be used for heat exchange, as a power source for driving turbines, etc.

In the petroleum industry, for example, a particular application is for the generation of steam for the recovery of bitumen or heavy oil. A common process utilized for the in situ recovery of heavy oil or bitumen is to inject steam underground pursuant to which the viscosity of bitumen or heavy oil is decreased such that it flows and is capable of being pumped to the surface. For this, steam generation apparatus commonly called steam injection boilers ("SIB") are used to generate steam of the required/desired quality or quantities. These boilers are typically fired with natural gas (which is piped to the boiler) in order to heat water to generate the desired steam.

The current art typically uses natural gas as the fuel to fire most oilfield steam generation boilers. For in situ recovery of bitumen or heavy oil, prominent processes utilized are steam assisted gravity drainage ("SAGD") and cyclic steam stimulation ("CSS"). The SAGD process is presently the most commonly used process for recent and new projects due to its enhanced efficacy in the recovery of bitumen or heavy oil. Generally, 80% quality steam is required/desired to be generated by the boiler in specified volumes per hour depending on output capabilities of the boiler, as well as steam output requirements for the recovery and extraction process. Exceeding 80% quality renders a project uneconomical, largely due to water treatment costs. Conversely, lower than 80% quality steam introduces inefficiencies to the process utilized for heavy oil or bitumen recovery and, hence, is also undesirable from a cost-effectiveness perspective. Typically the quality of the steam will degrade as heat exchange surfaces foul over the run time of the equipment.

Typical problems generally encountered under conventional steam generation boilers include (but are not limited to):

(a) failure to maintain 80% quality steam (or such other quality of steam as required or desired) at the outlet of the boiler - often lower quality steam is generated; and

(b) cost of fuel, typically natural gas, to fire the boilers used for steam generation (plus the cost of associated pipeline construction and maintenance to bring the natural gas or other fuel to the boiler).

In addition, problems typical for pipeline transport of produced bitumen include that the availability and handling of diluent increases the overall cost of transporting the bitumen to upgrading facilities, pipelines are required to return diluent to the production facility, and electrical power required at the production facility and pipeline facilities often requires expensive transmission lines from the power host or supplier.

It has been proposed previously to convert to other fuels so that propane or light fuel oils could be utilized to fire the boilers instead of natural gas. However, as with natural gas, a source for the propane or light fuel oils would need to be located nearby in order to be piped to the boiler, thus increasing costs. Moreover, the heat input to the boiler will change due to the difference in the energy density of the new fuels, resulting in a drop in the steam quality and/or the production of less steam and, in turn, less heavy oil or bitumen being produced. Liquid fuels will create a longer flame, in other words, of different shape than that for which the combustion chamber was designed and built to accommodate. As such, existing boilers will have to be derated such that existing fire boxes can be utilized to accommodate the differently shaped flame when liquid fuel is used.

Moreover, an alternative processes which utilize solvents instead of steam to reduce the viscosity of heavy oil or bitumen is presently being employed for the recovery and extraction of heavy oil and bitumen. However, while possessing the advantage that it does not require natural gas for firing the boiler or for that matter the boiler (and related ancillary equipment) or the water which is heated to create steam, still must overcome a significant cost disadvantage relative to the SAGD and CSS processes for recovering and extracting heavy oil or bitumen.

Canadian patent application No. 2,149,617, published August 21, 2004, teaches a method for enabling the use of a "heavy oil residuum" by converting it to a useful product. The method involves the use of a heavy oil residuum which is substantially non

flowable. The viscosity of the residuum is reduced by the application of heat and use a diluent. This method appears to suggest the use of that a diluent to reduce viscosity of the residuum, and the making of an emulsion with the heavier residuum, and subsequently with water, and then burning the resultant product to produce energy as heat. The burning of the residuum emulsion result in a net energy contribution from the residuum's combustion.

United States Publication no. US 2005/0218037 published October 6, 2005, teaches a system for heating multiphase residues containing water, oil and solids to obtain hydrocarbons and other useful products. This system comprises a tubular reactor provided with a fixed pitch screw conveyor where the multiphase residue is heated under reduced pressure and in the presence of an inert gas, the heating being carried out in distinct temperature zones with a first zone of evaporation of free and emulsified water and extraction of light hydrocarbons, a second zone of thermal de-sorption and a third zone of mild pyrolysis, the various hydrocarbon fractions being collected in condensers at the relevant stages, while the solids are separated for post-treatment and industrial use.

SUMMARY OF THE INVENTION

The present invention provides a steam generation apparatus for replacing natural gas as the fuel for firing a boiler with a liquid fuel comprised at least in part by bitumen, asphaltines or heavy oil that may be locally produced, while maintaining the net undesirable emissions arising from the combustion of heavy oil or bitumen to a level which are within current environmental guidelines and legislation, and constantly and consistently producing 80% quality steam or such other quality of steam as may be required or desired. The liquid fuel includes a variable and energy/cost optimized component of bitumen, asphaltines or heavy oil, which may be locally produced.

The present invention provides a steam generation apparatus which uses bitumen or heavy oil produced from the field in order to separate heavier ends of the produced hydrocarbons for use as fuel. The lighter products from the included separation equipment are blended into the produced bitumen, thus also increasing the API gravity of the mixed material and reducing the amount of diluent required for pipeline transportation. The technology may be employed by existing open pit mining operations for the generation of steam and power by burning asphaltines or bitumen components rather than natural gas.

In accordance with a broad aspect of the present invention, there is provided a steam generation apparatus replacing natural gas as fuel with a liquid fuel from a component of a feedstock, the feedstock being bitumen, asphaltine or heavy oil, comprising a refinery for separating products from the feedstock, some of the products to be used to provide the liquid fuel; a steam generation subsystem fueled at least in part by the liquid fuel; a product tank system for storing the products from the refinery with a delivery system to deliver selected components of the products to parts of the apparatus, particularly those of the products used to provide the liquid fuel.

In accordance with another broad aspect of the present invention, there is provided a steam generation apparatus where the refinery is provided with the ability to separate and produce several different products such as produced gas vapour, condensates, gas oil or vacuum gas oil draws depending upon the makeup of the feedstock, with the bottom product of the tower being an asphaltine, where, in a preferred embodiment, the modulation of the energy output is done by adjustment of the refinery's output of asphaltene or other product to adjust the amount and nature of the liquid fuel provided by the asphaltene or other product.

In accordance with another broad aspect of the present invention, a method of generating energy in the form of steam is provided using liquid fuel from a component of a feedstock, the feedstock being bitumen, asphaltine, or heavy oil, comprising the steps of in a refinery, separating products from the feedstock, some of the products to be used to provide the liquid fuel, in a steam generation subsystem, burning the liquid fuel, through a product tank system for storing the products from the refinery using a delivery system to deliver selected components of the products to parts of the apparatus, particularly those of the products used to provide the liquid fuel to fire the steam generation operation, and in a preferred embodiment, where the refinery is provided with the ability to separate and produce several different products such as produced gas vapour, condensates, gas oil or vacuum gas oil draws depending upon the makeup of the feedstock, with the bottom product of the tower being an asphaltine, and in a nother embodiment, where the modulation of the energy output is done by adjustment of the refinery's output of asphaltene or other product to adjust the amount and nature of the liquid fuel provided by the asphaltene or other product.

In accordance with another aspect of the present invention, lighter portions of the products of the refinery are added to produced bitumen, asphaltines or heavy oil as diluent for reducing the produced material's viscosity in order to facilitate a reduction in the amount of extraneously provided diluent required to meet pipeline specifications for transport, and which in another embodiment also provides for the use of generated power (whether heat in steam or electrical power generated from produced steam or otherwise) to provide heat to surface equipment to increase efficiencies in cold ambient temperatures or which also provides for the use of power (whether heat in steam or electrical) to elevate pipeline temperatures to reduce diluent requirements in dilbit by reducing viscosity with temperature increase of pipeline (and included dilbit).

BRIEF DESCRIPTION OF THE DRAWINGS

A further, detailed, description of the invention, briefly described above, will follow by reference to the following drawings of specific embodiments of the invention. These drawings depict only typical embodiments of the invention and are therefore exemplary and descriptive but are not to be considered limiting of its scope. In the drawings:

FIG. 1 is a partial schematic showing a feed drum and pumps of the present invention.

FIG. 2 is a partial schematic showing heat exchangers and an alternate application of the heater described in the prior art.

FIG. 3 is a partial schematic showing a vacuum tower and pumps of the present invention.

FIG. 4 is a partial schematic showing the blending and storage tanks of the present invention.

FIG. 5 is a partial schematic showing an off-gas compressor system within the present invention.

FIG. 6 is a partial schematic showing the Bitumen Firing Unit steam generator of the prior art, and flash drums of the system, configured for use in accordance with the present invention.

FIG. 7 is a partial schematic showing a Bitumen Firing Unit steam generator and flash drums configured for use within the present invention.

FIG. 8 is a partial schematic showing the Bitumen Firing Unit steam generator and flash drums configured for use within the present invention.

FIG. 9 is a partial schematic showing the low pressure steam flash drum of the present invention.

FIG. 10 is a partial schematic showing the power generation system of the present invention.

FIG. 11 is a partial schematic showing the flare system of the present invention.

FIG 12 is a list of symbology showing miscellaneous and instrument symbols and descriptions.

FIG 13 is a list of symbology evidencing equipment symbols.

DETAILED DESCRIPTION OF THE INVENTION

The present invention generally comprises bitumen feed surge vessel, heat exchanger system, a heater, a vacuum tower, an off-gas compressor, product tankage, and flow control system, a steam generation system, a power generation system, and a flare system.

It is to be understood that the description following is an embodiment of the present invention, is descriptive and exemplary but no limiting, and that there are substitutions and replacements of certain process equipment or process steps which will be apparent to those skilled in the art, and which are claimed as part of this invention.

