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(71) Applicant: **Alstom Technology Ltd**
5400 Baden (CH)

(72) Inventors:
• **Lamarque, Frederic**
95160 Montmorency (FR)
• **Renard, Bruno**
77340 Pontault Combault (FR)

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(54) **Energy conversion cycle for the steam produced by a sodium-cooled fast neutron reactor**

(57) The present invention relates to an energy conversion cycle for the steam produced by a sodium-cooled fast neutron reactor having a first stage, in which a first expansion of steam coming from a steam generator (2) associated with the reactor (1) is performed to bring the steam from a "fossil fuel cycle" initial state (21) to an intermediate state of temperature and pressure of said

steam corresponding to a "nuclear cycle" initial state (22), a second stage in which a second expansion of the steam from the intermediate state (22) is performed until steam in a first wet state (23) situated below the steam saturation curve (S) is obtained, a third stage in which the steam is dried and super-heated, and a fourth stage in which a third expansion of the steam is performed from the super-heated state (24) thereof to a second wet state (25).

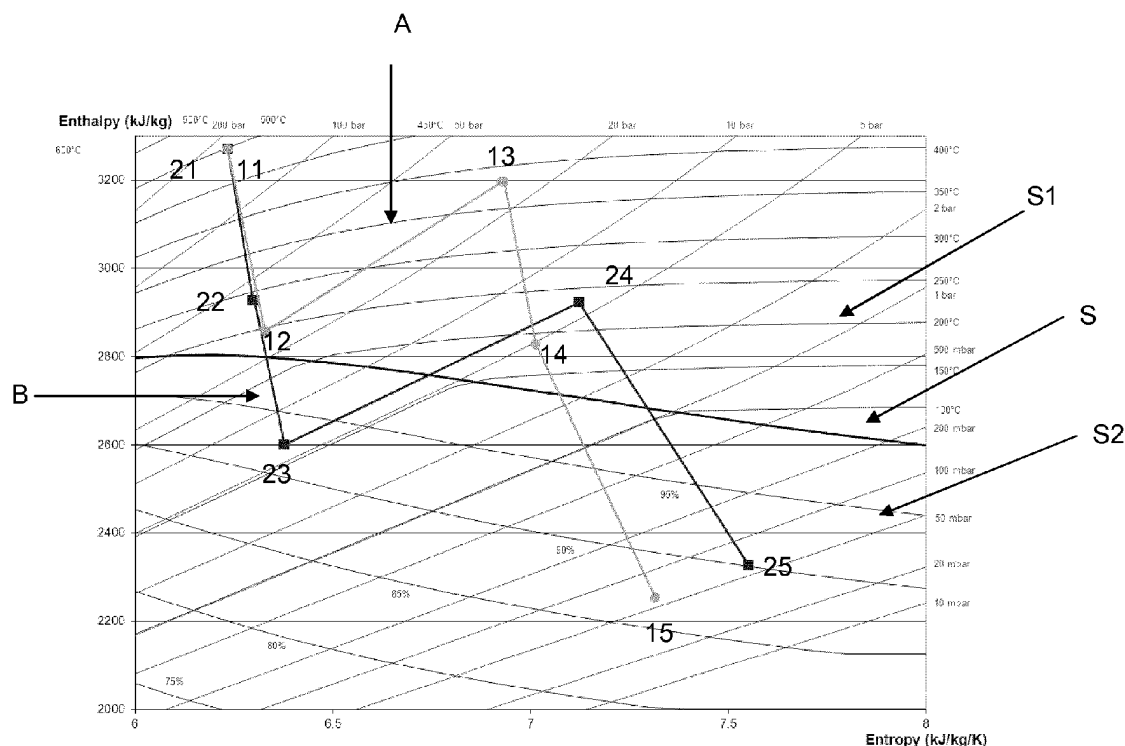


Figure 3

Description

[0001] The present invention relates to an energy conversion cycle for converting energy supplied by a sodium-cooled fast neutron reactor (so-called Sodium Fast Neutron Reactor - FNR).

[0002] The invention relates to a nuclear installation which comprises at least a nuclear reactor, a steam generator, steam turbines and a dryer and/or a super-heater.

[0003] Gaseous or liquid water circulates in a closed circuit through the unit and is subject to variations of temperature and of pressure.

[0004] The term "cycle" refers to changes of temperature and pressure of the gaseous or liquid water between the outlet of the steam generator and the return of same into the steam generator.

[0005] In order to obtain the best cycle efficiencies, the use of a sodium-cooled fast neutron reactor is advantageous.

