



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
26.12.2018 Bulletin 2018/52

(51) Int Cl.:
F25B 43/02 (2006.01) **F22B 37/50** (2006.01)
F01K 13/00 (2006.01)

(21) Application number: **18174722.1**

(22) Date of filing: **29.05.2018**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

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(30) Priority: **21.06.2017 JP 2017121576**

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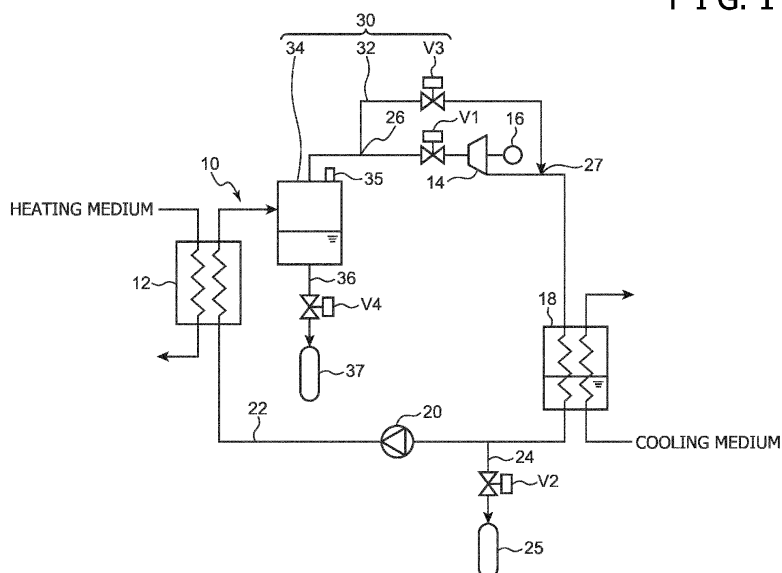
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(54) **IMPURITY RECOVERY METHOD AND OIL RECOVERY METHOD**

(57) An impurity recovery method capable of omitting operations of separating impurities outside the system is provided. A method for recovering impurities in a working medium from a thermal energy recovery device (10) includes: a preparation step of preparing an impurity recovery unit having a bypass flow path (32), a bypass valve (V3), and a separator (34); a connection step of connecting the bypass flow path to a circulation flow path (22); a separator installation step of installing the separator; a valve opening/closing step of closing a shutoff

valve (V1) and opening the bypass valve (V3) in a state that supplies of the heating medium to an evaporator (12) and the cooling medium to a condenser (18) are maintained and a pump (20) is driven; a pump stopping step of stopping the pump when a condition where a predetermined amount of impurities is accumulated in the separator (34) is established; and an impurity recovery step of recovering the impurities from the separator via a liquid extraction valve (V4).

FIG. 1



Description

BACKGROUND OF THE INVENTION

(FIELD OF THE INVENTION)

[0001] The present invention relates to an impurity recovery method and an oil recovery method in a thermal energy recovery device.

(DESCRIPTION OF THE RELATED ART)

[0002] Conventionally, a thermal energy recovery device for recovering power from exhaust heat from various facilities of a factory and the like is known. For example, JP 2016-79881 A discloses a thermal energy recovery device including an evaporator, an expander, a power recovery machine, a condenser, a pump, and a circulation flow path. The evaporator evaporates a working medium flowing out of the evaporator. The power recovery machine is connected to the expander and recovers power in association with driving of the expander. The condenser condenses the working medium flowing out of the expander. The pump sends the working medium flowing out of the condenser to the evaporator.

[0003] Ordinary, in such a thermal energy recovery device, in order to separate impurities or oil contained in a working medium, after recovering a working medium in the liquid phase from the inside of the system (for example, the inside of the condenser) and separating impurities or oil from the working medium, only the working medium in the liquid phase is returned to the inside of the system.

[0004] In a method for recovering impurities or oil from a working medium in the thermal energy recovery device as described in JP 2016-79881 A, operations outside the system may be complicated.

[0005] An object of the present invention is to provide an impurity recovery method capable of omitting an operation of separating impurities on the outside of the system and an oil recovery method capable of omitting an operation of separating oil on the outside of the system.

[0006] In order to achieve the above object, the present invention provides a method for recovering impurities contained in a working medium and having a boiling point higher than that of the working medium from a thermal energy recovery device including: an evaporator for evaporating the working medium by heating the working medium with a heating medium; an expander for expanding the working medium flowing out of the evaporator; a power recovery machine connected to the expander; a condenser for condensing the working medium flowing out of the expander by cooling the working medium with a cooling medium, a pump for sending the working medium flowing out of the condenser to the evaporator; and a circulation flow path for connecting the evaporator, the expander, the condenser, and the pump in this order, the

impurity recovery method including: a preparation step of preparing an impurity recovery unit having a bypass flow path capable of bypassing a shutoff valve and the expander, a bypass valve provided in the bypass flow path, and a separator for separating impurities contained in the working medium; a connection step of connecting the bypass flow path to the circulation flow path so as to bypass the shutoff valve and the expander; a separator installation step of installing the separator in a portion on a downstream side of the circulation flow path than the evaporator and on an upstream side of the circulation flow path than an upstream side connection which is a connection between the circulation flow path and an upstream side end of the bypass flow path, and in a portion, of the bypass flow path or the circulation flow path, on a downstream side than a downstream side connection which is a connection between the circulation flow path and a downstream side end of the bypass flow path and on an upstream side than the condenser; a valve opening and closing step of closing the shutoff valve and opening the bypass valve in a state that supply of the heating medium to the evaporator and supply of the cooling medium to the condenser are maintained and the pump is driven; a pump stopping step of stopping the pump when a condition showing that a predetermined amount of impurities is accumulated in the separator is established; and an impurity recovery step of recovering the impurities from the separator.