Bitumen Feed Surge Drum

Referring to FIG. 1, in this embodiment bitumen is dewatered utilizing standard SAGD equipment prior to entering through a feed surge drum 10 through supply line 1. The feed surge drum 10 has an internal baffle (not shown) and a boot for water separation. The boot on the drum 10 will be controlled with an interface level control. The drum 10 is purged with nitrogen 11 for pressure control on the drum 10. The drum 10 ideally does not produce significant amounts of hydrocarbon vapour off the drum 10 because of the low operating temperature. Any small amount of hydrocarbon vapours is safely disposed of in the closed flare system through valve 12. The drum 10 also provides the ability to automatically bypass produced bitumen from the drum 10 to bitumen blend tanks 61 or 62 through line 6 as shown in FIG. 4. A bitumen feed pump 13 provide the pressure to deliver the bitumen to two locations. The primary feed line 4 will be flow controlled through the feed heat exchangers 21, 22, 23, 24 and through a

heater 30 (asphaltine fired) and into a vacuum tower 40. The flow rate of the bitumen into the exchanger train is set by matching the firing requirements of the heaters with the asphaltine production from the bottom of tower 40. The level in the Residual Storage tank 64 will automatically reset the flow into the exchanger train to maintain the balance. The secondary line 6 will bypass the vacuum tower 40 for blending with the vacuum gas oils and then sent to the bitumen blend tanks 61 and 62.

Feed Heat Exchange Train

Referring to FIG. 1 and 2, in this embodiment, the bitumen enters a heat exchanger system 20 essentially dry. The heat exchanger system 20 consists of four series. First exchanger 21 in the series will be used as a pre-condenser for the Vacuum column overheads.

Second exchanger 22 in the series preheats the bitumen against the gas oil product. Third exchanger 23 in the system is a cross between the vacuum gas oil and the bitumen. Fourth exchanger 24 in the series is a cross between the asphaltines and the bitumen. The heat exchanger train takes advantage of the available heat in the system in order to minimize the energy requirements of the BFU heater 30.

BFU Heater

Referring to FIG. 2 and 3, a BFU heater 30 has been completely described in US Patent No. 6,990,930. In this embodiment, the BFU heater 30 has been adopted for use within a vacuum column system. The temperature of the bitumen entering a vacuum tower 40 is controlled on the outlet of the BFU heater 30. The temperature of the bitumen may be controlled by adjusting the flow rate of the asphaltines entering the burners. The atomizing steam flow rate is flow controlled based on a fixed ratio with the asphaltine flow. Hydrocarbon gas produced from the vacuum tower 40 may also be burned in the BFU heater 30. The BFU heater 30 can have other services in addition to heating the bitumen. A first service is to superheat low pressure atomizing steam, a second service is to superheat high-pressure steam for power generation, and a third service is to share duty with the OTSG (Once Through Steam Generators) for higher steam quality. The merits of providing or using these various services would be determined based on individual project requirements.

Vacuum Tower

Referring to FIG. 3 and 4, in this embodiment, a refining step is taken using a vacuum tower 40, which is primarily used to separate the asphaltines from the balance of the gas oils and fuel gas contained in the bitumen feed. Stripping steam is used to enhance separation efficiency. The steam is controlled at a desired flow rate. The ratio of steam to bitumen is typical for refinery vacuum tower 40 applications.

There are typically a number of products that are removed from the vacuum tower 40 during and resulting from its processing of the bitumen feedstock. Asphaltines are removed from the bottom of the vacuum tower 40. Vacuum gas oil (VGO) and gas oil (GO) are removed from middle of the vacuum tower 40. Condensate is removed as a liquid product from a reflux drum 44. These three products are cooled though heat exchangers 22, 23 and 24 against the incoming bitumen, combined and pumped by pumps 41, 42 and 43 to the bitumen blend the tanks 61, 62. Vacuum tower bottoms are pumped into the Resid Storage Tank 64. The product temperature of the gas oil and vacuum gas oil may be controlled with a bypass. This will maintain a constant or desired velocity on the bitumen side of the heat exchangers 22, 23 and 24 for fouling control and prevention considerations.

The vacuum tower 40 overheads are pre-cooled against the bitumen through exchanger 21 on line 8 and then further condensed in an overhead condenser 45. The vacuum tower overhead temperature is controlled with a hot gas bypass around the overhead condenser 45. The internal pressure in the column is controlled with a back pressure control into the suction of the off gas compressor 51 shown in FIG. 5 though line 7b.

The two phase overhead product is separated in the overhead reflux drum 44. The vacuum tower reflux pump 46 returns the reflux back to the top of the vacuum tower 40 under flow control. The condensate product is removed from the overhead reflux drum 44 under level control, blended with the VGO and GO and pumped to tanks 61 and 62 through line 7a.

Water is separated in the boot of the overhead reflux drum 44 and is sent through line 7 c to the unit battery limit for treatment in offsite facilities. The level in the boot is controlled with an interface level control (not shown). The requirement for a water pump will be determined as required for a specific project needs.

The vapour product off the reflux drum 44 is compressed in down stream equipment and then used as fuel gas for the heater 30 and flare header sweep gas.

Asphaltines are removed from the bottom of the vacuum tower 40 and are pumped by pump 43 into a product tank 64 for storage through line 8. The temperature of asphaltines entering the product tank 64 will be controlled by bypassing a portion of the BFW (Boiler Feed Water) around the heat exchanger 25. This will allow a relatively constant continuous flow of asphaltine through the exchanger 25 such that minimum velocity can be maintained for control and prevention of fouling considerations.

Off Gas Compressor

Referring to FIG. 5, the off gas compressor 51 has two main functions: one is as a vacuum source for the vacuum tower 40; and the other is to increase the discharge pressure of the fuel gas to acceptable levels.

An off gas cooler 52 and off gas knock out drum 53 are included in this embodiment. The Knock out drum 53 will typically be a two phase separator. The compressed fuel gas will be used as fuel in the heater 30 though line 31 and flare header sweep gas though line 107. The condensed hydrocarbons will be blended with the condensate from the reflux drum 44 and used to increase the API of the blended bitumen.

Product Tanks

Four 40,000 bbl product tanks 61, 62, 63 and 64 typically are specified for a facility. In this embodiment, tanks 61 and 62 will be used as day tanks for the blending of gas oil, vacuum gas oil, condensate, diluent and bitumen. The blending will occur on-line and agitators have been included in the tanks 61, 62 to ensure uniformity of the dilbit. Additional storage space within the tank has been provided for quality control prior to transferring the dilbit into the pipeline. The tanks 61 and 62 can be used as emergency storage for produced bitumen. The tank 63 is a floating roof tank for diluent storage. The asphaltine fuel system will be designed with a continuously circulating system to ensure that the lines remain flowing.

Steam Generation Equipment

Referring to FIG. 6 through FIG. 9, desired steam generation 70 is the result of a balance between asphaltine production from the bottom of vacuum tower 40 and over-all system demand for steam production, for example: formation stimulation, power generation or process use, more typically a mixed set of those uses. The flow rate of

bitumen into the vacuum tower 40 is set to maintain that balance. Fluctuations in the energy balance can be accommodated by the surge time in the storage tank 64.

For example, boiler feed water of appropriate quality for 1600 psig steam will typically be available from offsite facilities. A boiler feed water pump 17 has been included to increase the pressure of the boiler feed water appropriate to the required steam pressure. The boiler feed water flowed though line 1 to the heat exchanger 24 will be preheated against the vacuum tower asphaltines.

Steam is generated using a combination of once-through steam generator and separately fired coils within the heater 72a-72f. The once-through steam generator and the heater coils will be fired with asphaltines and/or fuel gas. Based on project requirements, the fired equipment may be designed for multiple fuel applications, i.e. asphaltines, bitumen or natural gas. This flexibility may be required for start-up purposes if there is no source of stored heavy fuel or if energy demands fluctuate or costs are such that the energy capable of being provided by asphaltines alone is sub-optimal. The combination of once-through steam generator and the heater 30 will produce steam consistently at 80% quality without up-grading typical water treatment facilities.

Flash drums 71a-71f are shown here for each of the steam generators 72a-72f. The condensate that is recovered from the high pressure flash drums 71a-71f is pumped by pumps 73a-73f back to the inlet of the once-through steam generator and heater 72a-72f.

High pressure condensate is also let down to 150 psig as a source for generating low pressure steam. A flash drum 64 has been provided as the knock-out drum for generating the 150 psig steam. Condensate from the flash drum 64 is used as the continuous blow down for the steam system. This condensate is sent to the unit battery limit for disposal offsite. The 150 psig steam is flow controlled into the vacuum tower 40 for stripping steam. The low pressure steam is also superheated in the heater and used for atomizing steam.

Power Generation Equipment

Referring to FIG. 10, power generation equipment 80 has been provided to power all the electrical needs for the equipment described. Additional power generation can be accommodated based on desired energy outputs. Adjustments can be made to the design of the vacuum tower 40 such that additional asphaltines can be separated from the

bitumen and used in the production of steam. This adjustment to the heat and refining balance can have at least some of the following material benefits: First, a SAGD facility can become an island with no incoming transmission lines; and Second, a SAGD facility could be a net exporter of power depending upon the ability to sell or use the excess power; and last, additional condensate, gas oil and vacuum gas oil is produced and can be used as diluent components to further reduce bitumen viscosity bringing a further net reduction in diluent and diluent support requirements and associated costs and facility complexity.

For example, dry, high pressure steam is superheated in a separate coil in the heater 30. The high pressure superheated steam is then used in a condensing steam turbine generator 81 though line 2 to generate the necessary power. It is also possible that an extraction turbine could be specified as an alternative to generating the lower pressure steam. The condensate from the steam turbine generator is further cooled in a surface condenser and vapours removed in a downstream atmospheric flash drum 83. The lower pressure condensate is pumped back to the boiler feed water feed pump 17 and used as blow down from the steam system.

Flare

Referring to FIG. 11, vessels in hydrocarbon service will be protected from overpressure with a closed flare system 90. The Flare system 90 will be designed based on API RP 521. The flare system in a preferred embodiment will include the flare distribution system, a knock out drum 91, a knock out drum pumps 92 and a flare stack 93. Liquids collected in the knock out drum can be returned to the feed surge drum.

In the preceding description, for purposes of explanation, numerous details are set forth in order to provide a thorough understanding of the embodiments of the invention. However, it will be apparent to one skilled in the art that these specific details are not required in order to practice the invention.

The above-described embodiments of the invention are intended to be examples only. Alterations, modifications and variations can be effected to the particular embodiments by those of skill in the art without departing from the scope of the invention, which is defined solely by the claims appended hereto.

CLAIMS:

1. A steam generation apparatus replacing natural gas as fuel with a liquid fuel from a component of a feedstock, the feedstock being bitumen, asphaltine or heavy oil, comprising:

   (a) refinery for separating products from the feedstock, some of the products to be used to provide the liquid fuel;

   (b) a steam generation subsystem fueled at least in part by the liquid fuel;

   (c) a product tank system for storing the products from the refinery with a delivery system to deliver selected components of the products to parts of the apparatus, particularly those of the products used to provide the liquid fuel.

