(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 831 914 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
09.06.2021 Bulletin 2021/23

(21) Application number: **20211199.3**

(22) Date of filing: **02.12.2020**

(51) Int Cl.:
C10M 175/00 *(2006.01)* ***C09K 5/10*** *(2006.01)*
C10N 30/02 *(2006.01)*

(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
KH MA MD TN

(30) Priority: **03.12.2019 IT 201900022791**

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(54) METHOD FOR THE REMOVAL OF IMPURITIES FROM DIATHERMIC OIL AND APPARATUS IMPLEMENTING SAID METHOD

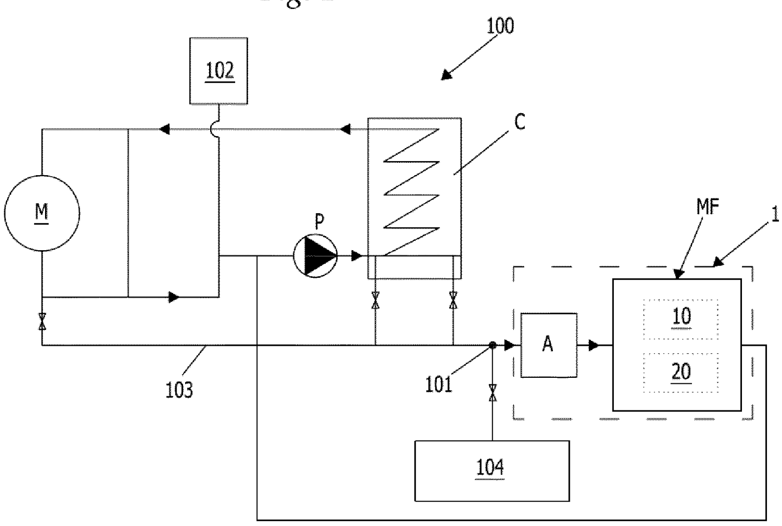
(57) The invention relates to the field of maintenance of industrial systems and concerns a method for the removal of impurities from diathermic oil in a circuit (100), comprising the following steps:
- taking a sample of diathermic oil from said circuit (100);
- subjecting said sample of diathermic oil to a laboratory test to check the aging of the oil and the presence of carbonaceous deposits;
- drawing said diathermic oil from said circuit (100);
- subjecting said diathermic oil to a filtration process;
- re-introducing said diathermic oil into said circuit after said filtration process (100).

Said laboratory test comprises the step of measuring the kinematic viscosity value of said diathermic oil and comparing the measured value with a reference value; if said viscosity value detected is greater than said reference value, said step of drawing said diathermic oil from said circuit (100) comprises the step of taking said diathermic oil to a temperature ≤ 80°C before subjecting the diathermic oil al filtration process.

The step of subjecting the diathermic oil to a filtration process comprises the step of choosing, depending on the kinematic viscosity value detected, between static filtration or dynamic filtration.

The invention also concerns an apparatus for the removal of impurities from diathermic oil in a circuit.

Fig. 1



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Description

Technical field

[0001] The invention relates to the field of maintenance of industrial systems that use oils at high temperatures and, more in detail, the invention concerns a method for the removal of impurities from diathermic oil, i.e., the elimination of sludge present therein, and an apparatus implementing this method.

Background art

[0002] In systems that use oil at high temperature, exceeding 250° C, it is essential to eliminate any impurities and carbonaceous residues that can be released by the oil, and which can cause various problems in the circuit.

[0003] Diathermic oil is exposed to high thermal deterioration and to oxidation, leading to the formation of oil degradation products, even thick tar-like formations, which are conveyed by the oil inside the system.

[0004] The formation of impurities and carbonaceous residues in diathermic oils is therefore cause by degradation of these oils, whose molecules, through a phenomenon known as cracking (thermal shock), break and generate both light fractions (gases) and, above all in oil extraction mineral fluids, heavy fractions (sludge). Cracking is caused by a sudden increase in temperature, which prevents gradual absorption of heat by the oil, thereby causing thermal shock.