[0007] In the present impurity recovery method, by going through the connection step, the separator installation step, and the valve opening and closing step, the working medium is circulated inside of the system while bypassing the expander, so impurities contained in the working medium are separated by the separator in that process. Then, in the pump stopping step, the pump is stopped when a condition showing that a predetermined amount of impurities in the liquid phase is accumulated in the separator (that, for example, a predetermined time passes after closing the shutoff valve and opening the bypass valve) is established. Thereby, impurities are separated from the working medium in the inside of the system. Therefore, after that, by recovering the impurities in the liquid phase from the separator in the impurity recovery step, separation operation of impurities from the working medium in the outside of the system can be omitted.

[0008] In this case, preferably, the impurity recovery method further includes a working medium recovery step of recovering the working medium before the impurity recovery step, and in the working medium recovery step, by evacuating a portion of the bypass flow path or the circulation flow path where the working medium in the gas phase exists, the working medium in the liquid phase contained in the impurities in the liquid phase within the separator is vaporized and the working medium in the gas phase is recovered from the portion.

[0009] In this way, the purity of the impurities recovered from the separator is increased. Specifically, in the working medium recovery step, the working medium in the

liquid phase contained in the impurities in the liquid phase within the separator is vaporized by evacuation and the working medium in the gas phase is recovered, so the purity of the impurities recovered from the separator in the impurity recovery step performed after the working medium recovery step is increased.

[0010] Specifically, preferably, in the working medium recovery step, after recovering the working medium in the liquid phase from the portion of the condenser or the circulation flow path where the working medium in the liquid phase exists, the working medium contained in the separator is vaporized and recovered.

[0011] In this way, the working medium is efficiently recovered.

[0012] Further, preferably, in the impurity recovery step, the impurities are recovered from the inside of the separator in a state that the inside of the separator is maintained at a positive pressure.

[0013] In this way, back flow of outside air to the separator is suppressed, so recovery of impurities becomes smooth.

[0014] Moreover, preferably, in the separator installation step, the separator is installed in the bypass flow path.

[0015] In this way, the configuration of the circulation flow path does not need to be changed in order for installation of the separator, so it is possible to easily connect the impurity recovery unit to the existing thermal energy recovery device.

[0016] Moreover, the present invention provides a method for recovering oil from a thermal energy recovery device including: an evaporator for evaporating a working medium by heating the working medium with a heating medium; an expander for expanding the working medium flowing out of the evaporator while being supplied with oil, a power recovery machine connected to the expander; a condenser for condensing the working medium flowing out of the expander by cooling the working medium with a cooling medium; a pump for sending the working medium flowing out of the condenser to the evaporator, a circulation flow path for connecting the evaporator, the expander, the condenser, and the pump in this order; a bypass flow path which is connected to the circulation flow path and bypasses the expander; a bypass valve which is provided in the bypass flow path and can be opened and closed; a shutoff valve provided in a portion, of the circulation flow path, on a downstream side than an upstream side connection which is a connection between the circulation flow path and an upstream side end of the bypass flow path and on an upstream side than the expander; a separator which is provided in a portion, of the circulation flow path, on a downstream side than the evaporator and on an upstream side than the upstream side connection, and in a portion, of the bypass flow path or the circulation flow path, on a downstream side than a downstream side connection which is a connection between the circulation flow path and a downstream side end of the bypass flow path and on an up-

stream side than the condenser, and separates oil contained in the working medium; and an oil supply flow path for supplying oil in the separator to the expander, the oil recovery method including: a valve opening and closing step of closing the shutoff valve and opening the bypass valve in a state that supply of the heating medium to the evaporator and supply of the cooling medium to the condenser are maintained and the pump is driven; a pump stopping step of stopping the pump when a condition showing that a predetermined amount of oil is accumulated in the separator is established; and an oil recovery step of recovering the oil from the separator.

[0017] In the present oil recovery method, by going through the valve opening and closing step, the working medium is circulated inside of the system while bypassing the expander, so oil contained in the working medium is separated by the separator in that process. Therefore, after that, by going through the pump stopping step and the oil recovery step, separation operation of oil from the working medium in the outside of the system can be omitted also in the present method.

[0018] As described above, according to the present invention, it is possible to provide an impurity recovery method capable of omitting an operation of separating impurities on the outside of the system and an oil recovery method capable of omitting an operation of separating oil on the outside of the system.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019]

FIG. 1 is a diagram for explaining an impurity recovery method of a first embodiment of the present invention.

FIG. 2 is a diagram for explaining a modification of the impurity recovery method.

FIG. 3 is a diagram for explaining an impurity recovery method of a second embodiment of the present invention.

FIG. 4 is a diagram for explaining an impurity recovery method of a third embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0020] Hereinafter, modes for carrying out the present invention will be described in detail with reference to the drawings.

