New connection on: : 21-05-2018 : 19:13:16 - Last disconnection on: : 21-05-2018 : 04:55:12

V 4.0.0.44358(LP,U,linux) (Rev:43856 2017-04-27 09:03:29 +0200#(D201802)) (RPM D201802)

Welcome to EPOQUE Rebuild under the Production Environment

[No database/cluster active] ..fi epodoc

Database: EPODOC

[EPODOC: SS 1] gas and (natural or LNG or GNL) and refrigerant and (circuit or cycle) and expan+ and cool+

Results in EPODOC **159**

[SS 2] 1 and first and second and heat+ and exchange

Results in EPODOC **20**

[SS 3] 2 and pd<20140707

Results in EPODOC **14**

[SS 4] ..li

1/14 © EPODOC / EPO

PN - EP2447652 A2 20120502

PNFP - EP2447652 A3 20120627

PR - EP20020713770 20020306; US20010273531P 20010306; US20010828551 20010406

AP - EP20120152549 20020306

DT - **

CT - || STSE (A3)
XP000825425 A[X];
WO0144735 A1 20010621 [AP] (EXXONMOBIL UPSTREAM RES CO [US])
[AP] 1-12
* page 2, line 14 - page 3, line 21 *
* page 7, line 13 *
* page 11, line 28 - page 12, line 12 *;
US5768912 A 19980623 [AD] (DUBAR CHRISTOPHER ALFRED [AU])
[AD] 1-12
* column 4, line 42 - column 5, line 28 *;

US5916260 A 19990629 [AD] (DUBAR CHRISTOPHER A T [AU])
[AD] 1-12
* column 4, line 37 - line 57 *;
US4911741 A 19900327 [AD] (DAVIS ROBERT N [US], et al)
[AD] 1-12
* column 2, line 5 - line 37 *

CTNP - || STSE (A3)
[X] FINN A J ET AL, "DEVELOPMENTS IN NATURAL GAS LIQUEFACTION", HYDROCARBON PROCESSING, GULF PUBLISHING CO. HOUSTON, US, (199904), vol. 78, no. 4, ISSN 0018-8190, page 47, XP000825425
[X] 1-12
* page 4, column 1 - column 2 *

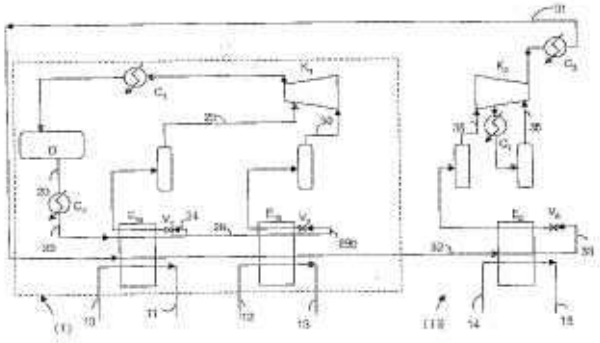
CCI - F25J1/0022 ; F25J1/0037 ; F25J1/0042 ; F25J1/005 ; F25J1/0052 ; F25J1/0072 ; F25J1/0082 ; F25J1/0205 ; F25J1/0208 ; F25J1/021

CCA - F25J2220/62 ; F25J2270/90

PA - (A2 A3)
LUMMUS TECHNOLOGY INC [US]

TI - (A2 A3)
LNG production using dual independent **expander** refrigeration cycles

AB - (A2)
A process for producing a liquefied **natural gas** stream from an inlet **gas** feed stream, the process comprising the steps of: **cooling** at least a portion of the inlet **gas** feed stream by **heat exchange** contact with a **first gas**-phase **refrigerant** in a methane refrigeration **cycle** operated independently of a **second gas**-phase **refrigerant** in a nitrogen refrigeration **cycle**; the methane refrigeration **cycle** comprising the steps of: **expanding** a **first gas**-phase **refrigerant** comprising methane to form a cold methane vapour steam; **cooling** at least a portion of the inlet feed **gas** stream by **heat exchange** contact with the cold **refrigerant** vapour stream; compressing the cold methane vapour stream to form a compressed methane vapour stream; and **cooling** at least a portion of the compressed methane vapour stream by **heat exchange** contact with the cold methane vapour stream; and the nitrogen refrigeration **cycle** comprising the steps of: **expanding** a **second gas**-phase **refrigerant** comprising nitrogen to a cold nitrogen vapour stream; **cooling** at least a portion of the inlet feed **gas** stream by **heat exchange** contact with the cold nitrogen vapour stream simultaneously as **cooling** at least a portion of the inlet feed **gas** stream by **heat exchange** contact with the cold methane vapour stream; compressing the cold nitrogen vapour stream to form a compressed nitrogen vapour stream; and **cooling** at least a portion of the compressed nitrogen vapour stream by **heat exchange** contact with the cold nitrogen vapour stream; whereby a liquefied **natural gas** stream is produced.



PN - WO2011114012 A2 20110922

PNFP - WO2011114012 A3 20150604

PR - FR20100001030 20100315

AP - WO2011FR00111 20110225

DT - **

CT - |EP| ISR (A3)
FR2545589 A1 19841109
[X] (TECHNIP CIE [FR])
[X] 1-6
* page 10, lines 32-35; figures 1,6 *
* page 13, lines 13-18 *
* page 16, line 3 - page 18, line 4 *
* page 18, line 34 - page 20, line 30 *;
FR2920529 A1 20090306
[Y] (TOTAL SA [FR])
[Y] 1-6
* page 11, lines 1-9; figure 1 *;
US6742357 B1 20040601
[Y] (ROBERTS MARK JULIAN [US])
[Y] 1-6
* column 11, lines 11-55; figure 2 *
* column 14, lines 16-36 *
* column 15, lines 32-65; figure 5 *;
EP1008823 A2 20000614
[Y] (AIR PROD & CHEM [US])
[Y] 1-6
* paragraphs [0019] , [0022] , [0026] , [0027] , [0049] , [0052] , [0053]; figures 1,4 *