2. The steam generation apparatus of claim 1 where the refinery is a vacuum tower and associated equipment.

3. The steam generation apparatus of claim 1 where the refinery is an independently licensed asphaltine solvent extraction process.

4. The apparatus of claim 1 where the refinery is provided with the ability to separate and produce several different products such as produced gas vapour, condensates, gas oil or vacuum gas oil draws depending upon the makeup of the feedstock, with the bottom product of the tower being an asphaltine.

5. The apparatus of claim 1 where the component of the feedstock used to provide the liquid fuel is chosen, tailored by selection of the amount of product of each type of product separated from the feedstock.

6. The apparatus of claim 5 where the component so chosen to provide the liquid fuel is chosen with reference to optimizing energy output from the steam generation apparatus balancing energy demand against the value of the product included in the component.

7. The apparatus of claim 4 where some separated products remaining after providing the liquid fuel are added to produced bitumen, asphaltines or heavy oil as diluent, for reducing the produced material's viscosity in order to facilitate a reduction in the amount of extraneously provided diluent required to meet pipeline specifications for transport.

8. A method of generating energy in the form of steam using liquid fuel from a component of a feedstock, the feedstock being bitumen, asphaltine, or heavy oil, comprising the steps of:

(a) in a refinery, separating products from the feedstock, some of the products to be used to provide the liquid fuel;

(b) in a steam generation subsystem, burning the liquid fuel;

(c) through a product tank system for storing the products from the refinery using a delivery system to deliver selected components of the products to parts of the apparatus, particularly those of the products used to provide the liquid fuel to fire the steam generation operation.

9. The method of claim 8 where the refinery is a vacuum tower and associated equipment.

10. The method of claim 8 where the refinery uses an independently licensed asphaltine solvent extraction process.

11. The method of claim 8 where the refinery provides the separation and production of several different products such as produced gas vapour, condensates, gas oil or vacuum gas oil draws depending upon the makeup of the feedstock, with the bottom product of the tower being an asphaltine

12. The method of claim 8 where the component of the feedstock used to provide the liquid fuel is chosen, tailored by selection of the amount of product of each type separated from the feedstock.

13. The method of claim 12 where the component so chosen is selected to optimize energy output from the steam generation apparatus and its associated equipment balancing energy demand against the value of the product included in the component.

14. The method of claim 8 where lighter portions of the products of the refinery are added to produced bitumen, asphaltines or heavy oil as diluent for reducing the produced material's viscosity in order to facilitate a reduction in the amount of extraneously provided diluent required to meet pipeline specifications for transport.

15. The method of claim 8 which also provides for the use of generated power (whether heat in steam or electrical power generated from produced steam or otherwise) to provide heat to surface equipment to increase efficiencies in cold ambient temperatures.

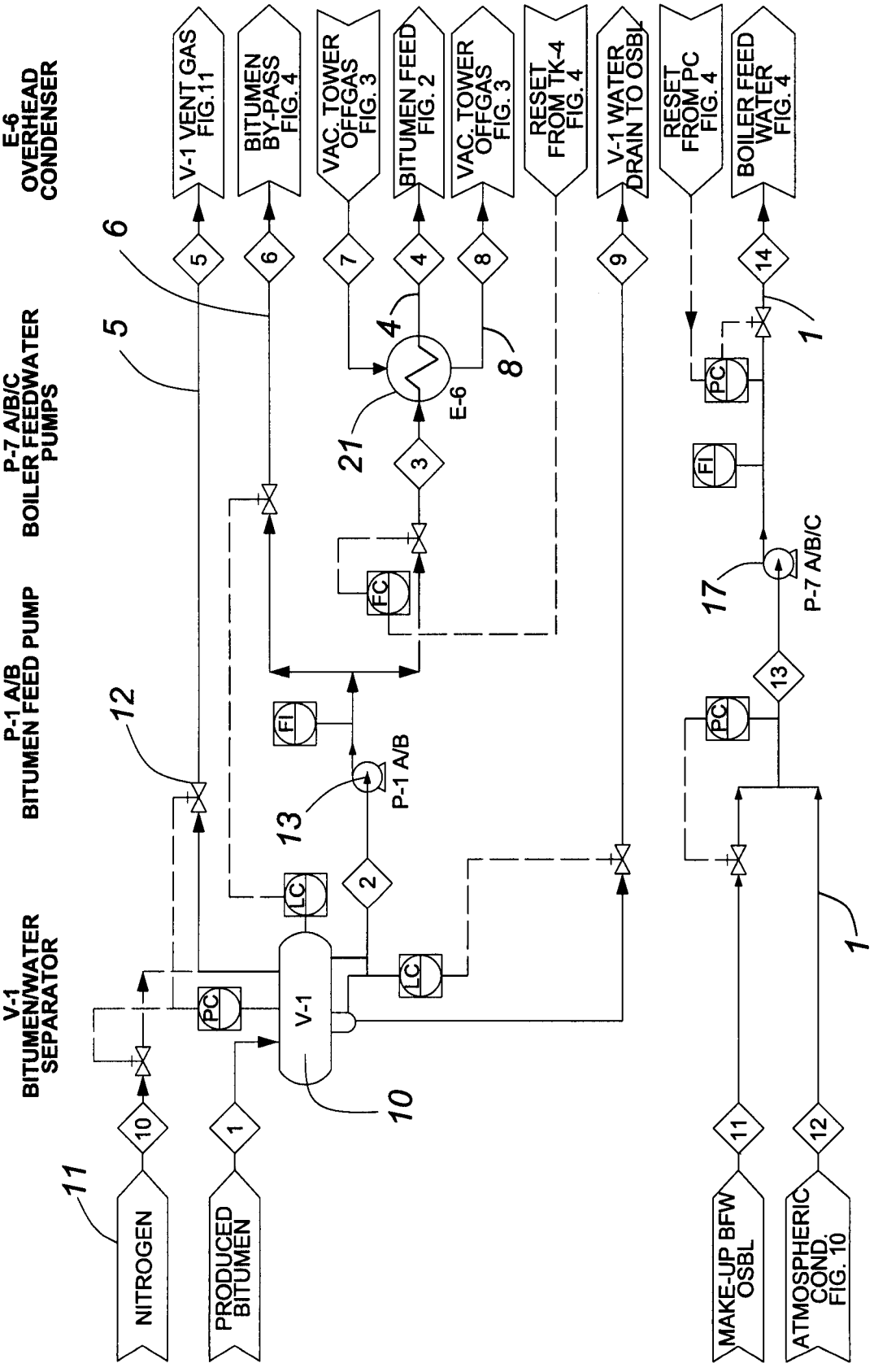
16. The method of claim 8 which also provides for the use of power (whether heat in steam or electrical) to elevate pipeline temperatures to reduce diluent requirements in dilbit by reducing viscosity with temperature increase of pipeline (and included dilbit).

17. The apparatus of claim 1 which also provides for the delivery of generated power (whether heat in steam or electrical power generated from produced steam or otherwise) to equipment to provide heat to surface equipment to increase efficiencies in cold ambient temperatures.

18. The apparatus of claim 1 which also provides for the delivery of power (whether heat in steam or electrical) to equipment to elevate pipeline temperatures to reduce diluent requirements in dilbit by reducing viscosity with temperature increase of pipeline (and included dilbit).

19. The apparatus of claim 1 where the modulation of the energy output is done by adjustment of the refinery's output of asphaltene or other product to adjust the amount and nature of the liquid fuel provided by the asphaltene or other product.

20. The method of claim 8 where the modulation of the energy output is done by adjustment of the refinery's output of asphaltene or other product to adjustment the amount and nature of the liquid fuel provided by the asphaltine or other product.


V-1 BITUMEN/WATER SEPARATOR
P-1 A/B BITUMEN FEED PUMP
P-7 A/B/C BOILER FEEDWATER PUMPS
E-6 OVERHEAD CONDENSER
V-1 VENT GAS FIG.11
BITUMEN BY-PASS FIG. 4
VAC. TOWER OFFGAS FIG. 3
BITUMEN FEED FIG. 2
VAC. TOWER OFFGAS FIG. 3
RESET FROM TK-4 FIG. 4
V-1 WATER DRAIN TO OSBL
RESET FROM PC FIG. 4
BOILER FEED WATER FIG. 4
NITROGEN
PRODUCED BITUMEN
MAKE-UP BFW OSBL
ATMOSPHERIC COND. FIG. 10
V-1
P-1 A/B
P-7 A/B/C
E-6
PC
LC
FC
FI
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21