(First Embodiment)

[0021] An impurity recovery method of a first embodiment of the present invention will be described with reference to FIG. 1. FIG. 1 shows a thermal energy recovery device 10 to which an impurity recovery unit 30 is connected (in a state that a connection step and a separator installation step are finished).

[0022] The thermal energy recovery device 10 has an evaporator 12, an expander 14, a power recovery machine 16, a condenser 18, a pump 20, and a circulation flow path 22 which connects the evaporator 12, the expander 14, the condenser 18, and the pump 20 in this order.

[0023] The evaporator 12 evaporates a working medium by exchanging heat between the working medium and a heating medium (such as exhaust gas of engine).

[0024] The expander 14 is provided in a portion on a downstream side of the circulation flow path 22 than the evaporator 12. The expander 14 expands the working medium in the gas phase flowing out of the evaporator 12. For example, as the expander 14, a positive displacement screw expander having a rotor rotationally driven by expansion energy of the working medium in the gas phase is used.

[0025] The power recovery machine 16 is connected to the expander 14. The power recovery machine 16 recovers power from the working medium by rotating in association with driving of the expander 14. In the present embodiment, a generator is used as the power recovery machine 16. In addition, a compressor and the like may be used as the power recovery machine 16.

[0026] The condenser 18 is provided in a portion on a downstream side of the circulation flow path 22 than the expander 14. The condenser 18 condenses the working medium by exchanging heat between the working medium flowing out of the expander 14 and a cooling medium (such as cooling water).

[0027] The pump 20 is provided in a portion (a portion between the condenser 18 and the evaporator 12) on a downstream side of the circulation flow path 22 than the condenser 18. The pump 20 sends the working medium in the liquid phase flowing out of the condenser 18 to the evaporator 12.

[0028] In the circulation flow path 22, a shutoff valve V1 and a liquid extraction flow path 24 are provided. The shutoff valve V1 is provided in a portion of the circulation flow path 22 between the evaporator 12 and the expander 14. The liquid extraction flow path 24 is provided in a portion of the circulation flow path 22 between the condenser 18 and the pump 20. The liquid extraction flow path 24 is a flow path for extracting (recovering) the working medium in the liquid phase from the circulation flow path 22 to the outside. In the liquid extraction flow path 24, a liquid extraction valve V2 which can be opened and closed is provided.

[0029] The impurity recovery unit 30 is a unit for recovering impurities contained in the working medium and having a boiling point higher than that of the working medium from the thermal energy recovery device 10. The impurity recovery unit 30 has a bypass flow path 32, a bypass valve V3, and a separator 34.

[0030] The bypass flow path 32 can be connected to the circulation flow path 22 so as to bypass the shutoff valve V1 and the expander 14.

[0031] The bypass valve V3 is provided in the bypass

flow path 32 and can be opened and closed.

[0032] The separator 34 can separate the impurities in the liquid phase contained in the working medium. As the separator 34, a demister separator or a cyclone separator is preferably used. In the separator 34, an impurity recovery flow path 36 for recovering the impurities in the liquid phase is provided. In the impurity recovery flow path 36, a liquid extraction valve V4 which can be opened and closed is provided.

[0033] Next, the impurity recovery method will be described. The impurity recovery method of the present embodiment includes a connection step, a separator installation step, a valve opening and closing step, a pump stopping step, a working medium recovery step, and an impurity recovery step.

[0034] In the connection step, the bypass flow path 32 is connected to the circulation flow path 22 so as to bypass the shutoff valve V1 and the expander 14. In addition, at this time, the thermal energy recovery device 10 is stopped.

[0035] In the separator installation step, the separator 34 is installed (connected). In the present embodiment, the separator 34 is installed in a portion, of the circulation flow path 22, on a downstream side than the evaporator 12 and on an upstream side than an upstream side connection 26. The upstream side connection 26 is a connection of the circulation flow path 22 between the circulation flow path 22 and an upstream side end of the bypass flow path 32. However, as shown in FIG. 2, the separator 34 may be provided in the bypass flow path 32. Alternatively, the separator 34 may be provided in a portion, of the circulation flow path 22, on a downstream side than a downstream side connection 27 and on an upstream side than the condenser 18. The downstream side connection 27 is a connection between the circulation flow path 22 and a downstream side end of the bypass flow path 32.

[0036] The valve opening and closing step is performed after the connection step and the separator installation step. Before the valve opening and closing step, the shutoff valve V1 is opened, and the respective liquid extraction valves V2, V4 and the bypass valve V3 are closed. In the valve opening and closing step, the shutoff valve V1 is closed and the bypass valve V3 is opened in a state that supply of the heating medium to the evaporator 12 and supply of the cooling medium to the condenser 18 are maintained and the pump 20 is driven. Then, the working medium is circulated inside of the system while bypassing the expander 14. Thereby, in the separator 34, the impurities in the liquid phase are accumulated.

[0037] Then, in the pump stopping step after the valve opening and closing step, the pump 20 is stopped when a condition showing that a predetermined amount of impurities in the liquid phase is accumulated in the separator 34 (for example, showing that a predetermined time is passed after closing the shutoff valve V1 and opening the bypass valve V3, or that a liquid level of the separator

34 is reached to a threshold value) is established.

[0038] Thereafter, in the working medium recovery step, the liquid extraction valve V2 is opened, and the working medium in the liquid phase is recovered from the inside of the system through the liquid extraction flow path 24 into a container 25 such as a cylinder. Moreover, in the impurity recovery step, the liquid extraction valve V4 is opened, and the impurities in the liquid phase are recovered from the separator 34 through the impurity recovery flow path 36 into a container 37 such as a cylinder.