CCI - F25J1/0022 ; F25J1/0052 ; F25J1/0092 ; F25J1/0214 ; F25J1/0238 ; F25J1/0239 ; F25J1/0254 ; F25J1/0292

CCA - F25J2220/64 ; F25J2230/30

PA - (A2)
IFP ENERGIES NOUVELLES [FR]; FERRERO SEBASTIEN [FR]; PIGOURIER JEROME [FR]; MARTIN PIERRE-YVES [FR]; FISCHER BEATRICE [FR]; FERSCHNEIDER GILLES [FR]
- (A3)

IFP ENERGIES NOUVELLES [FR]; FERRERO SÉBASTIEN [FR]; PIGOURIER JÉRÔME [FR]; MARTIN PIERRE-YVES [FR]; FISCHER BÉATRICE [FR]; FERSCHNEIDER GILLES [FR]

TI - (A2 A3)
PROCESS FOR LIQUEFYING A **NATURAL GAS** WITH **REFRIGERANT** MIXTURES CONTAINING AT LEAST ONE UNSATURATED HYDROCARBON

AB - (A2 A3)
The invention relates to a process for liquefying **natural gas**, in which the **natural gas** is **cooled**, condensed and subcooled by indirect **heat exchange** with two **refrigerant** mixtures circulating in the circuits (I) and (II). A **first refrigerant** mixture is compressed, **cooled** and at least partially condensed by **heat exchange** in C1 with an external fluid. The **first refrigerant** mixture is then subcooled by **heat exchange** in C2 before being partially or completely **expanded** so as to **cool** the **natural gas** and a **second refrigerant** mixture by **heat exchange**. The **second refrigerant** mixture is compressed, **cooled** and at least partially condensed by **heat exchange** in C3 with an external fluid before being **cooled** in the **first circuit** (I) by **heat exchange** with the **first refrigerant** mixture so as to be subsequently **expanded** and to allow the **natural gas** to be **cooled**, by **heat exchange**, until it is liquefied. The **first** and **second refrigerant** mixtures comprise at least ethylene.

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PN - JP2011001554 A 20110106

PNFP - JP5960945B B2 20160802

PR - US20010273531P 20010306; US20010828551 20010406

AP - JP20100171738 20100730

DT - I

CT - || STSE (A)
JPS613985 A 19860109 [ ] (SNAM PROGETTI);
WO9859207 A1 19981230 [ ] (EXXON PRODUCTION RESEARCH CO [US]);
US4911741 A 19900327 [ ] (DAVIS ROBERT N [US], et al);
JPH11311480 A 19991109 [ ] (INST FRANCAIS DU PETROLE [FR])

CCI - F25J1/0022 ; F25J1/0037 ; F25J1/0042 ; F25J1/005 ; F25J1/0052 ; F25J1/0072 ; F25J1/0082 ; F25J1/0205 ; F25J1/0208 ; F25J1/021

CCA - F25J2220/62 ; F25J2270/90

FI - C10L3/00&A; C10L3/06; F25B1/00&397Z; F25J1/00&B

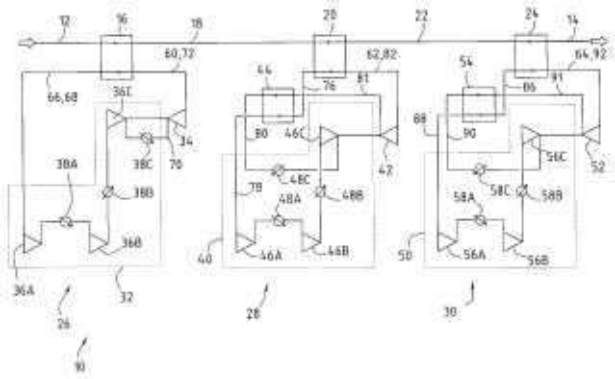
FT - 4D047/AA10; 4D047/AB08; 4D047/CA03; 4D047/CA06; 4D047/CA09; 4D047/CA12; 4D047/CA13; 4D047/CA17; 4D047/EA00

PA - (A)
LUMMUS TECHNOLOGY INC

TI - (A)
LNG PRODUCTION USING DUAL INDEPENDENT **EXPANDER** REFRIGERATION **CYCLE**

AB - (A)
PROBLEM TO BE SOLVED: To provide a method for producing a liquefied **natural gas** stream that includes **cooling** at least a portion of a pressurized **natural gas** feed stream by **heat exchange** contact with **first** and **second expanded** refrigerants used in independent refrigeration cycles.SOLUTION: The **first expanded refrigerant** is selected from methane, ethane and treated and pressurized **natural gas**. The **second expanded refrigerant** is nitrogen.

4/14 © EPODOC / EPO



PN - US2010126214 A1 20100527

PNFP - US9506690 B2 20161129

PR - FR20080057996 20081125

AP - US20090624587 20091124

DT - *; Rep

CT - || R141 (A1)
US2008141711 A1 20080619 [ ] (ROBERTS MARK JULIAN [US], et al);
US2003089125 A1 20030515 [ ] (FREDHEIM ARNE OLAY [NO], et al);
US5141705 A 19920825 [ ] (STENVALL PETER [SE], et al);
US2004109798 A1 20040610 [

] (CHOPARD FABRICE [FR], et al);
US2007157663 A1 20070712 [
] (MAK JOHN [US], et al);
US3581510 A 19710601 [
] (HUGHES JAMES H);
US2009217701 A1 20090903 [
] (MINTA MOSES [US], et al);
US5768912 A 19980623 [
] (DUBAR CHRISTOPHER ALFRED [AU])

- || STSE (B2)
US3581510 A 19710601 [
] (HUGHES JAMES H);
US5141705 A 19920825 [
] (STENVALL PETER [SE], et al);
US2003089125 A1 20030515 [
] (FREDHEIM ARNE OLAY [NO], et al);
US2004109798 A1 20040610 [
] (CHOPARD FABRICE [FR], et al);
US2007157663 A1 20070712 [
] (MAK JOHN [US], et al);
US2008141711 A1 20080619 [
] (ROBERTS MARK JULIAN [US], et al);
US2009217701 A1 20090903 [
] (MINTA MOSES [US], et al)