[0006] However, the temperature and pressure values at the outlet from a sodium-cooled fast neutron reactor are much higher than those generally encountered in a "nuclear cycle" and approach those generally encountered in a "fossil fuel cycle".

[0007] A "nuclear cycle" corresponds to changes of temperature and pressure generally encountered in a nuclear installation which usually operates with steam coming from the outlet of the steam generator, said steam being close to the saturation curve.

[0008] A "fossil fuel cycle" corresponds to changes of temperature and pressure generally encountered in a thermal power station using fossil fuel-fired boilers.

[0009] The sodium-cooled fast neutron reactor of the French Phenix FNR power station employs steam turbine technology enabling operation with steam working at temperature and pressure conditions close to those encountered in a "fossil fuel cycle" thereby allowing the steam to expand when it passes through a high-pressure turbine and a medium-pressure turbine in conditions of dry steam.

[0010] The temperature and pressure conditions in the different components of the installation, namely the turbines and the super-heater, must not be too high so as to have working lives of the order of 60 years.

[0011] Lower temperatures reduce the risk of creep in the different components.

[0012] In this context, the subject of the present invention is an energy conversion cycle for the steam produced by a sodium-cooled fast neutron reactor, which improves the lifetime of the equipment.

[0013] To do this, the inventive energy conversion cycle for the steam produced by a sodium-cooled fast neutron reactor is remarkable in that same has:

- a first stage, in which a first expansion of the steam coming from a steam generator associated with the reactor is performed to bring the steam from a "fossil fuel cycle" initial state to an intermediate state of tem-

perature and pressure of said steam corresponding to a "nuclear cycle" initial state,

- a second stage in which a second expansion of the steam from the intermediate state is performed until steam in a first wet state situated below the steam saturation curve is obtained,
- a third stage in which the steam is dried and super-heated from the first wet state thereof to bring it into a state of drying and super-heating situated above the saturation curve, and
- a fourth stage in which a third expansion of the steam is performed from the super-heated state thereof to a second wet state situated below the steam saturation curve, the steam being then condensed and brought back to the steam generator.

[0014] The cycle of the sodium-cooled fast neutron reactor as claimed in the invention is more situated in the zone of saturated steam than the cycles of sodium-cooled fast neutron reactors of the prior art, while working with the same temperature and pressure conditions directly at the outlet of the steam generator, which conditions are close to those encountered in thermal power stations.

[0015] The cycle as claimed in the invention allows efficiency to be increased compared with that currently obtained with the sodium-cooled fast neutron reactor of the French Phenix FNR power station.

[0016] This cycle can be used for high electrical power reactors to classes above 1500 MWe.

[0017] The invention allows a sodium-cooled fast neutron reactor to be used with standard components currently used for fossil fuel or nuclear power stations.

[0018] The invention thus makes it possible to avoid the implementation of super-heaters, such as those used for the sodium-cooled fast neutron reactor in French FNR power stations, these super-heaters being difficult to design and costly to fabricate.

[0019] The steam, in its "fossil fuel cycle" initial state thereof, is at a pressure comprised between 150 and 200 bars and at a temperature comprised between 450 and 570°C.

[0020] The intermediate state is defined for a pressure comprised between 30 and 50 bars and a temperature comprised between 234 and 300°C.

[0021] The steam in the first wet state thereof is at a temperature comprised between 152 and 188°C and at a pressure comprised between 5 and 12 bars after the second expansion.

[0022] The steam in the drying and super-heating state thereof is at a temperature comprised between 215 and 255°C and a pressure comprised between 5 and 12 bars.

[0023] The steam in the final state thereof is condensed at a temperature which depends on the cold source used.

[0024] The present invention also relates to a steam turbine installation comprising a sodium-cooled fast neutron reactor, for the implementation of the cycle defined

previously, and:

- at least one steam generator,
- a very high-pressure/high-temperature turbine connected to the steam generator of the nuclear reactor, in which a first expansion of the steam coming from the steam generator of the reactor is performed to bring the steam from a "fossil fuel cycle" initial state to an intermediate state of temperature and pressure of said steam corresponding to a "nuclear cycle" initial state,
- an intermediate turbine connected to the very high-pressure/high-temperature turbine, and operating in part with saturated steam, in which a second expansion of the steam is performed from the intermediate state until steam in a first wet state situated below the steam saturation curve is obtained,
- a dryer and a super-heater connected to the intermediate turbine, in which the steam is dried from the first wet state thereof and then super-heated to bring it to a drying and super-heating state situated above the saturation curve, and;
- outlet turbines connected to the dryer and to the super-heater, in which a third expansion of the steam is performed from the super-heated state thereof to a second wet state, the steam being then condensed and brought back to the steam generator.