[0039] As described above, in the impurity recovery method of the present embodiment, by going through the connection step, the separator installation step, and the valve opening and closing step, the working medium is circulated inside of the system while bypassing the expander 14, so impurities contained in the working medium are separated by the separator 34 in that process. Then, in the pump stopping step, the pump 20 is stopped when a condition showing that a predetermined amount of impurities in the liquid phase is accumulated in the separator 34 is established. Thereby, impurities are separated from the working medium in the inside of the system. Therefore, after that, by recovering the impurities in the liquid phase from the separator 34 in the impurity recovery step, separation operation of impurities from the working medium on the outside of the system can be omitted.

(Second Embodiment)

[0040] Next, with reference to FIG. 3, an impurity recovery method of a second embodiment of the present invention will be described. It should be noted that, in the second embodiment, only the parts different from the first embodiment will be described and the description of the same structures, operations and effects as the first embodiment will be omitted.

[0041] In the present embodiment, the working medium recovery step and the impurity recovery step are different from those of the first embodiment. In the working medium recovery step of the present embodiment, a gas vent unit 40 is used.

[0042] The gas vent unit 40 includes a gas vent flow path 41, a gas vent valve V5 which can be opened and closed, a vacuum pump 42, a compressor 43, a condenser 44 which condenses the working medium in the gas phase, and a container 45 such as a cylinder. The gas vent flow path 41 is connected to a portion of the circulation flow path 22 between the downstream side connection 27 and the condenser 18. In addition, not only to that portion, the gas vent flow path 41 may be connected to a portion of the bypass flow path 32 or the circulation flow path 22 where the working medium in the gas phase exists. The gas vent valve V5, the vacuum pump 42, the compressor 43, the condenser 44, and the container 45 are connected to the gas vent flow path 41 in this order. In addition, the gas vent valve V5 is closed before the working medium recovery step.

[0043] Next, the working medium recovery step and the impurity recovery step of the present embodiment will be specifically described.

[0044] In the working medium recovery step, firstly, the liquid extraction valve V2 is opened, and the working medium in the liquid phase is recovered from the inside of the system through the liquid extraction flow path 24 into the container 25. In addition, as shown in FIG. 3, the liquid extraction flow path 24 may be provided in a bottom of the condenser 18. After recovering the working medium in the liquid phase, the working medium in the liquid phase contained in (blended into) the impurities in the liquid phase within the separator 34 is vaporized and the working medium in the gas phase is recovered. Specifically, after recovering the working medium in the liquid phase through the liquid extraction flow path 24, the liquid extraction valve V2 is closed and the gas vent valve V5 is opened, and the vacuum pump 42 and the compressor 43 are driven to supply a cooling medium (such as cooling water) to the condenser 44. Then, pressure inside the system begins to reduce. Thereby, the working medium in the liquid phase contained in the impurities in the liquid phase within the separator 34 is vaporized, and the resulting working medium in the gas phase flows into the gas vent flow path 41 via the bypass flow path 32. That working medium is liquefied by the condenser 44 and stored in the container 45.

[0045] In the present embodiment, the impurity recovery step is performed after the working medium recovery step. Since the internal pressure of the system becomes negative by the working medium recovery step, in the impurity recovery step, the impurities in the liquid phase are recovered from the inside of the separator 34 in a state that the internal pressure of the separator 34 is maintained to be positive. Specifically, a valve 35 provided in a top of the separator 34 is opened, and respective on-off valves V6, V7 provided respectively on the upstream side and the downstream side of the separator 34 in the circulation flow path 22 are closed, thereafter the liquid extraction valve V4 is opened.

[0046] As described above, in the present embodiment, since the working medium accumulated with the impurities in the separator 34 is recovered in the working medium recovery step, the purity of the impurities in the liquid phase recovered from the separator 34 in the impurity recovery step performed after the working medium recovery step is increased.

[0047] Further, in the impurity recovery step, the internal pressure of the separator 34 is maintained to be positive, so back flow of outside air to the separator 34 is suppressed. Therefore, recovery of impurities becomes smooth.

(Third Embodiment)

[0048] Next, with reference to FIG. 4, an oil recovery method of a third embodiment of the present invention will be described. It should be noted that, in the third

embodiment, only the parts different from the second embodiment will be described and the description of the same structures, operations and effects as the second embodiment will be omitted.

[0049] The thermal energy recovery device of the present embodiment has the bypass flow path 32, the bypass valve V3, the separator 34, and an oil supply flow path 28, in addition to the evaporator 12, the expander 14, the power recovery machine 16, the condenser 18, the pump 20, and the circulation flow path 22. In the present embodiment, an oil supply type expander (a screw expander having a bearing and a rotor) is used as the expander 14, and the separator 34 separates oil contained in the working medium. The oil supply flow path 28 is a flow path for supplying the oil in the separator 34 to the bearing of the expander 14. That is, the separator 34 of the present embodiment is provided for the purpose of constantly supplying oil to the expander 14 during operation of the thermal energy recovery device.