CCI - F25J1/0022 ; F25J1/0035 ; F25J1/005 ; F25J1/0057 ; F25J1/0072 ; F25J1/0082 ; F25J1/0092 ; F25J1/0097 ; F25J1/0204 ; F25J1/0207 ; F25J1/0215 ; F25J1/0217 ; F25J1/0218 ; F25J1/025 ; F25J1/0262 ; F25J1/0265 ; F25J1/0278 ; F25J1/0288 ; F25J1/0294

CQI - F25J1/0263

CCA - F25J2210/06 ; F25J2240/40 ; F25J2240/70 ; F25J2270/16 ; F25J2290/44

PA - (B2)
PARADOWSKI HENRI [FR]; VOVARD SYLVAIN [FR]; TECHNIP FRANCE [FR]

TI - (A1)
PROCESS FOR THE PRODUCTION OF A SUBCOOLED

LIQUEFIED **NATURAL GAS** STREAM FROM A **NATURAL GAS** FEED STREAM, AND ASSOCIATED INSTALLATION

- (B2)
Process for the production of a subcooled liquefied **natural gas** stream from a **natural gas** feed stream, and associated installation

AB - (A1 B2)
A process for the production of a subcooled liquefied **natural gas** stream from a **natural gas** feed stream. Passing a **first natural gas** feed stream through a **first heat** exchanger for precooling by **heat exchange** with a **first** stream of gaseous **refrigerant** produced in a **first** refrigeration **cycle** comprising a **first** dynamic **expansion** turbine. Passing the precooled feed stream through a **second heat** exchanger for liquefying by **heat exchange** with a **second** stream of gaseous **refrigerant** produced in a **second** refrigeration **cycle** comprising a **second** dynamic **expansion** turbine. Passing the liquefied **natural gas** stream through a third **heat** exchanger for subcooling the liquefied **gas** by **heat exchange** with a third **refrigerant** stream produced in a third refrigeration **cycle** comprising a third dynamic **expansion** turbine separate from the **first** turbine and the **second** turbine. An installation includes devices for conveying the **natural gas** stream, the **heat** exchangers and the turbines and compression devices **cooling** the refrigerants for the **heat** exchangers.

PN - US5943881 A 19990831

PR - FR19960008758 19960712

AP - US19970891133 19970710

DT - **

CT - || STSE (A)
US4251247 A 19810217 [ ] (GAUBERTHIER JOSEPH J, et al);
US4274849 A 19810623 [ ] (GARIER CHRISTIAN, et al);
US4325231 A 19820420 [ ] (KRIEGER HEINRICH);
US4339253 A 19820713 [ ] (CAETANI ENZO, et al);
US4586942 A 19860506 [ ] (GAUTHIER PIERRE [FR]);
US4755200 A 19880705 [ ] (LIU YU-NAN [US], et al);
US5535594 A 19960716 [ ] (GRENIER MAURICE [FR]);
EP0117793 A1 19840905 [ ] (AIR LIQUIDE [FR]);
DE19722490 C1 19980702 [ ] (LINDE AG [DE], et al);
WO9424500 A1 19941027 [ ] (GAZ DE FRANCE [FR], et al)

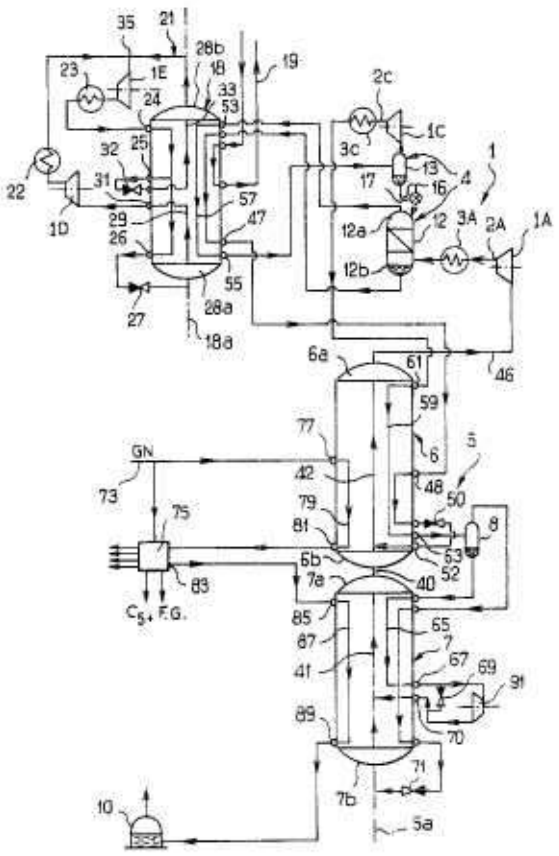
CCI - F25J1/0022 ; F25J1/0042 ; F25J1/0055 ; F25J1/0092 ; F25J1/0212 ; F25J1/0214 ; F25J1/0215 ; F25J1/0262 ; F25J1/0268 ; F25J1/0279 ; F25J1/0291 ; F25J1/0292

CCA - F25J2220/64 ; Y10S62/912 ; Y10S62/913

PA - GAZ DE FRANCE [FR]

TI - **Cooling** process and installation, in particular for the liquefaction of **natural gas**

AB - A refrigerating mixture is compressed in the penultimate stage of a plurality of stages of a compression unit. The mixture is partially condensed in order to **cool** it substantially to ambient temperature; the condensed mixture is separated in order to obtain a vapour fraction and a liquid fraction;



the vapour fraction is **cooled** and partially condensed; the resultant vapour fraction is sent to the final compression stage at least the high pressure vapour fraction and the liquid fraction are **cooled**, **expanded**, and circulated in at least **first heat exchange** means (5) with the fluid to be **cooled**. Moreover, according to the invention, during condensation of the vapour fraction, the vapour fraction produced by separating the condensed mixture is **cooled** by circulating it in **heat**-**exchange** relationship with a refrigerating fluid, in **second heat exchange** means.