[0025] Advantageously, a pipe connecting the outlet from the very high-pressure turbine and the super-heater allows heated steam to be drawn off downstream of the very high-pressure turbine, said steam being used by the super-heater.

[0026] The intermediate turbine is a high-pressure turbine and the outlet turbines are either medium and low-pressure turbines or only low-pressure turbines. The low-pressure turbines are supplied in parallel.

[0027] The high-pressure and the medium-pressure turbine (when this exists in the second embodiment) are arranged in a combined unit.

[0028] The very high-pressure/high temperature and the intermediate turbine are arranged so as to expand the steam from a fossil fuel cycle initial state at a pressure comprised between 150 and 200 bars and at a temperature comprised between 450 and 570°C, to a wet steam state the temperature of which is comprised between 152 and 188°C and the pressure of which is comprised between 5 and 12 bars after the first expansion and the second expansion.

[0029] The dryer and the super-heater allow the steam to pass from an initial wet steam state the temperature of which is comprised between 152 and 188°C and the pressure of which is comprised between 5 and 12 bars after the second expansion, to a drying and super-heating state, the pressure of which is comprised between 5 and 12 bars and the temperature of which is comprised between 215 and 255°C.

[0030] The very high-pressure/high-temperature tur-

bine, the intermediate turbine and the outlet turbines (without a medium-pressure turbine) turn, at the network frequency, e.g. at 3000 rpm, an alternator input shaft that produces electrical power of less than 1200 MWe.

[0031] The very high-pressure/high-temperature turbine, the intermediate turbine and the outlet turbines (with a medium-pressure turbine) turn, at half the network frequency, e.g. at 1500 rpm, an alternator input shaft that produces electrical power of greater than 1200 MWe.

[0032] The invention will be better understood and the advantages thereof will appear more clearly with the reading of the following detailed description, given as a non-limiting example, referring to the attached figures.

Figure 1 shows schematically a first embodiment as claimed in the invention of the sodium-cooled fast neutron reactor FNR.

Figure 2 shows schematically a second embodiment as claimed in the invention of the sodium-cooled fast neutron reactor FNR.

Figure 3 is an enthalpy diagram, also called a Mollier diagram, showing, on curve A, an example close to a part of the cycle used in the sodium-cooled fast neutron reactor FNR of the French Phenix power station, and, on curve B, an example of a part of the cycle as claimed in the invention used in a sodium-cooled fast neutron reactor.

[0033] The cycle as claimed in the invention as shown in figure 3 can be implemented by two different steam turbine installations that each present a sodium-cooled fast neutron nuclear reactor 1, 1' which allows energy to be liberated to produce steam in a steam generator 2, 2', a very high-pressure/high-temperature turbine 3, 3', an intermediate turbine 4, 3", and outlet turbines 5, 4', 5', these turbines being suitable for turning an input shaft 6a, 6a' of an alternator 6, 6' which produces electricity.

[0034] The very high-pressure/high-temperature turbine 3, 3' is connected to one or a plurality of steam generators 2, 2' of the nuclear reactor 1, 1', by one or a plurality of pipes, and allows a first expansion of the steam to be made, to bring it from a "fossil fuel cycle" initial state at the outlet from the steam generator 2, 2' of the reactor 1, 1' to an intermediate state of temperature and pressure of the steam, characteristic of a "nuclear cycle" initial state.

[0035] The valves V, V' allow the flow-rate of steam coming from the steam generator(s) 2, 2' to be adjusted.

[0036] In the first embodiment shown in figure 1, the intermediate turbine is a high-pressure turbine 4 connected by a pipe to the very high-pressure/high-temperature turbine 3, operating mainly with saturated steam.

[0037] The high-pressure turbine 4 allows a second expansion of steam to be performed from the intermediate state corresponding to a "nuclear cycle" initial state until steam in a first wet state under the saturation curve S is obtained.

[0038] The drying and super-heating of the steam are

then performed by successively passing into a dryer 7, physically separating liquid water and steam, then into a super-heater 8, these devices being situated in a pipe 12 between the high-pressure turbine 4 and the low-pressure turbines 5.