[0050] Next, the oil recovery method of the present embodiment will be described. The configuration of the thermal energy recovery device of the present embodiment is substantially equivalent to the configuration of the first embodiment and second embodiment after the connection step and the separator installation step are finished, except for the oil supply flow path 28. That is, the present oil recovery method includes the valve opening and closing step, the pump stopping step, the working medium recovery step, and the impurity recovery step. In addition, the operations in the respective steps are the same as those of the above embodiments.

[0051] As described above, also in the present embodiment, by going through the valve opening and closing step, the working medium is circulated inside of the system while bypassing the expander 14, so oil contained in the working medium is separated by the separator 34 in that process. Therefore, after that, by going through the pump stopping step and the oil recovery step, separation operation of oil from the working medium on the outside of the system can be omitted.

[0052] An impurity recovery method capable of omitting operations of separating impurities outside the system is provided. A method for recovering impurities in a working medium from a thermal energy recovery device includes: a preparation step of preparing an impurity recovery unit having a bypass flow path, a bypass valve, and a separator; a connection step of connecting the bypass flow path to a circulation flow path; a separator installation step of installing the separator; a valve opening/closing step of closing a shutoff valve and opening the bypass valve in a state that supplies of the heating medium to an evaporator and the cooling medium to a condenser are maintained and a pump is driven; a pump stopping step of stopping the pump when a condition where a predetermined amount of impurities is accumulated in the separator is established; and an impurity recovery step of recovering the impurities from the separator.

Claims

1. A method for recovering impurities contained in a working medium and having a boiling point higher than that of the working medium from a thermal energy recovery device comprising: an evaporator for evaporating the working medium by heating the working medium with a heating medium; an expander for expanding the working medium flowing out of the evaporator; a power recovery machine connected to the expander; a condenser for condensing the working medium flowing out of the expander by cooling the working medium with a cooling medium, a pump for sending the working medium flowing out of the condenser to the evaporator; and a circulation flow path for connecting the evaporator, the expander, the condenser, and the pump in this order, the impurity recovery method comprising:

a preparation step of preparing an impurity recovery unit having a bypass flow path capable of bypassing a shutoff valve and the expander, a bypass valve provided in the bypass flow path, and a separator for separating impurities contained in the working medium;
 a connection step of connecting the bypass flow path to the circulation flow path so as to bypass the shutoff valve and the expander;
 a separator installation step of installing the separator in a portion on a downstream side of the circulation flow path than the evaporator and on an upstream side of the circulation flow path than an upstream side connection which is a connection between the circulation flow path and an upstream side end of the bypass flow path, and in a portion, of the bypass flow path or the circulation flow path, on a downstream side than a downstream side connection which is a connection between the circulation flow path and a downstream side end of the bypass flow path and on an upstream side than the condenser;
 a valve opening and closing step of closing the shutoff valve and opening the bypass valve in a state that supply of the heating medium to the evaporator and supply of the cooling medium to the condenser are maintained and the pump is driven;
 a pump stopping step of stopping the pump when a condition showing that a predetermined amount of impurities is accumulated in the separator is established; and
 an impurity recovery step of recovering the impurities from the separator.

2. The impurity recovery method according to claim 1, further comprising:

a working medium recovery step of recovering

- the working medium before the impurity recovery step,
 wherein in the working medium recovery step,
 by evacuating a portion of the bypass flow path
 or the circulation flow path where the working
 medium in the gas phase exists, the working me-
 dium in the liquid phase contained in the impu-
 rities in the liquid phase within the separator is
 vaporized and the working medium in the gas
 phase is recovered from the portion. 5
3. The impurity recovery method according to claim 2,
 wherein in the working medium recovery step, after
 recovering the working medium in the liquid phase
 from the portion of the condenser or the circulation
 flow path where the working medium in the liquid
 phase exists, the working medium contained in the
 separator is vaporized and recovered. 10
4. The impurity recovery method according to claim 3, 20
 wherein in the impurity recovery step, the impurities
 are recovered from the inside of the separator in a
 state that the inside of the separator is maintained
 at a positive pressure. 25
5. The impurity recovery method according to any of
 claims 1 to 4,
 wherein in the separator installation step, the separ-
 ator is installed in the bypass flow path. 30
6. A method for recovering oil from a thermal energy
 recovery device comprising: an evaporator for evap-
 orating a working medium by heating the working
 medium with a heating medium; an expander for ex-
 panding the working medium flowing out of the evap-
 orator while being supplied with oil, a power recovery
 machine connected to the expander; a condenser
 for condensing the working medium flowing out of
 the expander by cooling the working medium with a
 cooling medium; a pump for sending the working me-
 dium flowing out of the condenser to the evaporator,
 a circulation flow path for connecting the evaporator,
 the expander, the condenser, and the pump in this
 order; a bypass flow path which is connected to the
 circulation flow path and bypasses the expander; a
 bypass valve which is provided in the bypass flow
 path and can be opened and closed; a shutoff valve
 provided in a portion, of the circulation flow path, on
 a downstream side than an upstream side connec-
 tion which is a connection between the circulation
 flow path and an upstream side end of the bypass
 flow path and on an upstream side than the expand-
 er; a separator which is provided in a portion, of the
 circulation flow path, on a downstream side than the
 evaporator and on an upstream side than the up-
 stream side connection, and in a portion, of the by-
 pass flow path or the circulation flow path, on a down-
 stream side than a downstream side connection 55

which is a connection between the circulation flow
 path and a downstream side end of the bypass flow
 path and on an upstream side than the condenser,
 and separates oil contained in the working medium;
 and an oil supply flow path for supplying oil in the
 separator to the expander, the oil recovery method
 comprising:

a valve opening and closing step of closing the
 shutoff valve and opening the bypass valve in a
 state that supply of the heating medium to the
 evaporator and supply of the cooling medium to
 the condenser are maintained and the pump is
 driven;
 a pump stopping step of stopping the pump
 when a condition showing that a predetermined
 amount of oil is accumulated in the separator is
 established; and
 an oil recovery step of recovering the oil from
 the separator.