[0005] The presence of heavy fractions, impurities and sludge in a diathermic oil system can cause a narrowing in the smaller pipes, as well as failure of the mechanical seals of the circulation pumps.

[0006] When impurities and carbonaceous residues deposit inside the walls of the pipes of a system they reduce the heat conveying flow cross section; the rough surfaces increase internal resistance and therefore lead to a loss of energy; after a pause in operation, when the system is started up again, both the heating time and the energy required increase, and in order to adapt the oil must be heated to a higher temperature, thereby accelerating the deterioration process.

[0007] This gives rise to the need to remove the impurities from the diathermic oil.

[0008] Currently, the state of aging of the oil and the effective presence of residues and impurities is checked with a standard laboratory test (n-pentane insolubles test), following which it is possible to decide whether said diathermic oil should be subjected to a static filtration process, which takes place through the use of metallic mesh filter media with holes of different sizes, placed in series with one another.

[0009] This method is performed with the system operating and the oil passes through the filter media at the operating temperature of around 250-270°C, temperature maintained constant for the entire process.

[0010] The filtration process currently used therefore requires the use of metallic mesh filters with gaskets and O-rings capable of withstanding the high temperatures of the oil; on the contrary, conventional cartridge filters would tend to split.

[0011] The main drawbacks of this method essentially depend on the high operating temperatures of the oil, which remain constant for the entire duration of the filtration process.

[0012] Unfortunately, elimination of the impurities generated by the diathermic oil using this filtration process, and at such high temperatures, does not ensure efficient removal of sludge from the fluid, and is very high risk for operators and for the entire system. The temperatures at play do not allow maintenance or filter change operations to be carried out rapidly and safely.

[0013] The document US 2016/076415 A1 discloses a method and an apparatus for cleaning an oil of a lubrication circuit of a motor vehicle, where said apparatus comprises a pump, an instrument for measuring the viscosity of the oil, means for varying the temperature of said oil and a single filtration unit comprising at least one filter. The filtration described is a static filtration.

Presentation of the invention

[0014] The invention intends to overcome these limits, defining a new method capable of eliminating impurities, sludge and, more in general, all the heavy fractions at low temperature without stressing and causing further degradation of the oil, avoiding possible further degradation of the molecules, simultaneously restoring the conditions of safety of the system, thereby ensuring greater safety of the operators and a reduction in maintenance costs and downtime.

[0015] These objects are achieved with a method for the removal of impurities from diathermic oil in a circuit, comprising the following steps:

- taking a sample of diathermic oil from said circuit;
- subjecting said sample of diathermic oil to a laboratory test to check the aging of the oil and the presence of carbonaceous deposits;
- drawing said diathermic oil from said circuit;
- subjecting said diathermic oil to a filtration process;

- re-introducing said diathermic oil into said circuit after said filtration process,

characterized in that:

- said laboratory test comprises the step of measuring the kinematic viscosity value of said diathermic oil and comparing the measured value with a reference value;
- if said measured kinematic viscosity value is greater than said reference value, said step of drawing said diathermic oil from said circuit comprises the step of bringing said diathermic oil to a temperature ≤ 80°C before subjecting said diathermic oil to said filtration process;
- said step of subjecting said diathermic oil to a filtration process comprises the step of choosing between static filtration or dynamic filtration, depending on the viscosity value measured,

where:

- said step of static filtration comprises the step of providing a static filtration unit comprising at least one cartridge filter, and of feeding said diathermic oil to said at least one cartridge filter;
- said step of dynamic filtration comprises the step of providing a dynamic filtration unit comprising a centrifugal separator provided with an internal drum, and of feeding said diathermic oil to said centrifugal separator.

[0016] Advantageously, said kinematic viscosity reference value is 35 cSt.

[0017] According to a first aspect of the invention, if said kinematic viscosity value is between 35 and 38 cSt, said filtration process comprises the step of static filtration.