[0039] The super-heater 8 situated downstream of the dryer 7 and upstream of the low-pressure turbines 5, and a drawing-off of the steam exiting the very high-pressure/high-temperature turbine 3, allow the steam to be super-heated to bring it to a super-heated state above the saturation curve S. A pipe 13 connecting the outlet from the very high-pressure turbine 3 and the super-heater 8 allows heated steam to be drawn off that is used by the super-heater 8, downstream of the very high-pressure turbine 3.

[0040] The two low-pressure turbines 5 supplied in parallel and connected to the dryer 7 and to the super-heater 8 by a pipe 12 allow a third expansion of steam to be performed from its super-heated state to a final state. More than two low-pressure turbines 5 can be used to perform this third expansion.

[0041] Water recovered from the dryer 7 and from the super-heater 8 is sent back into the cycle by pipes 11.

[0042] A system 9, 10 of a condenser, re-heaters and pumps is used to bring condensed steam into the steam generator 2, but is not described here and is known from the prior art.

[0043] This installation can produce electrical power of the order of 600 to 1200 Mwe.

[0044] In the second embodiment shown in figure 2, the intermediate turbine is a high-pressure turbine 3" connected by a pipe to the very high-pressure/high-temperature turbine 3', operating mainly with saturated steam.

[0045] The high-pressure turbine 3" allows a second expansion of steam to be performed from the intermediate state corresponding to a "nuclear cycle" initial state until steam in a first wet state under the saturation curve S is obtained.

[0046] The drying and super-heating of the steam are then performed by successively passing said steam into a dryer 7 physically separating liquid water and steam, then into a super-heater 8, these devices being situated in pipes between the high-pressure turbine 3" and a medium-pressure turbine 4'.

[0047] The super-heater 8' situated downstream of the dryer 7' and upstream of the medium-pressure turbine 4', and a drawing-off of the steam exiting the very high-pressure/high-temperature turbine 3', allow the steam to be super-heated to bring said steam to a super-heated state above the saturation curve S.

[0048] A pipe 13' connecting the outlet from the very high pressure turbine 3' and the super-heater 8' allows heated steam to be drawn off downstream of the very high-pressure turbine 3' used by the super-heater 8'.

[0049] It is shown in figure 2 that the high-pressure turbine 3" and the medium-pressure turbine 4' are arranged in a single combined unit.

[0050] The medium-pressure turbine 4' and the two low-pressure turbines 5' supplied in parallel and connected to the medium-pressure turbine 4' by a pipe 12' allow a third expansion of steam to be performed from the super-heated state thereof to a final state. More than two low-pressure turbines 5' can be used to produce this third expansion.

[0051] Water recovered at the level of the dryer 7' and from the super-heater 8' is sent back into the cycle by pipes 11'.

[0052] A system 9', 10' of a condenser, re-heaters and pumps is used to bring condensed steam into the steam generator 2', but is not described here and is known from the prior art.

[0053] As shown in figure 3, a Mollier diagram represents the entropy on the abscissa and the enthalpy of a fluid on the ordinate.

[0054] In particular, it allows a fluid to change state as a function of temperature and pressure.

[0055] Here, the fluid is water and a saturation curve S of water is shown in this diagram.

[0056] The saturation curve S corresponds to the limit between two domains, the water takes, for a given entropy, the form of dry steam for enthalpies greater than the enthalpy of the saturation curve S, and the form of saturated steam (or wet steam) for enthalpies less than the enthalpy of the saturation curve S. The name of dry saturated steam is given to the state of water just on the saturation curve S. The water content of wet steam increases as the enthalpy decreases, until attaining a water content of 1 when all of the steam phase is condensed into liquid water.

[0057] In other terms, the saturation curve S delimits a domain of saturated wet steam S2, with respect to a gaseous domain of dry, super-heated steam S1.

[0058] Curve A represents a cycle similar to that used in a sodium-cooled fast neutron reactor of the French Phenix power station FNR.

[0059] Curve B represents a cycle used in a sodium-cooled fast neutron reactor FNR as claimed in the invention.

[0060] In the cycle of curve A of the prior art, the steam coming from one or a plurality of steam generators of the reactor is at a temperature of around 500°C and at a pressure of the order of 180 bars.

[0061] After a first expansion in a very high-pressure turbine between points 11 and 12, the steam is at a temperature of the order of 250°C and at a pressure of the order of 30 bars.

[0062] The steam is then super-heated up to point 13. Between points 12 and 13, the temperature increases from 250°C to 380°C while the pressure stays constant overall, of the order of 30 bars.