FIG. 1

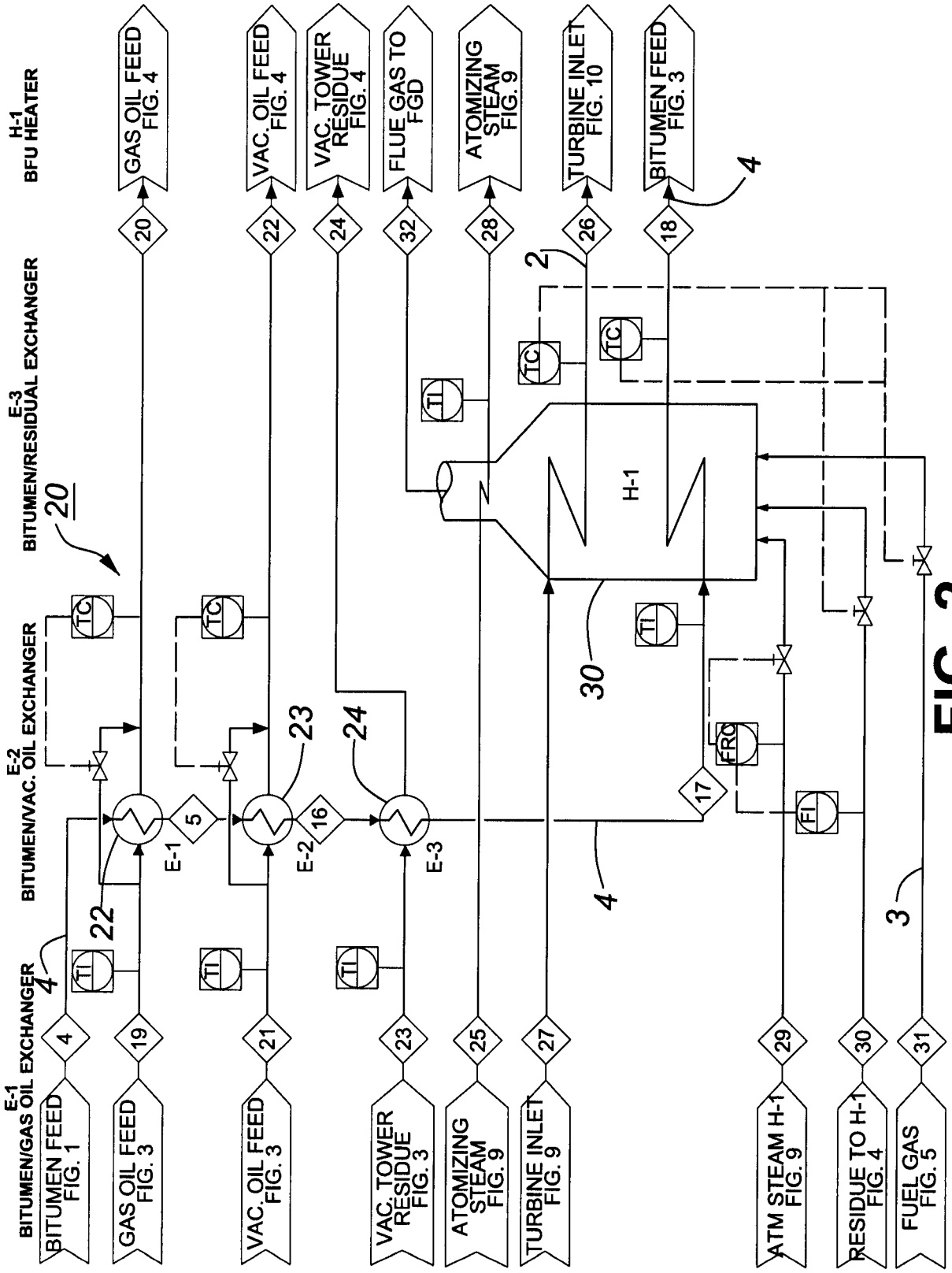
BITUMEN/GAS OIL EXCHANGER E-1
BITUMEN/VAC. OIL EXCHANGER E-2
BITUMEN/RESIDUAL EXCHANGER E-3
H-1 BFU HEATER
BITUMEN FEED FIG. 1
GAS OIL FEED FIG. 3
VAC. OIL FEED FIG. 3
VAC. TOWER RESIDUE FIG. 3
ATOMIZING STEAM FIG. 9
TURBINE INLET FIG. 9
ATM STEAM H-1 FIG. 9
RESIDUE TO H-1 FIG. 4
FUEL GAS FIG. 5
GAS OIL FEED FIG. 4
VAC. OIL FEED FIG. 4
VAC. TOWER RESIDUE FIG. 4
FLUE GAS TO FGD
ATOMIZING STEAM FIG. 9
TURBINE INLET FIG. 10
BITUMEN FEED FIG. 3
20
22
23
24
30
4
2
3
TI
TC
FRC
FI
H-1
E-1
E-2
E-3

FIG. 2

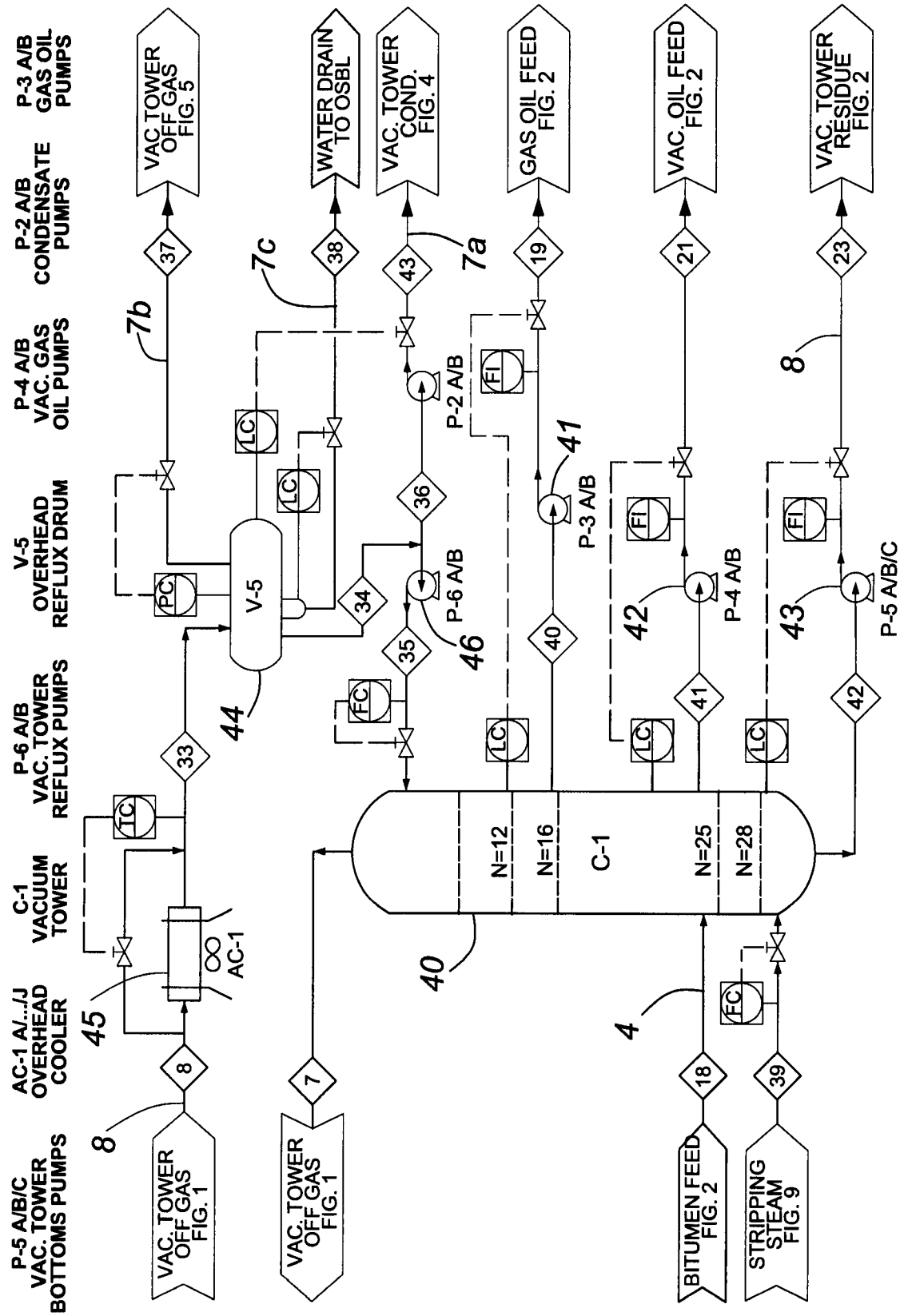
P-5 A/B/C VAC. TOWER BOTTOMS PUMPS
AC-1 A/.../J OVERHEAD COOLER
C-1 VACUUM TOWER
P-6 A/B VAC. TOWER REFLUX PUMPS
V-5 OVERHEAD REFLUX DRUM
P-4 A/B VAC. GAS OIL PUMPS
P-2 A/B CONDENSATE PUMPS
P-3 A/B GAS OIL PUMPS
VAC. TOWER OFF GAS FIG. 1
VAC. TOWER OFF GAS FIG. 1
BITUMEN FEED FIG. 2
STRIPPING STEAM FIG. 9
VAC TOWER OFF GAS FIG. 5
WATER DRAIN TO OSBL
VAC. TOWER COND. FIG. 4
GAS OIL FEED FIG. 2
VAC. OIL FEED FIG. 2
VAC. TOWER RESIDUE FIG. 2
AC-1
V-5
C-1
N=12
N=16
N=25
N=28
P-6 A/B
P-2 A/B
P-3 A/B
P-4 A/B
P-5 A/B/C
TC
PC
LC
FC
FI
7a
7b
7c
8
40
41
42
43
44
45
46