TXT - **cycle** with rectification of **refrigerant**

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PN - JPH11257767 A 19990924

PR - JP19980065650 19980316

AP - JP19980065650 19980316

DT - I

CCA - F25B2400/0401

FI - F25B1/00&399D

PA - MITSUBISHI ELECTRIC CORP

TI - AIR CONDITIONER COMBINING **NATURAL** CIRCULATION

AB - PROBLEM TO BE SOLVED: To prevent liquid from coming back to a compressor and stagnation of **refrigerant** in a system where the compressor is stopped and **natural** circulation is performed when the outer air temperature is lower than an indoor set temperature by disposing the compressor in the air path of an indoor **heat** exchanger thereby sustaining the set temperature of the compressor at the time of **natural** circulation **cooling**. SOLUTION: If the outdoor is high and the indoor thermal load is heavy at the time of air conditioning operation, the compressor 3 of an indoor unit 2 is operated to introduce high pressure high temperature **refrigerant gas** through a piping 17 to the condenser 8 of an outdoor unit 1 where it is condensed through **heat exchange** with outer air. Liquid **refrigerant** is fed through an **expansion** valve 7 to produce a liquid- **gas** phase **refrigerant** which is delivered to an evaporator 5 in order to **cool** the indoor air. When the outer air temperature drops below a set indoor temperature, the compressor 3 is stopped and **first** and **second refrigerant** channel change-over valves 12, 13 are opened in order to make a transition to **natural** circulation **cooling cycle**. Temperature of the compressor 3 is sustained at a set level by disposing the compressor 3 in the air path of the evaporator 5 thus preventing liquid back to the

compressor 3.

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PN - GB1310514 A 19730321

PR - GB19690033402 19690702

AP - GBD1310514 19690702

DT - *; Rep

CCI - B01D3/007 ; B01D3/14 ; C07C7/04 ; F25J3/0209 ; F25J3/0219 ; F25J3/0233 ; F25J3/0238 ; F25J3/0242 ; F25J3/0247 ; F25J3/0252 ; F25J3/0295

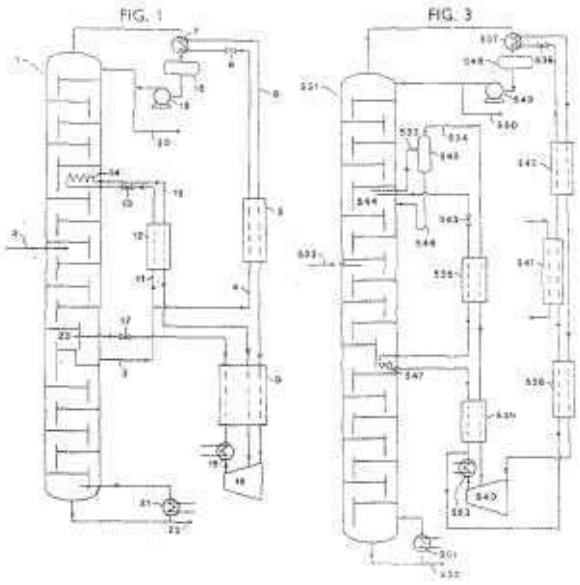
CLC - C07C7/04 , C07C9/06 , INV
- C07C7/04 , C07C9/04 , INV
- C07C7/04 , C07C11/04 , INV
- C07C7/04 , C07C11/06 , INV

CCA - F25J2200/02 ; F25J2200/04 ; F25J2200/08 ; F25J2200/40 ; F25J2200/50 ; F25J2200/72 ; F25J2200/76 ; F25J2205/02 ; F25J2210/12 ; F25J2215/60 ; F25J2215/62 ; F25J2215/64 ; F25J2235/60 ; F25J2245/02 ; F25J2270/02 ; F25J2270/04 ; F25J2270/88 ; F25J2270/902 ; F25J2290/40

PA - BLIGH B R

TI - PROCESS OF CONTUNUOUS DISTILLATION

AB - 1310514 Cold separation of **gas** mixtures B R BLIGH 1 July 1970 [2 July 1969] 33402/69 Heading F4P A **gas** mixture referred to as a **refrigerant** is withdrawn at 3, Fig. 1, from a single stage continuous **gas** mixture rectification column 1 and is thereafter subjected to a refrigeration **cycle** including **expansion**, evaporation, compression and condensation and is used to provide reflux at the top of the column and at one or more levels between the top and



the **gas** mixture feed zone 2, and at least a portion of the **refrigerant** is thereafter returned at 23 to the column. A **first** position 4 of the withdrawn **refrigerant** in the liquid phase is further **cooled** at a **heat** exchanger 5, **expanded** at a valve 6, partly vaporized in a condenser 7 in **heat exchange** with top **gas** which is thus condensed and returned by a pump 19 to the column as reflux. A **second** portion 11 of the withdrawn **refrigerant** is **cooled** at 12, **expanded** at 13 and partly vaporized in an intermediate condenser 14 thereby providing further reflux. The two portions are completely vaporized at 5, 12, 9, compressed at 10, condensed at 16, further **cooled** at 9 and **expanded** at 17 and returned to the column at an intermediate reboiler level 23 where the **refrigerant** gives up **heat**. The main reboiler comprises a steam **heated** exchanger 21. In a modification the **refrigerant** is withdrawn in the vapour phase through a line 533, 534, Fig. 3, and after being **heated** at 535, 539 is compressed at 540. A **first** portion of compr3ssed **gas** is **cooled** at 538, condensed at 542, **expanded** at 536 and **heated** in a condenser 537 traversed by top **gas** which is returned as refltx whilst the **refrigerant** is returned to the compressor. The remainder of the compressed **refrigerant gas** is **cooled** at 539, condensed in an intermediate reboiler 547, **cooled** at 535, valveexpanded at 543 and returned to the column at a evel 544 to provide reflux. The feed

mixture may comprise hydrogen, methane, ethane and propane obtained from **natural gas** after condensation therefrom of C 4 plus hydrocarbons. Top product **gas** from a de-ethanizer column (200), Fig. 4B (not shown), is passed to a de-methanizer (300, 301, 302) from the head of which methane and hydrogen are withdrawn and from the bottom of which C 2 h.c. are withdrawn and passed to a further separator (400, 401).