[0063] The steam is then expanded up to point 14 by a medium-pressure turbine. Between points 13 and 14, the pressure decreases from 30 bars to 5 bars and the temperature decreases from 380°C to 180°C.

[0064] The steam is then expanded up to point 15 by

low-pressure turbines.

[0065] A condenser and systems of heat exchangers and pumps then allow the condensed steam to be re-injected into the steam generator or generators of the reactor.

[0066] In a cycle as claimed in the invention, as shown in figure 3, the steam coming out from the steam generator or generators 2, 2' of the reactor 1, 1' is at a temperature of around 500°C and at a pressure of around 180 bars, this initial state being shown by point 21 that coincides with point 11.

[0067] But, in a "nuclear cycle", the initial point is usually close to the saturation curve S.

[0068] A first expansion therefore brings the steam which is at a temperature of 500°C and at a pressure of 180 bars at point 21 to an intermediate state with temperature and pressure corresponding to point 22, properties close to the initial point of a "traditional nuclear cycle".

[0069] The first expansion thus brings the steam from point 21 to point 22 corresponding to the "nuclear cycle" initial state, situated above the saturation curve S.

[0070] At point 22, the steam is substantially at a temperature of 280°C and at a pressure of 40 bars, in figure 3.

[0071] The steam is expanded between point 22 and point 23 where same is in a first wet state.

[0072] At point 23, the steam is substantially at a temperature of 170°C and at a pressure of 7 bars.

[0073] The steam is dried and super-heated from the first wet state thereof at point 23, to a first dried and super-heated state represented by point 24, the pressure remaining substantially constant.

[0074] At point 24, the steam is substantially at a temperature of 240°C and at a pressure of 7 bars.

[0075] The steam is then expanded between point 24 and a final point 25.

[0076] At point 25, the steam is substantially at a temperature of 35°C and at a pressure of 60 mbars.

[0077] These values are given only as an example and depend on the steam conditions given at the heat source at point 21 and the cold source at point 25.

[0078] For point 21, it can be arranged that the steam is at a temperature comprised between 450 and 570°C and at a pressure comprised between 150 and 200 bars in the "fossil fuel cycle" initial state.

[0079] For point 22, it can be arranged that the steam is at a temperature comprised between 234 and 300°C and at a pressure comprised between 30 and 50 bars after the second expansion.

[0080] For point 23, it can be arranged that the steam, in the first wet state, is at a temperature comprised between 152 and 188°C and a pressure comprised between 5 and 12 bars after the second expansion.

[0081] For point 24, it can be arranged, after drying and super-heating, for the steam to be at a temperature comprised between 215 and 255°C and a pressure comprised between 5 and 12 bars.

[0082] For point 25, after the third expansion, the

steam in the second wet state is condensed at a temperature which depends on the cold source used for the reactor.

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Claims

1. An energy conversion cycle for the steam produced by a sodium-cooled fast neutron reactor, wherein same has:

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- a first stage, in which a first expansion of steam coming from a steam generator (2) associated with the reactor (1) is performed to bring the steam from a "fossil fuel cycle" initial state (21) to an intermediate state of temperature and pressure of said steam corresponding to a "nuclear cycle" initial state (22),

- a second stage in which a second expansion of the steam from the intermediate state (22) is performed until steam in a first wet state (23) situated below the steam saturation curve (S) is obtained,

- a third stage in which the steam is dried and super-heated from the first wet state thereof (23) to bring it into a state of drying and super-heating (24) situated above the saturation curve (S), and

- a fourth stage in which a third expansion of the steam is performed from the super-heated state (24) thereof to a second wet state (25) situated below the steam saturation curve (S), the steam being then condensed and brought back to the steam generator.

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2. The cycle as claimed in claim 1 wherein the steam in the "fossil fuel cycle" initial state (21) thereof is at a pressure comprised between 150 and 200 bars and at a temperature comprised between 450 and 570°C.

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3. The cycle as claimed in either claim 1 or 2 wherein the intermediate state (22) is defined for a pressure comprised between 30 and 50 bars and a temperature comprised between 234 and 300°C.

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4. The cycle as claimed in any of the claims 1 to 3 wherein the steam in the first wet state thereof (23) is at a temperature comprised between 152 and 188°C and at a pressure comprised between 5 and 12 bars after the second expansion.

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5. The cycle as claimed in any of the claims 1 to 4 wherein the steam in the state of drying and super-heating (24) thereof is at a temperature comprised between 215 and 255°C and at a pressure comprised between 5 and 12 bars.