FIG. 3

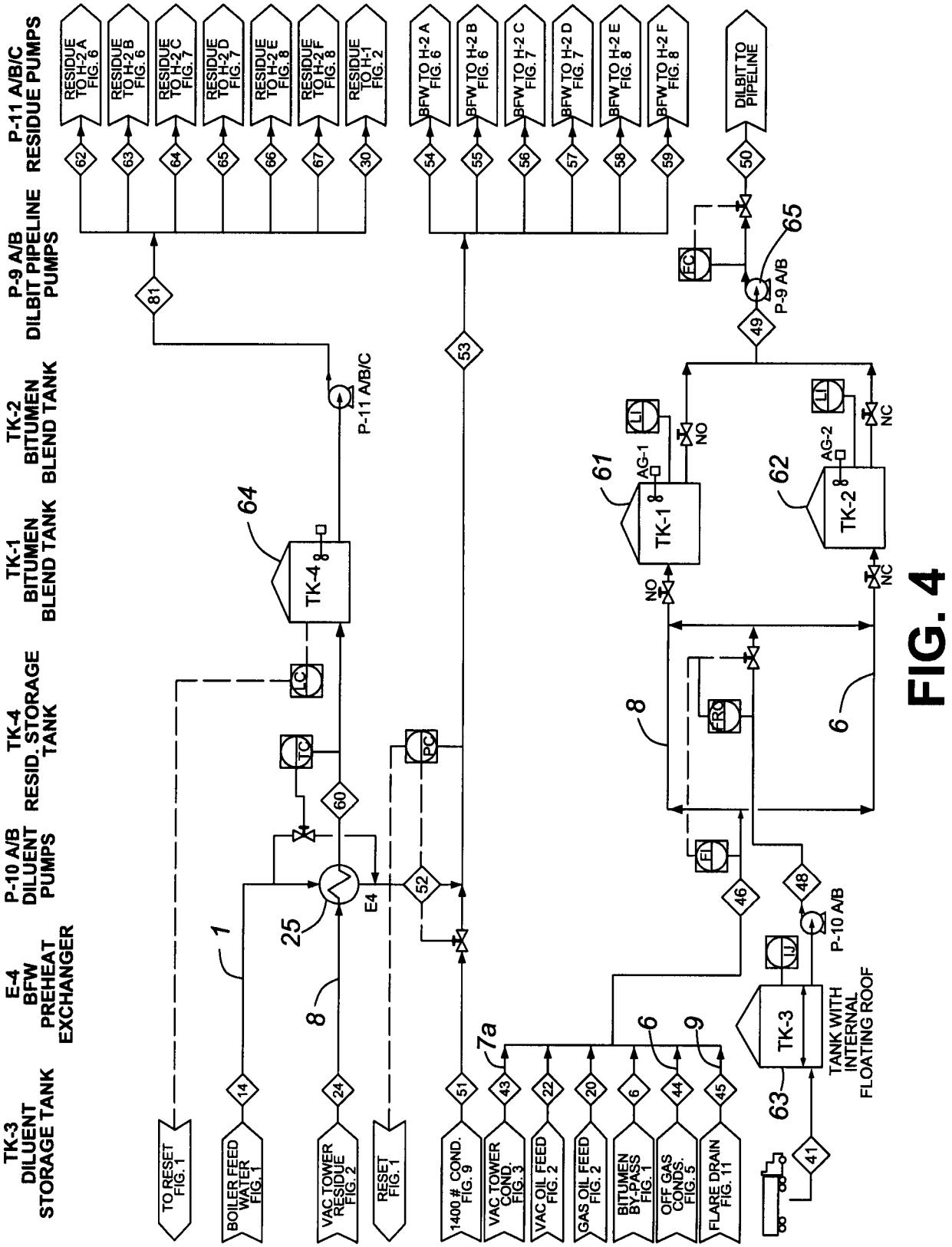
TK-3 DILUENT STORAGE TANK
E-4 BFW PREHEAT EXCHANGER
P-10 A/B DILUENT PUMPS
TK-4 RESID. STORAGE TANK
TK-1 BITUMEN BLEND TANK
TK-2 BITUMEN BLEND TANK
P-9 A/B DILBIT PIPELINE PUMPS
P-11 A/B/C RESIDUE PUMPS
TO RESET FIG. 1
BOILER FEED WATER FIG. 1
VAC TOWER RESIDUE FIG. 2
RESET FIG. 1
1400 # COND. FIG. 9
VAC TOWER COND. FIG. 3
VAC OIL FEED FIG. 2
GAS OIL FEED FIG. 2
BITUMEN BY-PASS FIG. 1
OFF GAS CONDS. FIG. 5
FLARE DRAIN FIG. 11
TANK WITH INTERNAL FLOATING ROOF
RESIDUE TO H-2 A FIG. 6
RESIDUE TO H-2 B FIG. 6
RESIDUE TO H-2 C FIG. 7
RESIDUE TO H-2 D FIG. 7
RESIDUE TO H-2 E FIG. 8
RESIDUE TO H-2 F FIG. 8
RESIDUE TO H-1 FIG. 2
BFW TO H-2 A FIG. 6
BFW TO H-2 B FIG. 6
BFW TO H-2 C FIG. 7
BFW TO H-2 D FIG. 7
BFW TO H-2 E FIG. 8
BFW TO H-2 F FIG. 8
DILBIT TO PIPELINE
P-11 A/B/C
P-9 A/B
P-10 A/B
TK-4
TK-1
TK-2
TK-3
E4
NO
NC
AG-1
AG-2
LT
TC
PC
FC
FRQ
LI
FI

FIG. 4

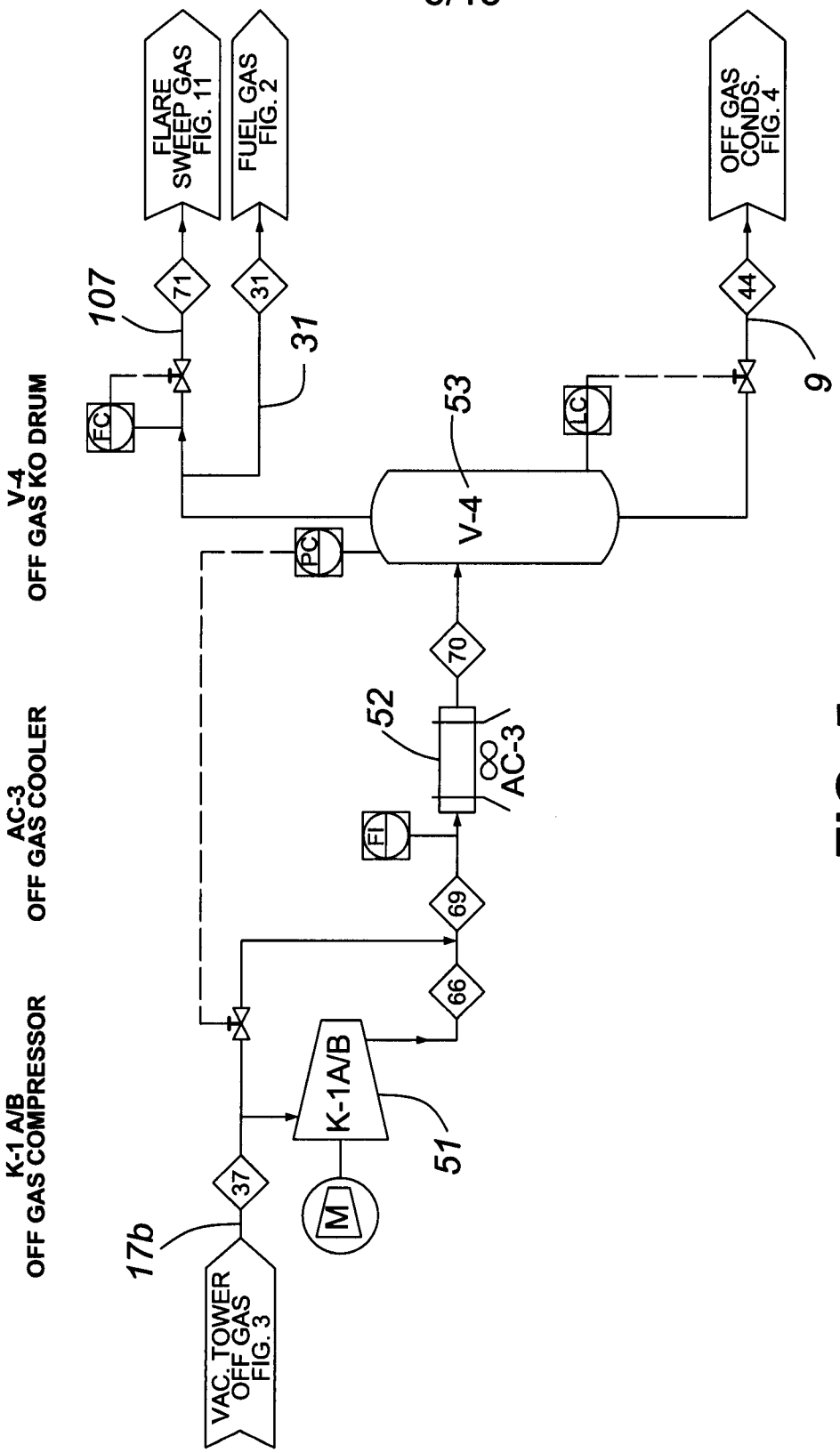
K-1 A/B
OFF GAS COMPRESSOR
AC-3
OFF GAS COOLER
V-4
OFF GAS KO DRUM
VAC. TOWER
OFF GAS
FIG. 3
17b
37
K-1A/B
M
51
66
69
FI
52
AC-3
70
PC
V-4
53
FC
107
71
FLARE
SWEEP GAS
FIG. 11
31
FUEL GAS
FIG. 2
TC
44
9
OFF GAS
CONDS.
FIG. 4

FIG. 5

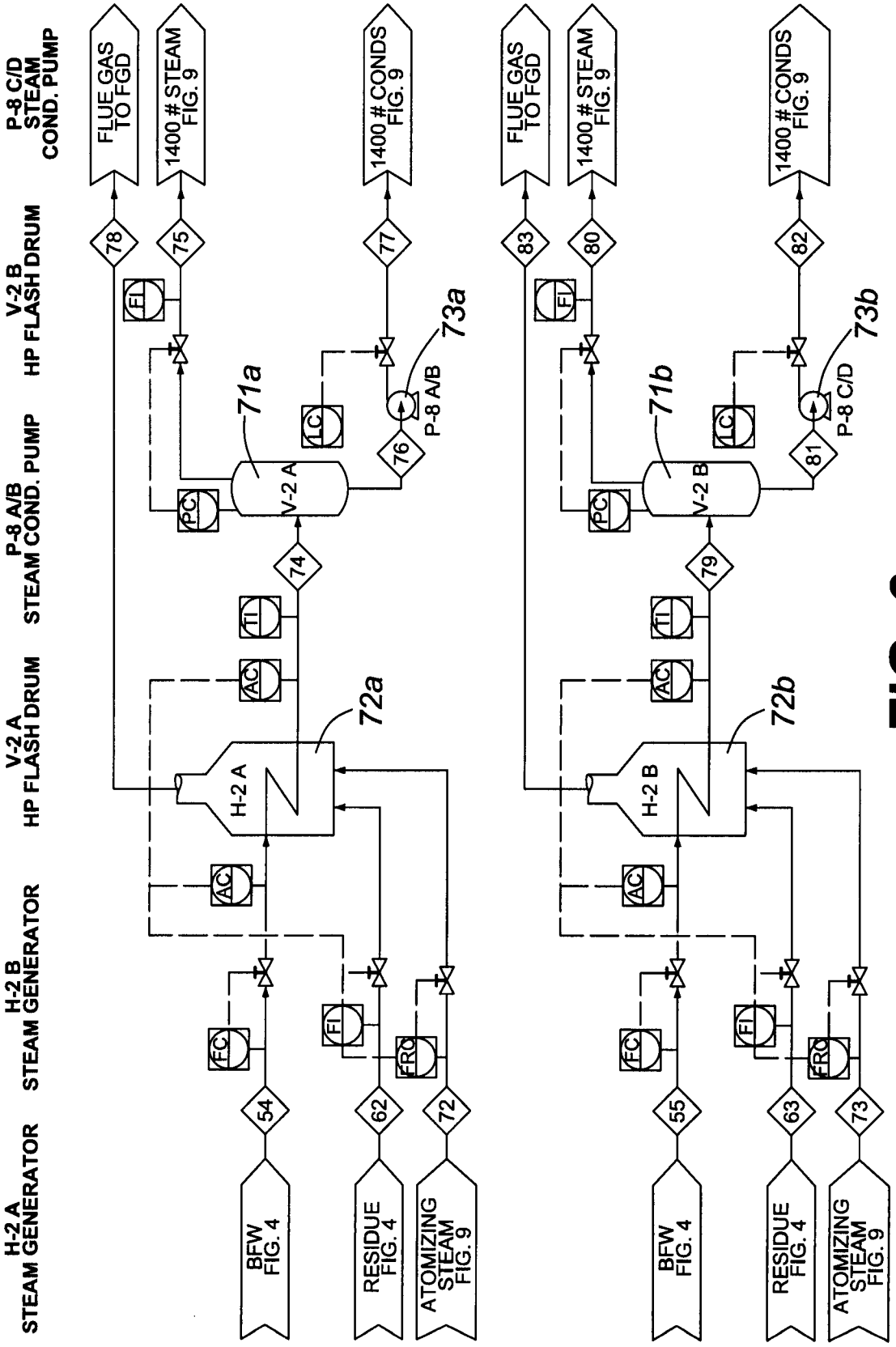
H-2 A
STEAM GENERATOR
H-2 B
STEAM GENERATOR
V-2 A
HP FLASH DRUM
P-8 A/B
STEAM COND. PUMP
V-2 B
HP FLASH DRUM
P-8 C/D
STEAM
COND. PUMP
FLUE GAS
TO FGD
1400 # STEAM
FIG. 9
1400 # CONDS
FIG. 9
BFW
FIG. 4
RESIDUE
FIG. 4
ATOMIZING
STEAM
FIG. 9
H-2 A
H-2 B
V-2 A
V-2 B
P-8 A/B
P-8 C/D
71a
71b
72a
72b
73a
73b
54
55
62
63
72
73
74
75
76
77
78
79
80
81
82
83
FC
FI
FRC
AC
TI
PC
LC