FIG. 1

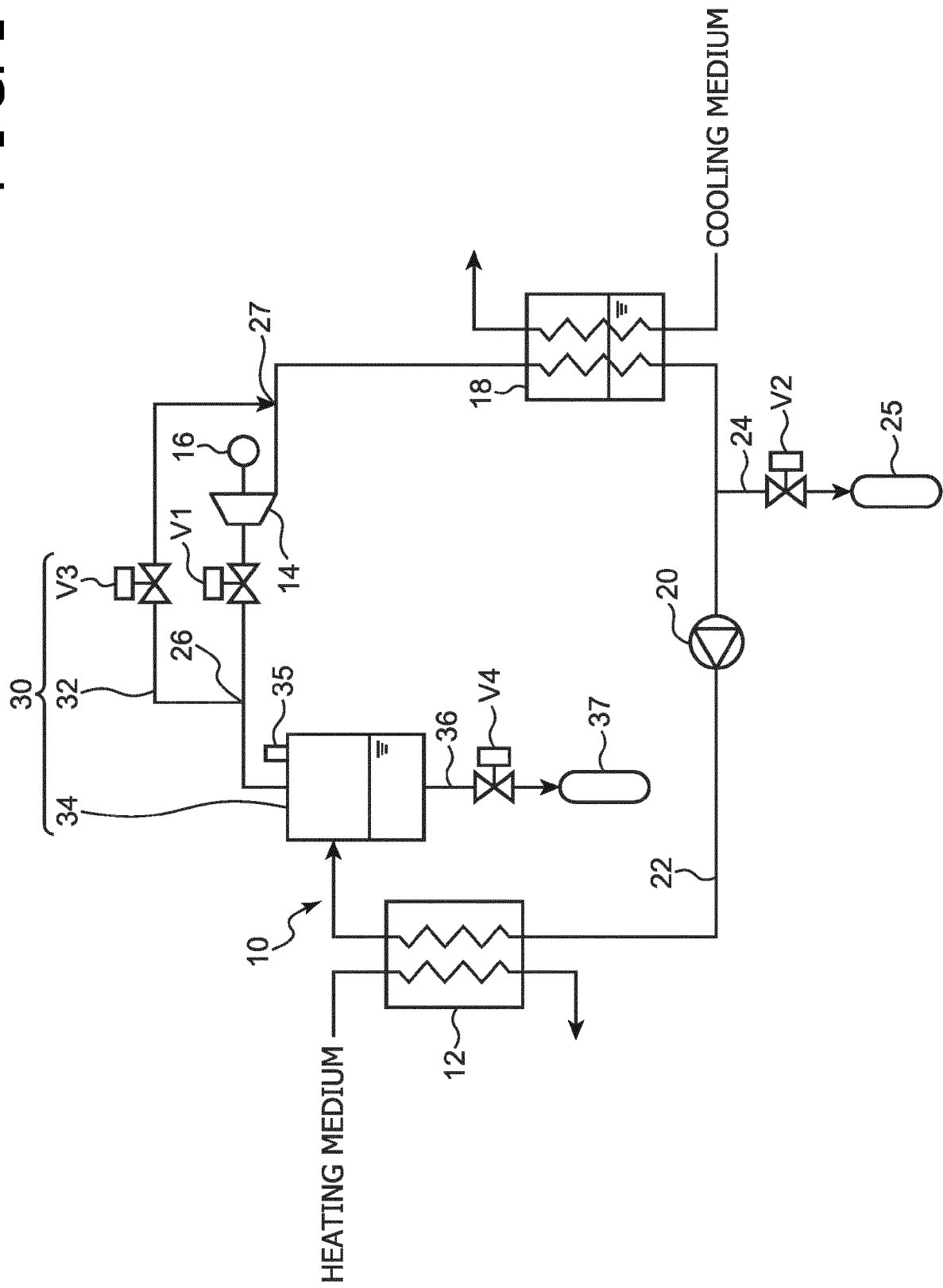


FIG. 2

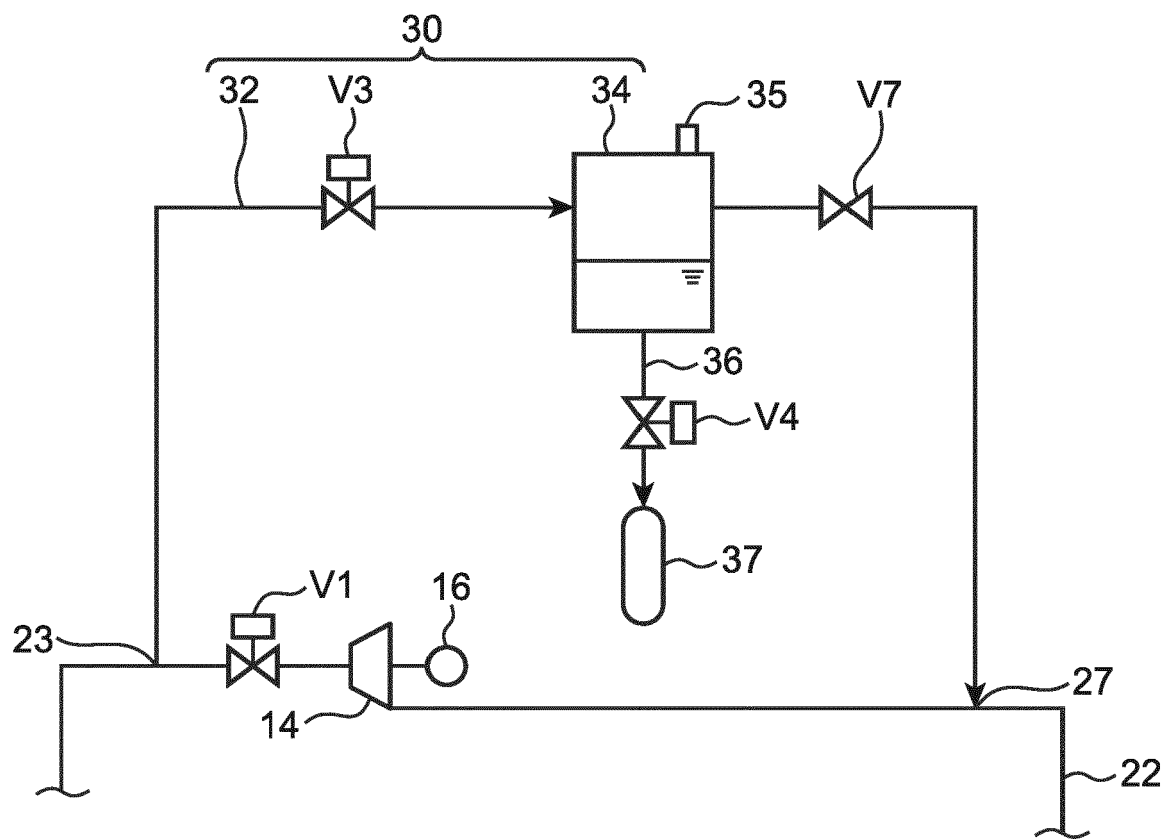


FIG. 3

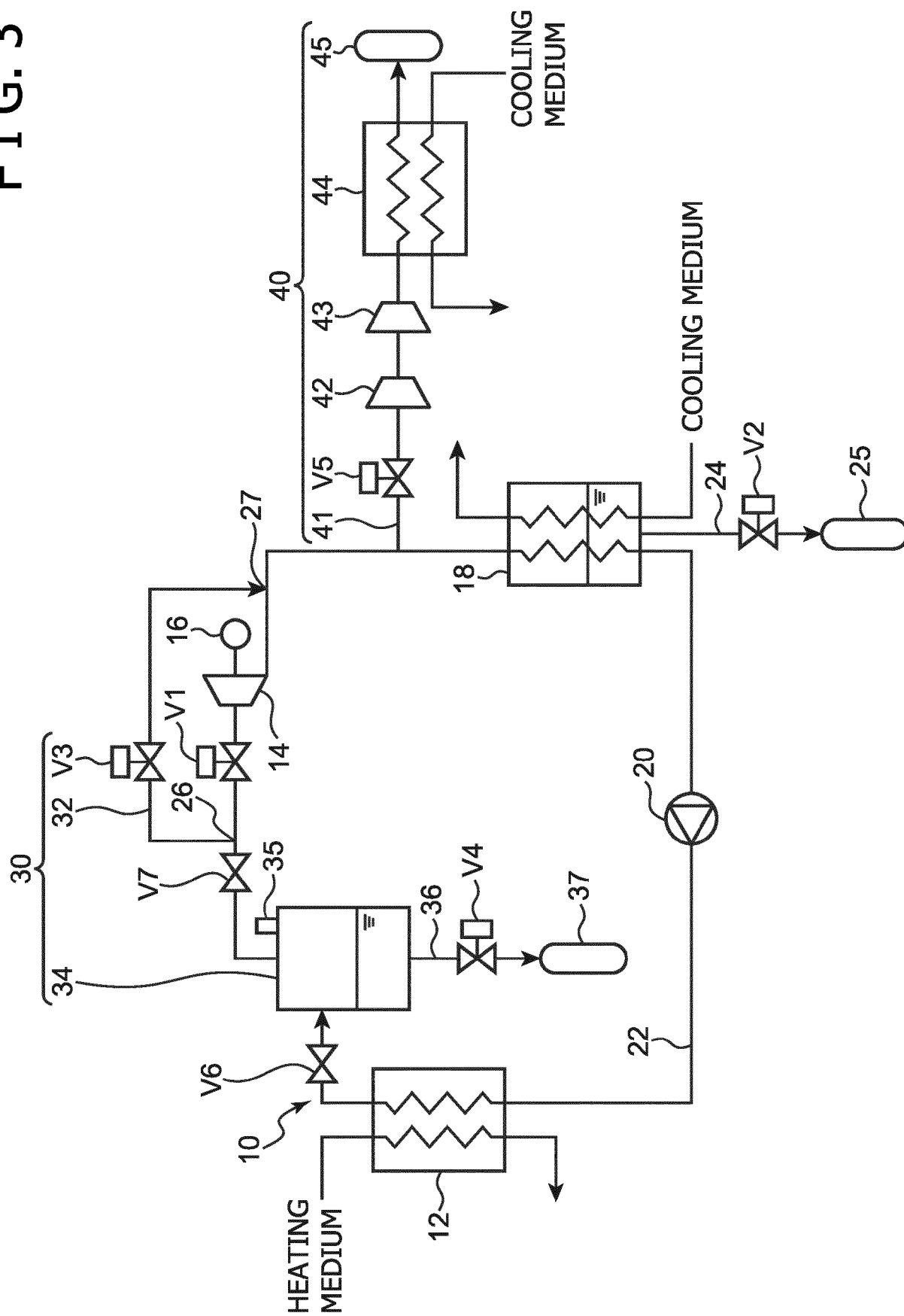
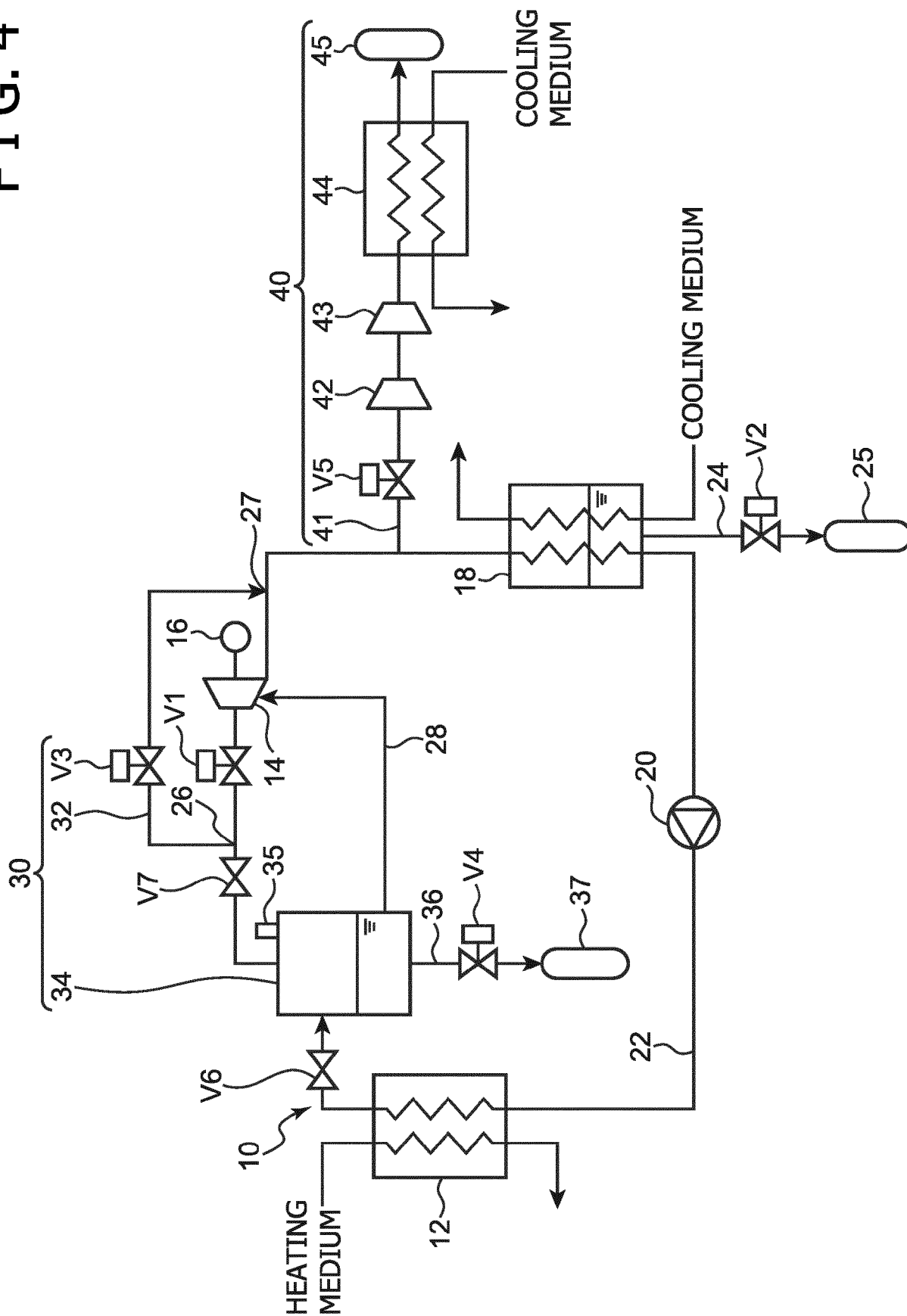


FIG. 4





EUROPEAN SEARCH REPORT

 Application Number
 EP 18 17 4722

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 12 September 2018	Examiner Weisser, Meinrad
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			

EPO FORM 1503 03.82 (P04C01)



Application Number

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CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☒ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).



**LACK OF UNITY OF INVENTION
SHEET B**

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The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-5

Method for connecting a separator for recovering impurities contained in a working medium to a thermal energy recovery device and method for operating said device including said separator.

2. claim: 6

Method for recovering oil from a thermal energy recovery device having an oil separator.

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

EP 18 17 4722

5

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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12-09-2018

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