[0018] Alternatively, if said kinematic viscosity value is > 38 cSt, said filtration process comprises the step of dynamic filtration.

[0019] The invention also relates to an apparatus for the removal of impurities from diathermic oil in a circuit, comprising:

- at least one pump for drawing said diathermic oil from said circuit;
- at least one filtering machine adapted to retain the impurities present in said diathermic oil, placed downstream of said at least one pump, characterized in that:
- said apparatus comprises at least one chiller for said diathermic oil provided upstream of said filtering machine;
- said filtering machine comprises a static filtration unit and a dynamic filtration unit, placed in parallel to one another,

where:

- said static filtration unit comprises at least one cartridge filter with a filtering capacity ≤ 30 microns;
- said dynamic filtration unit comprises a centrifugal separator comprising:
  - a centrifugal chamber provided with an inlet for said diathermic oil containing impurities and an outlet for treated diathermic oil;
  - a drum provided with filter media placed inside said centrifugal chamber and communicating with said inlet;
  - a collection tank for the impurities separated from said oil placed outside said drum.

[0020] In a preferred variant of the invention, said apparatus comprises
a first and a second pump, placed in parallel, for drawing said diathermic oil from said circuit, having a flow rate of 4000 litres/hour and 9000 litres/hour, respectively,
and said static filtration unit comprises a first and a second cartridge filter, with a filtering capacity of between 10 and 30 microns, adapted to retain the impurities present in said diathermic oil, placed downstream of said pumps.

[0021] According to further aspects of the invention, said apparatus comprises a magnetic filter to retain the ferrous impurities of said diathermic oil provided upstream of said at least one pump.

[0022] Moreover, said apparatus comprises a metallic mesh filter with a filtering capacity of 90 microns, provided upstream of said at least one pump.

[0023] Advantageously, said apparatus comprises an automatic de-aerator, placed downstream of said filtering machine, adapted to eliminate any air bubbles present in said circuit.

[0024] The method for the removal of impurities from diathermic oil described above, and the apparatus implementing it, offer important advantages compared to conventional methods and apparatus.

[0025] Surprisingly, a correlation between the kinematic viscosity value of the diathermic oil and the quantity of impurities present therein has been found: when the viscosity value increases a significant increase in sludge is observed. By knowing the kinematic viscosity value of the oil detected it is advantageously possible to establish whether the diathermic oil should be subjected to a treatment for the removal of impurities and to choose the most suitable filtration process.

[0026] The value detected is in fact compared with a kinematic viscosity reference value. Advantageously, it has been found that the reference value that optimizes cost and benefit is 35 cSt.

[0027] Treatment of the oil does not take place at the operating temperature conditions of the system, but on a branched line where the temperature of the oil is greatly reduced: surprisingly, it has been found that at temperatures ≤ 80°C the impurities and the residues present in the oil tend to aggregate and to be more easily retained.

[0028] However, it is possible to start treating the oil at operating temperature conditions of the system, through the use of chillers.

[0029] Advantageously, due to the reduced temperature process according to the invention:

- the oil is protected from further stress that could further degrade and break its molecules, already modified by the phenomenon of cracking;
- the time required for the operation is greatly reduced;
- the safe operating condition of the system is restored;
- high levels of operator safety are guaranteed.

[0030] The first step of the method according to the invention is a step of analysing and evaluating the diathermic oil to be treated: determination of the kinematic viscosity value of the oil is the most important operation of the entire process and is carried out analytically in the laboratory using the ASTM D445 method applied to a sample of diathermic oil taken from the system and at a temperature of 40°.

[0031] By determining the degree of kinematic viscosity of the oil it is possible to understand whether, and in what amounts, impurities and residues have formed, choosing, after the step of reducing the temperature of the oil, for example the most suitable size of cartridge filters for static filtration and whether or not to also use dynamic filtration.

[0032] The following table provides examples of these correlations.