FIG. 6

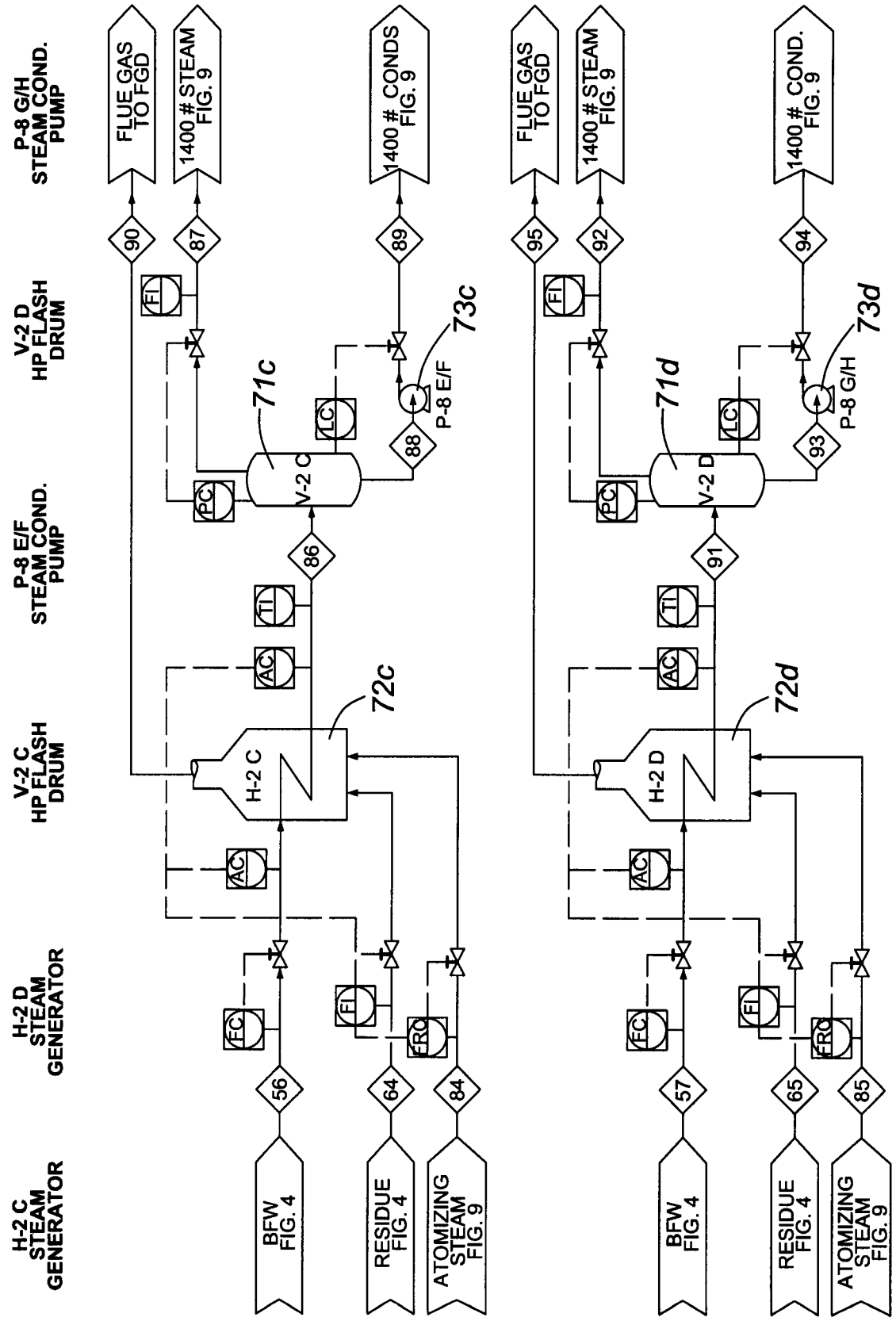
H-2 C STEAM GENERATOR
H-2 D STEAM GENERATOR
V-2 C HP FLASH DRUM
P-8 E/F STEAM COND. PUMP
V-2 D HP FLASH DRUM
P-8 G/H STEAM COND. PUMP
BFW FIG. 4
RESIDUE FIG. 4
ATOMIZING STEAM FIG. 9
FLUE GAS TO FGD
1400 # STEAM FIG. 9
1400 # CONDS FIG. 9
1400 # COND. FIG. 9
H-2 C
H-2 D
V-2 C
V-2 D
P-8 E/F
P-8 G/H
71c
71d
72c
72d
73c
73d
56
57
64
65
84
85
86
87
88
89
90
91
92
93
94
95
FC
FI
FRC
AC
TI
PC
LC

FIG. 7

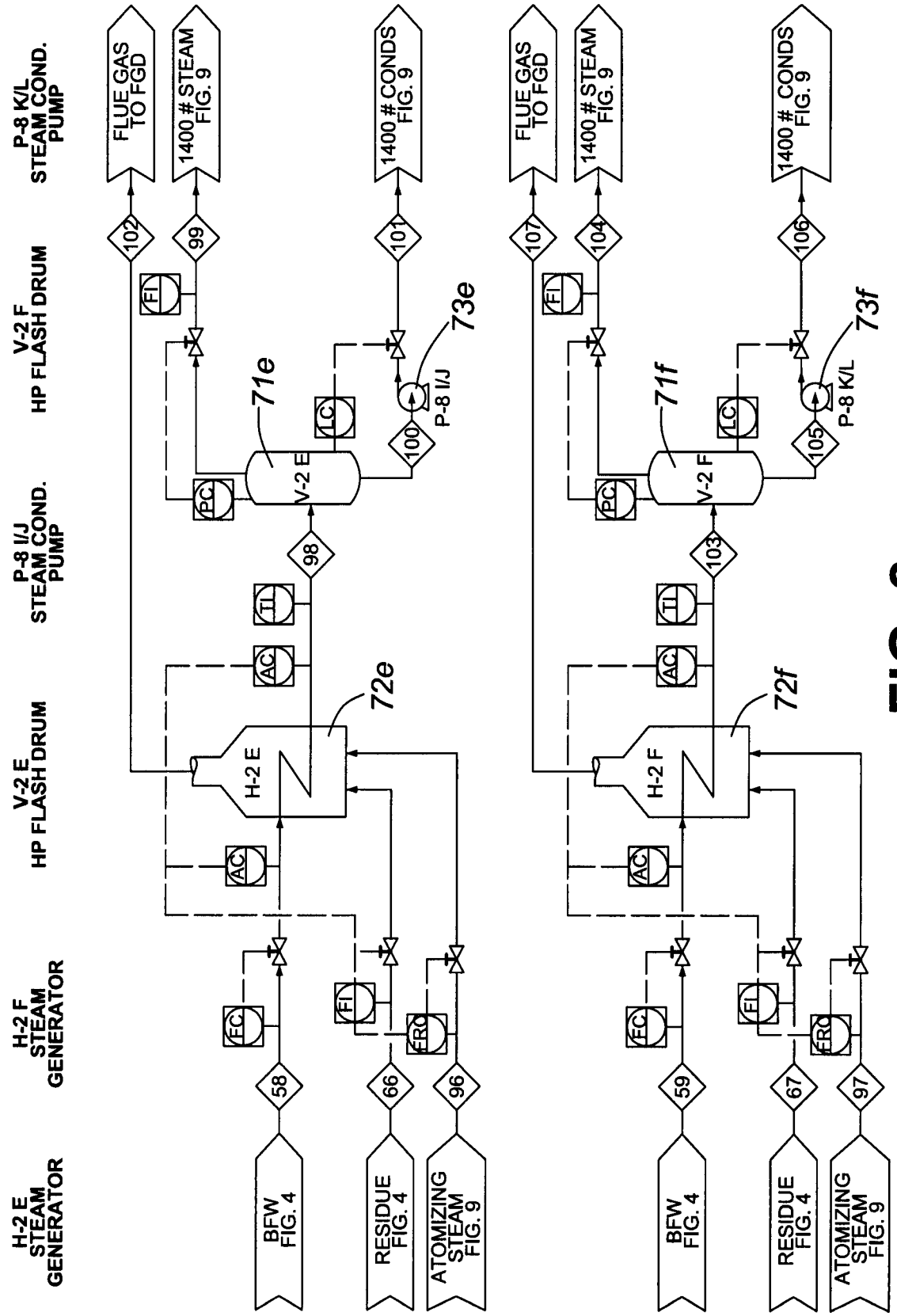
H-2 E STEAM GENERATOR
H-2 F STEAM GENERATOR
V-2 E HP FLASH DRUM
P-8 I/J STEAM COND. PUMP
V-2 F HP FLASH DRUM
P-8 K/L STEAM COND. PUMP
BFW FIG. 4
RESIDUE FIG. 4
ATOMIZING STEAM FIG. 9
1400 # STEAM FIG. 9
1400 # CONDS FIG. 9
FLUE GAS TO FGD
H-2 E
H-2 F
V-2 E
V-2 F
P-8 I/J
P-8 K/L
58
66
96
59
67
97
98
103
99
104
100
105
101
106
102
107
71e
71f
72e
72f
73e
73f
AC
TI
FC
FI
FRC
PC
LC