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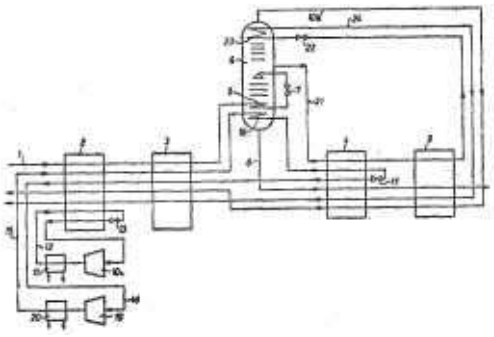

PN - GB1208196 A 19701007

PR - DE19671551611 19671220

AP - GB19680057849 19681205

DT - **

CCI - F25J1/0022 ; F25J1/004 ; F25J1/0045 ; F25J1/0052 ; F25J1/0072 ; F25J1/0214 ; F25J1/0218 ; F25J1/0219 ; F25J3/0209 ; F25J3/0233 ; F25J3/0257

CCA - F25J2200/02 ; F25J2200/50 ; F25J2200/74 ; F25J2200/94 ; F25J2270/12 ; F25J2270/42 ; F25J2270/60 ; F25J2290/34 ; Y10S62/927

PA - MESSER GRIESHEIM GMBH [DE]

TI - PROCESS FOR THE LIQUIFACTION OF NITROGEN-CONTAINING **NATURAL GAS**

AB - 1,208,196. **Natural gas** liquefaction process. MESSER GRIESHEIM G.m.b.H. 5 Dec., 1968 [20 Dec., 1967], No. 57849/68. Heading F4P. Compressed nitrogen-containing **natural** hydrocarbon **gas** in a line 1 is liquefied and subcooled in **heat** exchanger 2, 3 traversed by two multi-component refrigerants each in a closed **circuit** having a single compression stage 10a,

19 and the L.N.G. is **expanded** at a valve 7 into a fractionating column 6 from which nitrogenfree liquefied **natural gas** is withdrawn through a line 8, pure nitrogen through a line 10b and a partly gaseous mixture of methane and nitrogen is withdrawn through a line 21, liquefied in an exchanger 4 **cooled** by the colder of the two refrigerants, undercooled in an exchanger 9 in countercutrent **heat exchange** with itself after **expansion** through a valve 22, and the cold so produced is used in exchangers 9, 4 to sub-**cool** the nitrogen free L.N.G. in line 8 to a storage temperature of about -160 C.; the so-vaporized methane-nitrogen mixture being warmed to ambient temperature in exchanger 2, 3 and delivered as fuel **gas**. The **first refrigerant** comprises a mixture of C 1 to C 4 saturated hydrocarbons which having been compressed at 10 to 40 atmosphere and **cooled** to ambient temperature in a water-**cooled heat** exchanger 11 is in the liquid phase, and is **cooled** to - 75 C. in exchanger 2 by **heat exchange** with itself after **expansion** through a valve 13. The **second refrigerant** comprises a mixture of methane, ethane and nitrogen which is delivered by a compressor 19 and a water-**cooled** exchanger 20 into a line 15 in the gaseous phase and is liquefied and **cooled** in exchangers 2, 3, further **cooled** in a coil 16 of column 6 and is thereafter further **cooled** in exchanger 4 in **heat exchange** with itself after **expansion** through a valve 17, after which the **refrigerant** is

warmed to ambient temperature in exchanger 3, 2 and returned to the compressor inlet.

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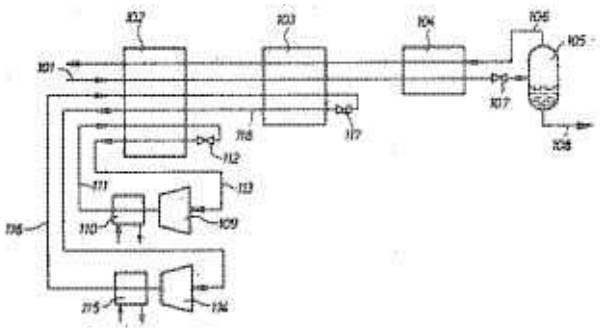


PN - GB1181049 A 19700211

PR - DE19671551611 19671220

AP - GB19680057848 19681205

DT - **

CCI - F25J1/0022 ; F25J1/004 ; F25J1/0045 ; F25J1/0052 ; F25J1/0072 ; F25J1/0214 ; F25J1/0218 ; F25J1/0219 ; F25J3/0209 ; F25J3/0233 ; F25J3/0257

CCA - F25J2200/02 ; F25J2200/50 ; F25J2200/74 ; F25J2200/94 ; F25J2270/12 ; F25J2270/42 ; F25J2270/60 ; F25J2290/34 ; Y10S62/927

PA - MESSER GRIESHEIM GMBH [DE]

TI - Process for the Liquifaction of **Natural Gas**

AB - 1,181,049. **Natural gas** liquefaction process. MESSER GRIESHEIM G.m.b.H. 5 Dec., 1968 [20 Dec., 1967]. No. 57848/68. Heading F4P. **Cooling**, followed by liquefaction and subcooling of compressed **natural** hydrocarbon **gas** in feed line 101 is effected in **heat**-exchangers 102, 103, respectively, and the sub-**cooled** liquid is then further **cooled** at 104 and **expanded** at a valve 107 into a separator 105; exchanger 102 being **cooled** by passage therethrough of a **first** multicomponent **refrigerant**, e.g. a mixture of C 1 to C 4 saturated hydrocarbons in a closed, **cycle**, exchanger 103 being **cooled** by a **second** multicomponent **refrigerant**, e.g. a mixture of nitrogen, methane and ethane also in a closed **cycle**

and in cascade arrangement with the **first** refrigeration **cycle** and the **refrigerant** of each **cycle** undergoes only one compression stage and is **expanded** to above atmospheric pressure. Exchanger 104 is **cooled** by flash **gas** from separator 105 which **gas** also **cools** exchangers 102, 103. In operation, the **first refrigerant** is compressed at 109 to about 40 atmosphere liquefied in a water-**cooled** exchanger 110, further **cooled** in exchanger 102 in countercurrent **heat exchange** with itself after **expansion** at 112 to about 3 atmosphere, and the **refrigerant** after leaving the warm end of exchanger 102 is returned to the compressor inlet. The **second refrigerant** is compressed at 114, **cooled** by water at 115, liquefied in exchanger 102, further **cooled** in exchanger 103, **expanded** at a valve 117 and returned through exchangers 103, 102 to the inlet of compressor 114.