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6. The cycle as claimed in any of the claims 1 to 5

wherein the steam in the final state (25) thereof is condensed at a temperature which depends on the cold source used.

7. A steam turbine installation comprising a sodium-cooled fast neutron nuclear reactor (1, 1') wherein same comprises, for the implementation of a cycle as claimed in any of claims 1 to 6:

- at least a steam generator (2, 2'),
- a very high-pressure/high-temperature turbine (3, 3') connected to the steam generator (2, 2') of the nuclear reactor (1, 1'), in which a first expansion of the steam coming from the steam generator (2, 2') of the reactor (1, 1') is performed to bring the steam from a "fossil fuel cycle" initial state (21) to an intermediate state of temperature and pressure of said steam corresponding to a "nuclear cycle" initial state (22),
- an intermediate turbine (4, 3'') connected to the very high-pressure/high-temperature turbine (3, 3') and operating in part with saturated steam, in which a second expansion of the steam is performed from the intermediate state (22) until steam in a first wet state (23) situated below the steam saturation curve (S) is obtained,
- a dryer (7, 7') and a super-heater (8, 8') connected to the intermediate turbine (4, 3''), in which the steam is dried from the first wet state (23) thereof and then super-heated to bring it to a drying and super-heating state (24) situated above the saturation curve (S), and
- outlet turbines (5, 4', 5') connected to the dryer (7, 7') and to the super-heater (8, 8'), in which a third expansion of the steam is performed from the super-heated state (24) thereof to a second wet state (25), the steam being then condensed and brought back to the steam generator (2, 2').

8. The steam turbine installation as claimed in claim 7, wherein a pipe (13, 13') connecting the outlet of the very high pressure turbine (3, 3') and the super-heater (8, 8') allows heated steam to be drawn-off downstream of the very high pressure turbine (3, 3'), said steam being used by the super-heater (8, 8').

9. The steam turbine installation as claimed in claim 7 or 8, wherein the intermediate turbine is a high-pressure turbine (4) and the outlet turbines are low-pressure turbines (5) supplied in parallel.

10. The steam turbine installation as claimed in claim 7 or 8, wherein the intermediate turbine is a high-pressure turbine (3''), and the outlet turbines are a medium-pressure turbine (4') and low-pressure turbines (5') supplied in parallel.

11. The steam turbine installation as claimed in claim

10, wherein the high-pressure turbine (3'') and the medium-pressure turbine (4') are arranged in a combined unit.

12. The steam turbine installation as claimed in claims 7 to 11, wherein the very high-pressure/high-temperature turbine (3, 3') and the intermediate turbine (4, 3'') are arranged so as to expand the steam from a fossil fuel cycle initial state (21) at a pressure comprised between 150 and 200 bars and at a temperature comprised between 450 and 570°C, to a wet steam state (23) the temperature of which is comprised between 152 and 188°C and the pressure of which is comprised between 5 and 12 bars after the first expansion and the second expansion.

13. The steam turbine installation as claimed in claims 7 to 12, wherein the dryer (7, 7') and the super-heater (8, 8') allow the steam to pass from an initial wet steam state (23) the temperature of which is comprised between 152 and 188°C and the pressure of which is comprised between 5 and 12 bars after the second expansion, to a drying and super-heating state (24) the pressure of which is comprised between 5 and 12 bars and the temperature of which is comprised between 215 and 255°C.

14. The steam turbine installation as claimed in one of the claims 7, 8, 9, 12 and 13, wherein the very high-pressure/high-temperature turbine (3), the intermediate turbine (4), and the outlet turbines (5) turn, at the network frequency, an alternator input shaft (6) that produces electrical power of less than 1200 MWe.

15. The steam turbine installation as claimed in one of the claims 7, 8, 10, 11, 12 and 13, wherein the very high-pressure/high-temperature turbine (3') the intermediate turbine (3''), and the outlet turbines (4', 5') turn, at half the network frequency, an alternator input shaft (6') that produces electrical power of greater than 1200 MWe.