FIG. 8

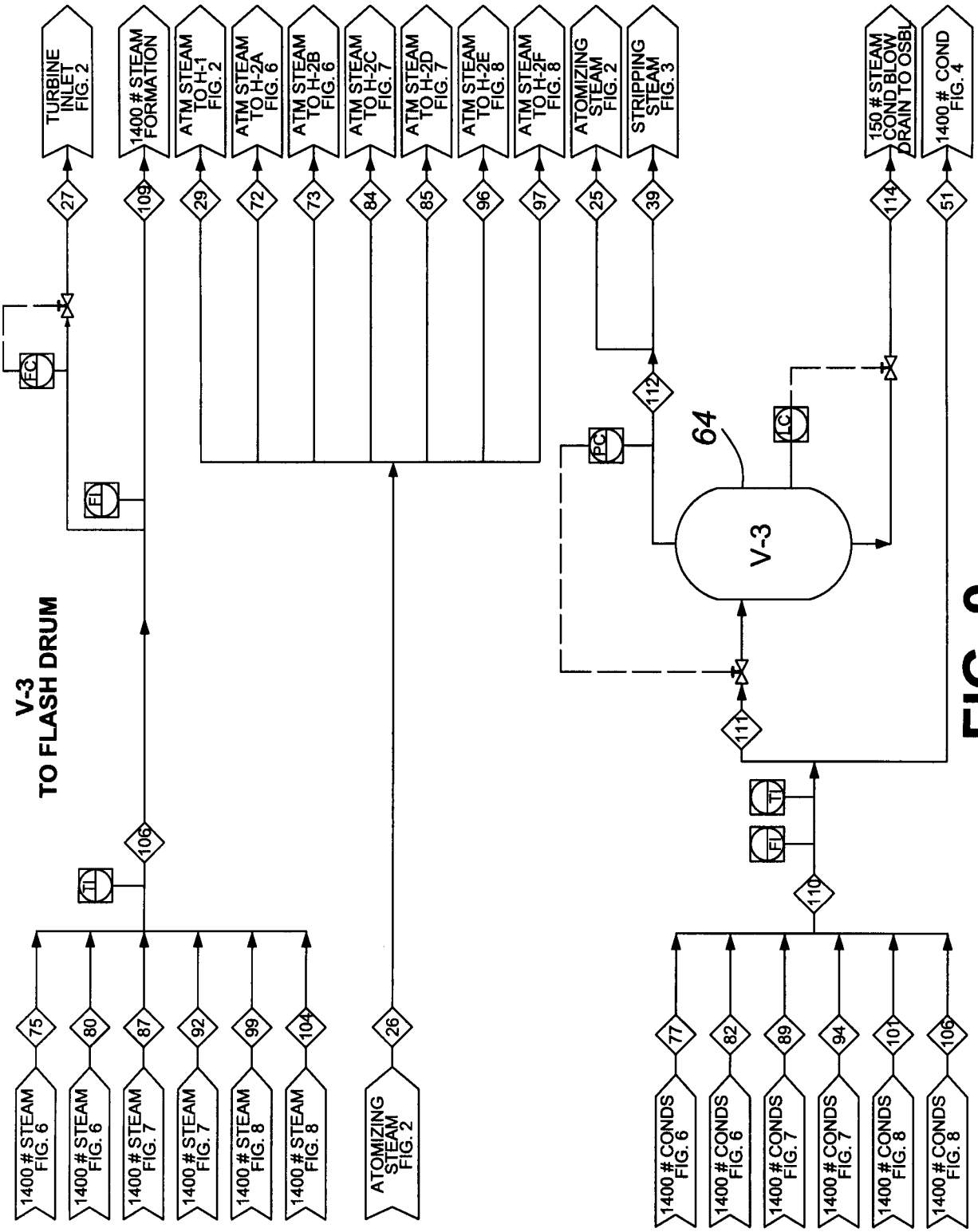
TURBINE INLET FIG. 2
1400 # STEAM FORMATION
ATM STEAM TO H-1 FIG. 2
ATM STEAM TO H-2A FIG. 6
ATM STEAM TO H-2B FIG. 6
ATM STEAM TO H-2C FIG. 7
ATM STEAM TO H-2D FIG. 7
ATM STEAM TO H-2E FIG. 8
ATM STEAM TO H-2F FIG. 8
ATOMIZING STEAM FIG. 2
STRIPPING STEAM FIG. 3
150 # STEAM COND BLOW DRAIN TO OSBL
1400 # COND FIG. 4
V-3 TO FLASH DRUM
V-3
64
1400 # STEAM FIG. 6
1400 # STEAM FIG. 6
1400 # STEAM FIG. 7
1400 # STEAM FIG. 7
1400 # STEAM FIG. 8
1400 # STEAM FIG. 8
ATOMIZING STEAM FIG. 2
1400 # CONDS FIG. 6
1400 # CONDS FIG. 6
1400 # CONDS FIG. 7
1400 # CONDS FIG. 7
1400 # CONDS FIG. 8
1400 # CONDS FIG. 8

FIG. 9

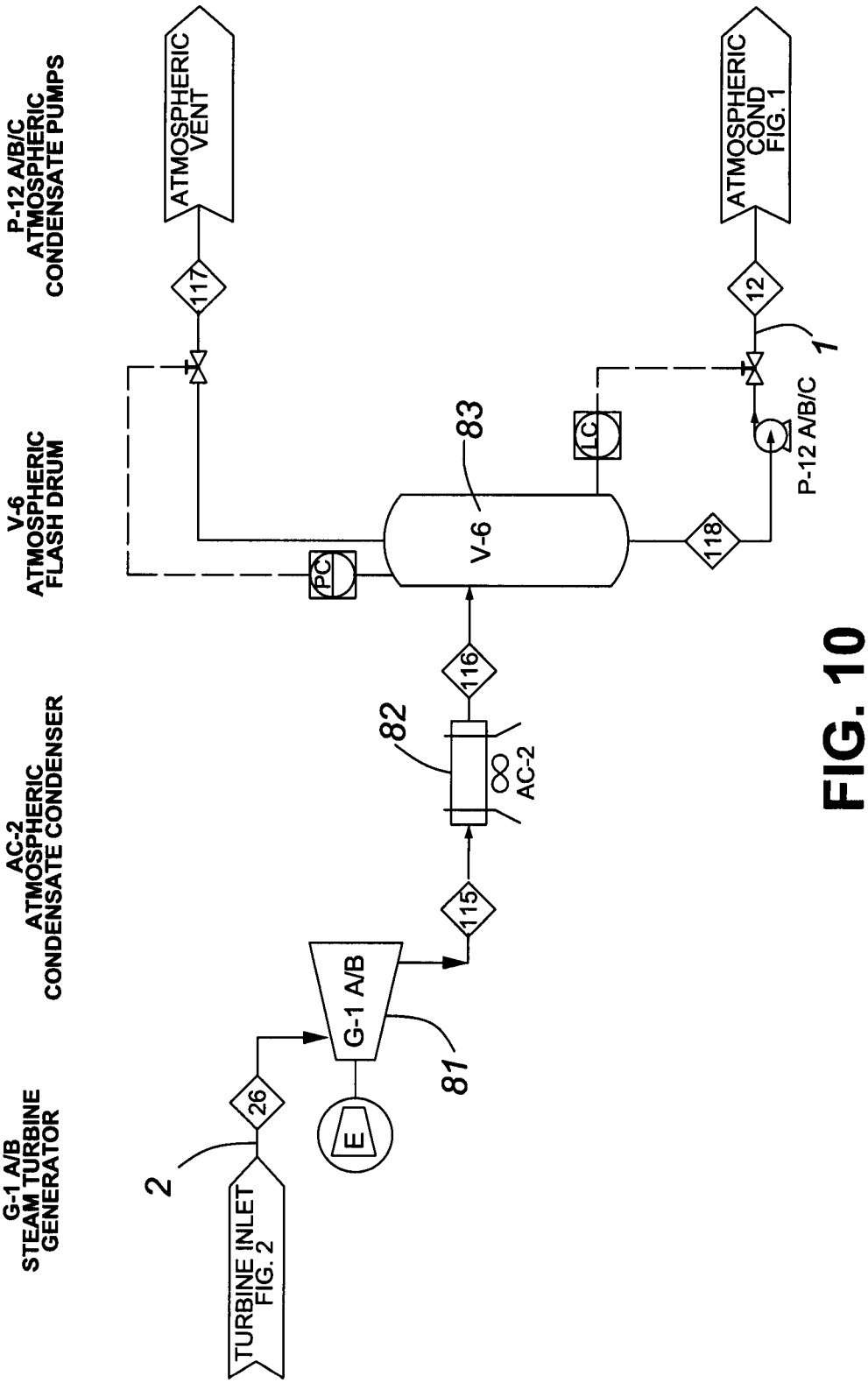
G-1 A/B
STEAM TURBINE
GENERATOR
AC-2
ATMOSPHERIC
CONDENSATE CONDENSER
V-6
ATMOSPHERIC
FLASH DRUM
P-12 A/B/C
ATMOSPHERIC
CONDENSATE PUMPS
TURBINE INLET
FIG. 2
2
26
G-1 A/B
E
81
115
82
AC-2
116
V-6
83
PC
117
ATMOSPHERIC
VENT
LC
118
P-12 A/B/C
12
ATMOSPHERIC
COND
FIG. 1
1