10/14 © EPODOC / EPO

PN - GB1487466 A 19770928

PR - DE19742438443 19740809

AP - GB19750030406 19750721

DT - **

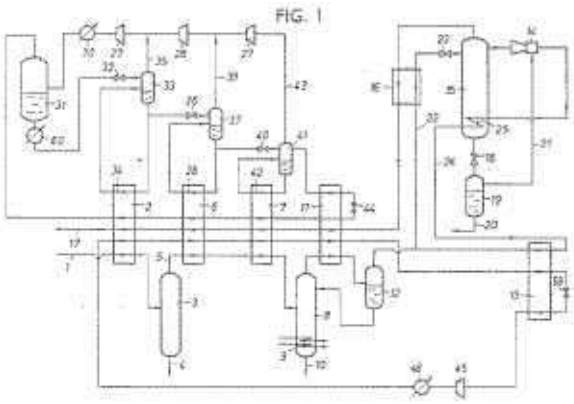
CCI - F25J1/0022 ; F25J1/004 ; F25J1/0052 ; F25J1/0055 ; F25J1/0214 ; F25J1/0264 ; F25J1/0291 ; F25J3/0209 ; F25J3/0233 ; F25J3/0257

CCA - F25J2200/02 ; F25J2200/70 ; F25J2200/78 ; F25J2205/02 ; F25J2210/06 ; F25J2215/04 ; F25J2220/64 ; F25J2240/60

PA - LINDE AG

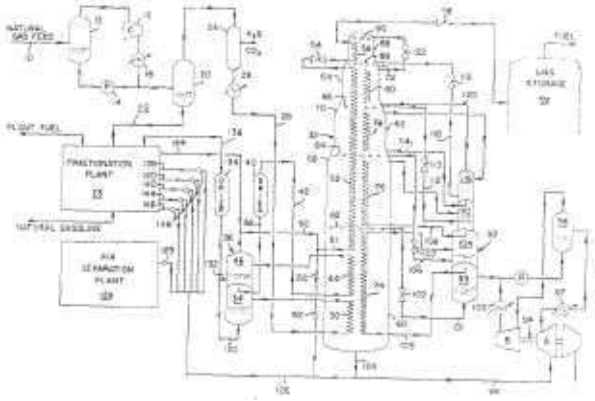
TI - LIQUEFACTION OF **NATURAL GAS**

AB - 1487466 Liquefying **natural gas** LINDE AG 21 July 1975 [9 Aug



1974] 30406/75 Heading F4P **Natural gas** 1 is liquefied by a **first** multicomponent **refrigerant** and then a **second** multi-component **refrigerant**, each **refrigerant** being in a respective closed **circuit**, the **first circuit** being such that the **refrigerant** is compressed at 27, 28, 29, partially liquefied by **cooler** 30 and then separated at 31, the liquid fraction being sub-**cooled** at 60 and then undergoing successive stages of **expansion** and separation at 32, 33, 36, 37, 40, 41, a part of each liquid fraction being passed to lines 34, 38, 42 of respective exchangers 2, 6, 7 to **cool** the **natural gas** before being returned to the separator from whence they came, whilst the gaseous fraction from separator 31 is **cooled** in exchangers 2, 6, 7 and 11 before **expansion** at 44 and passage to separator 41 via exchanger 11, and the **second refrigerant circuit** being such that the **refrigerant** is compressed at 45, **cooled** at 46, partially liquefied in exchangers 2, 6, 7, 11 and then completely liquefied in exchanger 13 in **heat exchange** with lowerboiling component of the **natural gas** and itself, it then being returned to compressor 45 via **expansion** valve 59 and exchanger 13. The feed **gas** 1 is **cooled** at 2 to condense out C 5 and higher hydrocarbons and water which are separated at 3. The remaining **gas** is dried and passed to exchangers 6, 7 where it is partially condensed before moving to a rectification column 8. The sump product of ethane,

propane and higher-boiling hydrocarbons is withdrawn at 10 and the gaseous head product of N 2 , methane and ethane, and small quantities of propane and butane, is passed through exchanger 11 for partial condensation before reaching separator 12. The gaseous fraction is liquefied and subcooled in exchanger 13 before passing via exchanger 25 and ejector 14 to column 15. The overhead N 2 -rich product is passed back through exchangers 11, 7, 6, 2. The **second circuit** may have a two stage compressor with an extra exchanger from which is fed an intermediate **refrigerant** portion to the **second** compressor stage (Fig. 2, not shown). Alternatively, the **second refrigerant** can be separated before being used in a pair of exchangers replacing 13 (Fig. 3, not shown). The successive liquid fractions in the **first circuit** may be increased in pressure before performing their **cooling** function, and they are then returned to the preceding separator (Fig. 4, not shown). Finally, an extra separator may be located between 31 and 33, the gaseous fraction being combined with that from 31 after **cooling** at 2, 6, 7, 11 and **expansion** (Fig. 5, not shown).



PN - GB1135871 A 19681204

PR - US19650468008 19650629; US19670659988 19670811; US19700003571 19700109; US19700049622 19700625; US19690882781 19691222