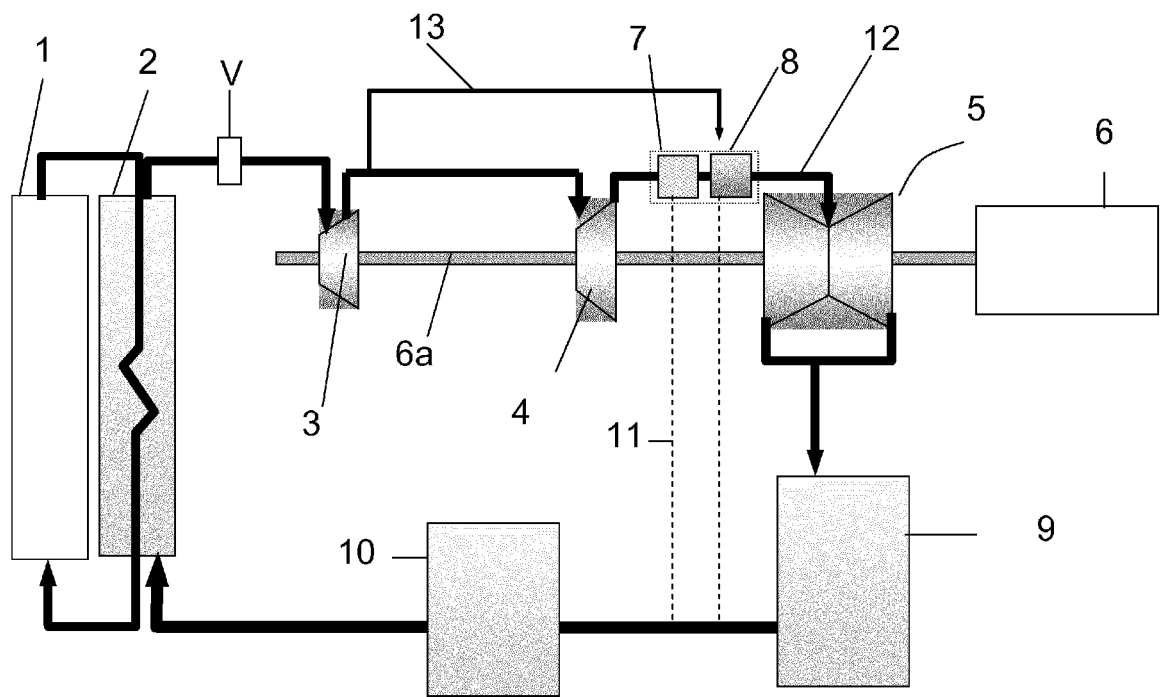


Figure 1

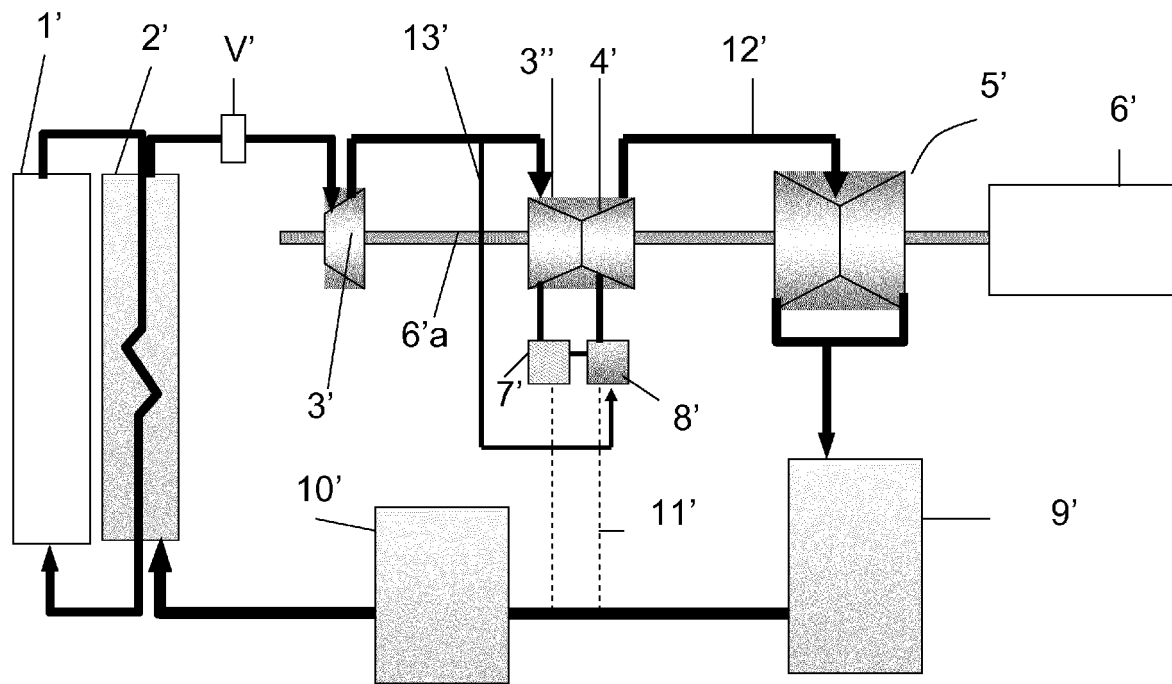


Figure 2

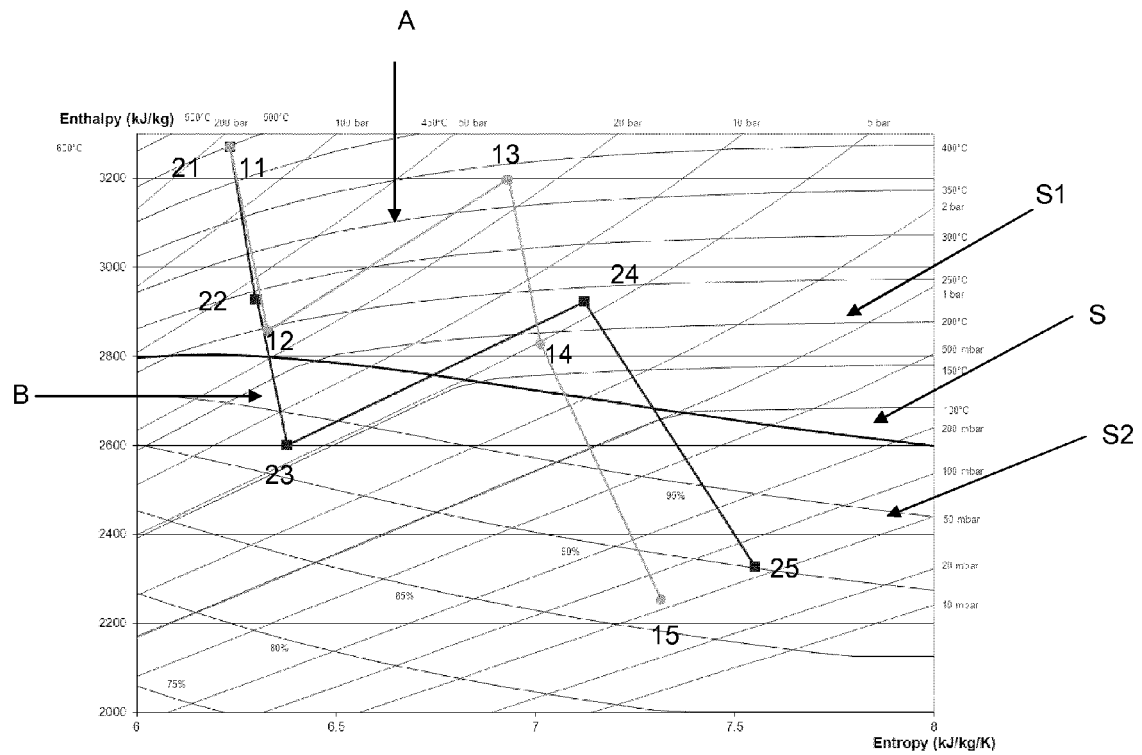


Figure 3



EUROPEAN SEARCH REPORT

Application Number
EP 13 18 4602

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	EP 0 163 564 A1 (COMMISSARIAT ENERGIE ATOMIQUE [FR]) 4 December 1985 (1985-12-04) * page 1, line 3 - line 17 * * page 21, line 23 - line 4 * * figure 7 * -----	1-15	INV. F01K7/22 F22B1/06
A	EP 0 147 304 A2 (COMMISSARIAT ENERGIE ATOMIQUE [FR]) 3 July 1985 (1985-07-03) * page 9, line 27 - page 10, line 18; figure 1 * -----	1-15	
			TECHNICAL FIELDS SEARCHED (IPC)
			F01K F22B
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 10 October 2013	Examiner Coquau, Stéphane
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03/82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 13 18 4602

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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10-10-2013

Patent document cited in search report		Publication date		Patent family member(s)		Publication date
EP 0163564	A1	04-12-1985	DE	3564054 D1		01-09-1988
			EP	0163564 A1		04-12-1985
			FR	2564229 A1		15-11-1985
			JP	S60244891 A		04-12-1985
			US	4705662 A		10-11-1987

EP 0147304	A2	03-07-1985	DE	3464794 D1		20-08-1987
			EP	0147304 A2		03-07-1985
			FR	2557280 A1		28-06-1985
			JP	S60155801 A		15-08-1985
			US	4633819 A		06-01-1987