FIG. 10

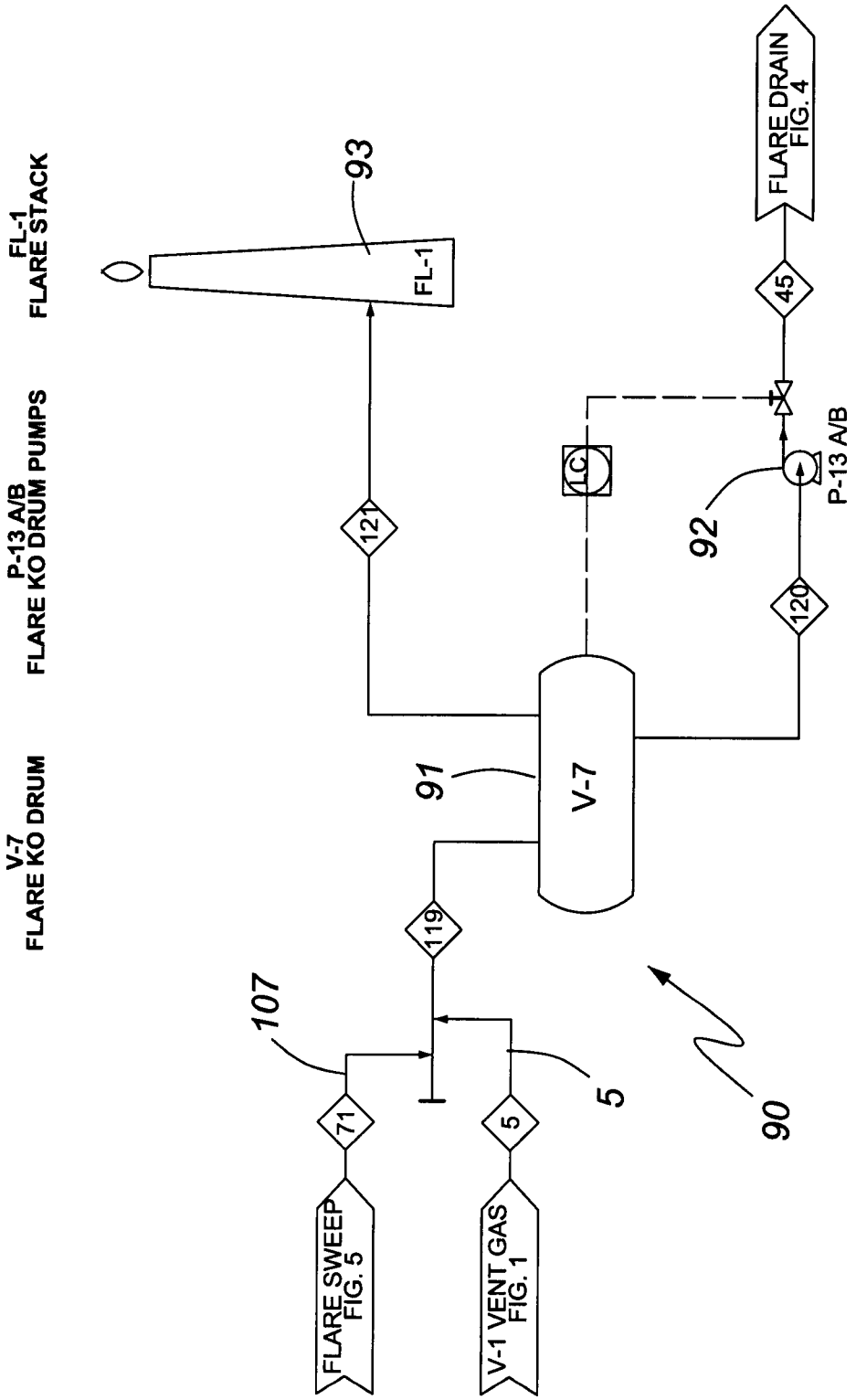
V-7
FLARE KO DRUM
P-13 A/B
FLARE KO DRUM PUMPS
FL-1
FLARE STACK
93
FL-1
FLARE DRAIN
FIG. 4
45
LC
121
92
P-13 A/B
120
91
V-7
119
107
71
5
5
FLARE SWEEP
FIG. 5
V-1 VENT GAS
FIG. 1
90

FIG. 11

SYMBOLOGY

INSTRUMENT

- TC — TEMPERATURE CONTROLLER
- FC — FLOW CONTROLLER
- PC — PRESSURE CONTROLLER
- LC — LEVEL CONTROLLER
- TI — TEMPERATURE INDICATOR
- FI — FLOW INDICATOR
- PI — PRESSURE INDICATOR
- LI — LEVEL INDICATOR
- FRC — FLOW RATIO CONTROLLER
- AC — ANALYZER CONTROLLER

MISC.

- STREAM DIRECTION
- STREAM LINE
- INSTRUMENT LINE
- STREAM NUMBER
- CONTROL VALVE
- MANUAL VALVE

FIG. 12

SYMBOLOGY

EQUIPMENT

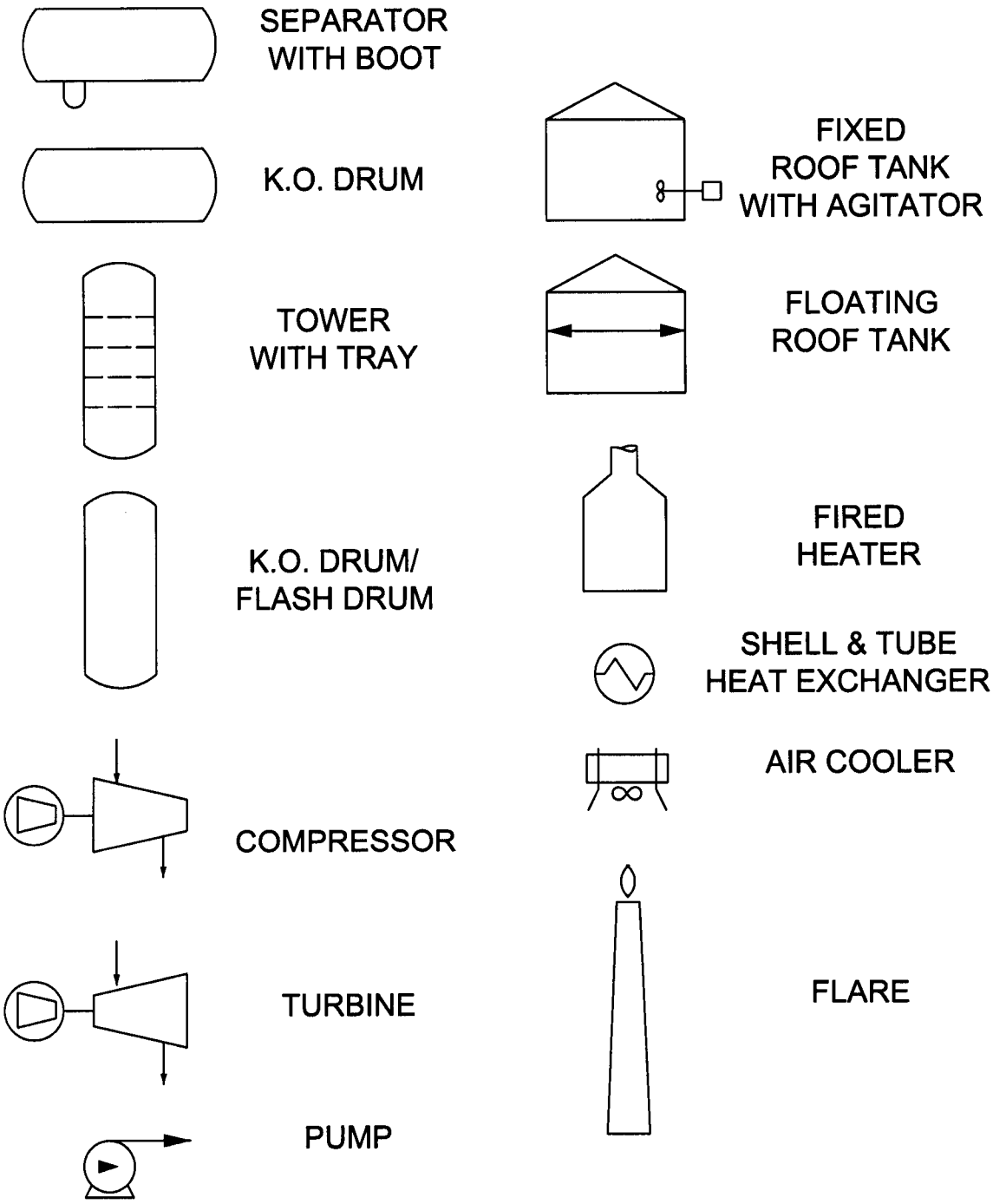

FIG. 13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2007/001859

A. CLASSIFICATION OF SUBJECT MATTER
IPC: ***F22B 33/00*** (2006.01) , ***C10C 3/08*** (2006.01) , ***C10C 3/10*** (2006.01) , ***C10G 1/04*** (2006.01) , ***F22B 37/02*** (2006.01) , ***F23K 5/08*** (2006.01), ***E21B 43/24*** (2006.01)
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: F22B 33/00, C10C 3/08, C10C 3/10, C10G 1/04, F22B 37/02, F23K 5/08, E21B 43/24
USPC: 196/14.52, 196/116, 208/427, 166/all

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
none

Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used)
Canadian Patents Database, Delphion
Keywords: refinery, steam generator, boiler, fuel, tank, feedstock, make-up, heat recovery, bitumen, vaccum, asphalt, asphatene, fraction

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	CA2332685A1 (KELLOGG BROWN & ROOT, INC.) 10 September 2001 (10-09-2001) *figs. 3-6; page 11, lines 1-3; page 12, lines 15-20*	1-4, 7-11, 14-18 5, 6, 12, 13, 19, 20
Y	CA2265596A1 (ORMAT INDUSTRIES LTD.) 26 March 1998 (26-03-1998) *fig. 2*	5, 6, 12, 13, 19, 20

[ ] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 January 2008 (10-01-2008)	12 February 2008 (12-02-2008)

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	Andrew Davidson 819- 953-4505

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CA2007/001859

Patent Document Cited in Search Report	Publication Date	Patent Family Member(s)	Publication Date
CA 2332685A1	10-09-2001	BR 0100963A	30-10-2001
		MX PA01002768A	20-08-2002
		US 6357526B1	19-03-2002
CA 2265596A1	26-03-1998	AU 4342697A	14-04-1998
		IL 129006A	10-03-2002
		IL 129006D0	17-02-2000
		US 5914010A	22-06-1999
		WO 9811971A1	26-03-1998