AP - GB19660028964 19660628

DT - **

CCI - F25J1/0022 ; F25J1/0055 ; F25J1/0212 ; F25J1/0231 ; F25J1/0234 ; F25J1/0238 ; F25J1/025 ; F25J1/0291 ; F25J3/04563

CCA - F25J2205/04 ; F25J2210/06 ; F25J2220/64 ; F25J2230/30 ; F25J2230/60 ; F25J2235/60

PA - AIR PROD & CHEM

TI - Liquefaction of **natural gas**

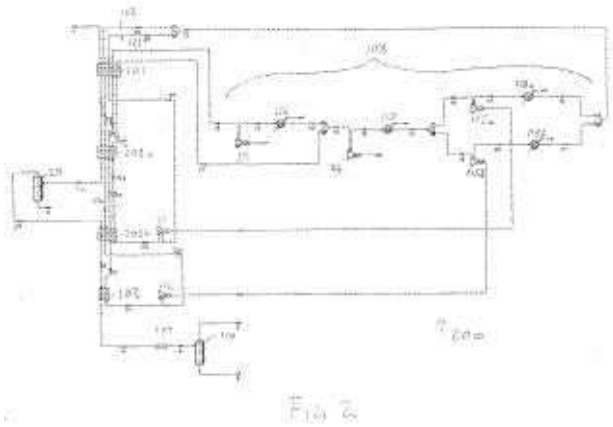
AB - 1,135,871. **Natural gas** liquefaction process. AIR PRODUCTS & CHEMICALS Inc. 28 June, 1966 [29 June, 1965], No. 28964/66. Heading F4P. **Natural** hydrocarbon **gas** having been freed of hexane and most of the pentane content in separators 12, 20, 34, 36 is fed at 600 p.s.i. a. through lines 50, 51 to the base of a vertical coil 52 where the residual **gas** is **cooled** to its liquefaction temperature in indirect **heat exchange** with successive sprays 82, 84, 86, 88 of at least four liquid refrigerants at decreasing temperatures; said liquid refrigerants being obtained by separation from a mixture thereof in a four-stage column 92 followed by **expansion** in valves 102, 107, 113, 119 resulting in a temperature fall prior to delivery from the spray heads 82, 84, 86, 88. The multi-component **refrigerant** mixture of Cl to C 6 saturated

hydrocarbons and nitrogen is supplied by a compressor 94 at about 515 p.s.i.a. to the **first** stage 99 of column 92. Liquid C 2- C 6 hydrocarbons are **expanded** at 102 and issue from spray 82 whilst gaseous hydrocarbons and nitrogen are **cooled** in a coil 74 beneath spray 82 and fed to the **second** stage 104 from which liquid C 2 - C 4 hydrocarbons are withdrawn **expanded** at 107 and issue from spray 84 whilst gaseous hydrocarbons and nitrogen are **cooled** in a coil 76 beneath spray 84 and fed to the third stage 110. Liquid C 1 -C 3 hydrocarbons are withdrawn from stage 110 and **expanded** at 113 and issue from spray 86 whilst residual **gas** is **cooled** in a coil 78 beneath spray 86 and fed to the fourth stage 116 which in turn supplies liquid **refrigerant** to spray 88 whilst the residual gaseous methane and nitrogen is liquefied in a coil 80 beneath spray 88, **expanded** at 122 into a spray 90 which further **cools** the liquefied **natural gas** leaving the head of coil 52 and having itself been **expanded** at 54 to about 200 p.s.i.a. The product is further **expanded** at 58 to atmospheric pressure and fed into a storage tank 59. After being vaporized the four liquid refrigerants are recombined withdrawn through a line 124 at 41 p.s.i.a. and recycled back to compressor 94 together with make-up **refrigerant** mixture which together with the original charge is obtained by passing condensate from the separators 20, 34, 36 into a conventional fractionating plant 23 having flow valve controlled withdrawal

lines 138, 140, 142, 144, 146 connected to a common line 126 to which is added nitrogen from an air separation plant 128.

TXT - N2 for **cycle** make up

12/14 © EPODOC / EPO



PN - GB2459484 A 20091028

PNFP - GB2459484 B 20120516

PR - GB20080007447 20080423

AP - GB20080007447 20080423

DT - *

CT - (A)
US5768912 A [ ]; US6446465 B1 [ ];
US2005056051 A1 [ ]
- (B)
US6446465 B1 [ ]; US5768912 A [ ];
US2005056051 A1 [ ]

CCI - F25J1/0022 ; F25J1/005 ; F25J1/0072 ; F25J1/0204 ; F25J1/0278 ; F25J1/0288 ; F25J1/0294

CNOI - (A B)
F25J1/00 ; F25J1/02

CCA - F25J2220/62 ; F25J2270/16

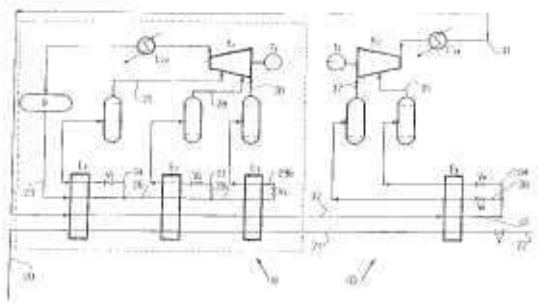
PA - (A B)
STATOILHYDRO ASA [NO]

TI - (A)
Nitrogen **cooling** of **natural gas**
- (B)
Dual nitrogen **expansion** process

AB - (A)
In a method of **natural gas** liquefaction, **first** and **second** differentially pressure **expanded** nitrogen **refrigerant** streams, are in **heat exchange** relationship with **natural gas** 1, and both a **first** and **second** compressed nitrogen streams 10, 27. Also disclosed is a method of **natural gas** liquefaction, in which the **natural gas** is **cooled** in three stages using

nitrogen **refrigerant** . The systems may permit the use of inert nitrogen alone in and **LNG cooling** system, negating the need for more volatile components such as methane, ethane, propane mixed in with the **cooling gas circuit**.

13/14 © EPODOC / EPO



PN - **FR2778232** A1 19991105

PNFP - FR2778232 B1 20000602

PR - FR19980005992 19980429

AP - FR19980005992 19980429

DT - *; Rep

CT - || STSE (A1)
GB1181049 A 19700211
[XA] (MESSER GRIESHEIM GMBH [DE])
[X] 1,2,4,5,12-15
* figure .; claim - *
[A] 3,6-11,16;
FR1270952 A 19610901
[XA] (SHELL INT RESEARCH)
[X] 1,2,4,5,12-15
* figure .; claim - *
[A] 3,6-11,16;
US4901533 A 19900220 [A] (FAN CHUNG T [US], et al);
GB2308645 A 19970702
[AD] (INST FRANCAIS DU PETROLE [FR])

CCI - **F25J1/0022** ; **F25J1/0052** ; **F25J1/0057** ; **F25J1/0214** ; **F25J1/0262** ; **F25J1/0272** ; **F25J1/0283** ; **F25J1/0292** ; **F25J1/0295**

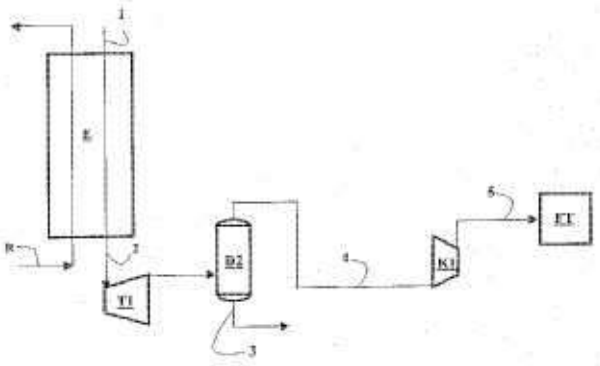
CCA - **F25J2290/12**

PA - (A1 B1)
INST FRANCAIS DU PETROLE [FR]

TI - (A1)
Natural gas liquefaction process

AB - (A1)
The **natural gas**, under pressure, is **cooled** in the **first** stage to less than -30 deg C. and totally

condensed and supercooled in the **second** stage. The secondary refrigerating mixture is **cooled** by **heat exchange** with the primary mixture and the supercooled **natural gas** is finally **expanded** to give the liquified product (**LNG**). The liquefaction process is carried out in the following stages. The **natural gas** is **cooled** in the **first** stage (I) to a temperature lower than -30 deg C. in a **first** refrigerating **cycle** using a **refrigerant** M1, which is compressed, partially condensed using an external **cooling** fluid, then supercooled, **expanded** and vaporized. The **gas** is then condensed and supercooled in a **second** stage (II) by using a **second refrigerant** mixture M2, which had been compressed, **cooled** by an external fluid, then **cooled** by **heat exchange** with the primary **refrigerant** mixture M1 in the **first** refrigeration stage. On leaving the **first** stage, it is in a partially condensed state and is conveyed, without phase separation, to the **second** stage where it is totally condensed , **expanded** and vaporized at two pressure levels. The supercooled **natural gas** is **expanded** to form the **LNG** product. An Independent claim is included for a processing plant to carry out the described process.



PN - FR2861164 A1 20050422

PNFP - FR2861164 B1 20101126

PR - FR20030012093 20031016

AP - FR20030012093 20031016

DT - *; Rep

CT - || STSE (A1)
US2003136146 A1 20030724
[XY] (FISCHER-CALDERON ERNESTO [US], et al)
[X] 1-6,9,10
* the whole document *
[Y] 7,8;
XP001146430 A[Y];
EP1306632 A1 20030502
[X] (SHELL INT RESEARCH [NL])
[X] 1,5,6,8-10
* the whole document *;
WO9836038 A1 19980820
[A] (NORSKE STATS OLJESELSKAP [NO], et al)
[A] 1-10
* page 5, line 30 - page 6, line 13 *
* page 10, line 3 - line 16 *
* page 12, line 21 - line 23; figure . *;
US6248794 B1 20010619
[DA] (GIESKES THOMAS [US])
[DA] 1-10
* column 5, paragraph 1; figure 3 *

CTNP - || STSE (A1)
[Y] - GEIJSEL J I ET AL, SYNERGIES BETWEEN LNG AND GAS TO LIQUIDS CONVERSION SYNERGIES ENTRE LE GNL ET LA CONVERSION DU GAZ EN LIQUIDES, INTERNATIONAL CONFERENCE AND EXHIBITION ON LIQUEFIED NATURAL GAS, XX, XX, PAGE(S) PS2-501-PS2-510, XP001146430
[Y] 7,8
* page 5.8, paragraph 7 - page 5.9, paragraph 1 *

CCI - C10G2/32 ; F25J3/061 ; F25J3/0635 ; F25J3/064 ; F25J1/0022 ; F25J1/0035 ;

F25J1/0037 ; F25J1/004 ;
F25J1/0042 ; F25J1/0052 ;
F25J1/0057 ; F25J1/0214 ;
F25J1/0229 ; F25J1/0238 ;
F25J1/0282 ; F25J1/0284 ;
F25J1/0292 ; F25J3/0209 ;
F25J3/0233 ; F25J3/0242

CCA - F25J2200/04 ; F25J2200/70 ;
F25J2200/74 ; F25J2200/78 ;
F25J2205/02 ; F25J2215/04 ;
F25J2220/62 ; F25J2230/08 ;
F25J2230/22 ; F25J2230/60 ;
F25J2235/60 ; F25J2240/02 ;
F25J2240/30 ; F25J2240/70 ;
F25J2245/02 ; F25J2260/60 ;
F25J2270/04 ; F25J2270/12 ;
F25J2270/66

PA - (A1 B1)
INST FRANCAIS DU PETROLE [FR]

TI - (A1)
Liquefying and converting **natural gas** involves using synergy with Fischer-Tropsch process, to form specific product

AB - (A1)
Liquefying and converting **natural gas** method involves (a) at least partially liquefying the **natural gas**; (b) **expanding** at least part of the partially liquefied **natural gas** to obtain a gaseous fraction and a liquid fraction; (c) compressing part of the gaseous fraction and (d) transforming the compressed **gas** using a Fischer-Tropsch process into a product containing at least five carbon atoms per molecule : Before (a), there is a stage (e) where the **natural gas** is **cooled** and distilled to obtain a purified **natural gas** and **natural gas** liquids. These **natural gas** liquids are distilled in a stage (f), and the resulting vapors are transformed by a Fischer-

Tropsch process. The purified **natural gas** from (e) is partially liquefied in a stage (g) to obtain a gaseous phase and a liquid phase; a **first** part of the gaseous phase is transformed by a Fischer-Tropsch process and a **second** part of the **gas** forming the **natural gas** used in stage (a). In stage (a), the **natural gas** is **cooled** by **heat exchange** with the gaseous fraction contained in stage (b), or by a **refrigerant** circulating in a **circuit** operating a compressor. The compressor is driven by a steam turbine, or by an electric motor with the electricity coming from an electricity generator driven by a steam turbine, with the steam produced in the Fischer-Tropsch process. In additional stages, (h) the liquid fraction from (b) is **expanded** to obtain a **second** gaseous fraction and a **second** liquid fraction, and (i) the liquid fraction obtained in (b) is **cooled** by **heat exchange** with the **second** gaseous fraction from (h). The **natural gas** is at a pressure of 2-15 MPa, is **expanded** in stage (b) to a pressure of 0.1-1 MPa absolute and is compressed in stage (c) to a pressure of 0.5-5 MPa absolute.

[SS 4]