Degree of kinematic viscosity [cSt]	Insolubles %	Degree of oxidation	Treatment chosen
30	0.01	0.01	-
32	0.08	0.08	-
34	0.20	0.20	-
35	0.30	0.30	Static filtration with 10 micron filter
36	0.40	0.40	Static filtration with 10-30 micron filter
38	0.50- 0.60	0.50-0.80	Static filtration with 30 micron filter
> 38	> 0.60	> 0.80	Dynamic filtration with centrifugal separator

[0033] The central step of the method for the removal of impurities takes place in bypass, in parallel to the system, with the circulation pumps of the system operating, and can be performed with the system operating, with diathermic oil at operating temperature.

[0034] Firstly it is necessary to reduce the temperature of the oil, bringing it to a temperature below 80°C.

[0035] Normally, chillers of know type are used to cool the oil; these are placed in series and the oil flows through them before reaching the filtration step.

[0036] With these chillers, it is possible to reduce the temperature of the diathermic oil drawn from a system that is operating, and therefore presumably with a temperature of around 250°C, to around 80°C.

[0037] After reaching the appropriate temperature, the most suitable filtration process is chosen, depending on the kinematic viscosity value detected in preliminary analysis step.

[0038] Once the filtration step has terminated, the diathermic oil is reintroduced into the system at the filtration temperature and immediately taken to the operating temperature by the heating means of the system.

[0039] The subsequent steps substantially provide for reiteration of the operations described above for n-times, depending on the kinematic viscosity value detected indicative of the presence or absence of impurities in the oil.

[0040] The process terminates when gradually all the impurities have been eliminated and the viscosity value detected is < 35 cSt or in any case below the initial viscosity value by at least 3-4 cSt.

Brief description of the drawings

[0041] A description of a preferred embodiment of the method defined above, using apparatus implementing this method, is provided below by way of non-limiting example and with the aid of the figures, where:

Fig. 1 schematically illustrates a diathermic oil system provided with an apparatus implementing the method for the removal of impurities according to the invention;
Fig. 2 schematically illustrates the apparatus of Fig. 1 according to the invention;
Fig. 3 schematically illustrates four chillers belonging to the apparatus of Fig. 2 connected in series;
Fig. 4 schematically illustrates part of the apparatus of Fig. 2, relating to the static filtration unit;
Fig. 5 schematically illustrates part of the apparatus of Fig. 2, relating to the dynamic filtration unit.

Detailed description of a preferred embodiment of the invention

[0042] With particular reference to Fig. 1, there is illustrated a portion of an industrial system 100 that internally uses diathermic oil to supply energy to machines M, comprising:

- a point 101 for drawing the diathermic oil from its circuit;
- a pump P;
- a boiler C adapted to return said diathermic oil to the operating temperature of the system;
- an expansion vessel 102 that maintains the circuit pressurized.

[0043] For treatment of the diathermic oil, a system 100 of this type is provided with an apparatus 1 for the removal of solid impurities, sludge and residues, from said oil, comprising a chiller A and a filtering machine 10, 20.

[0044] In order to avoid the occurrence of backpressures and problems of flow rate, the point for drawing the diathermic oil to be treated with said apparatus 1 is placed in the lowest point of the system along a specific discharge line 103, while the point for re-introduction of the treated oil is placed upstream of the pump P of the system. Optionally, the oil to be treated could be temporarily discharged from the system to a collection tank 104 placed along said discharge line 103, and be drawn from this tank to be sent to the apparatus 1 for the removal of impurities.

[0045] With particular reference to Fig. 2 there is illustrated a diagram of the main components of an apparatus 1 for the removal of impurities from diathermic oil arranged to implement the aforesaid method, in the case of use in bypass, with the system operating.

[0046] Said apparatus 1 essentially comprises:

- a plurality of chillers A1, A2, A3, A4 for said diathermic oil placed in series with one another;
- a filtering machine MF.

[0047] In detail, said filtering machine MF comprises:

- a static filtration unit 10;
- a dynamic filtration unit 20;
- opening and closing valves 2, 3 of the pipes for conveying the oil to said static filtration unit 10 or to said dynamic filtration unit 20.

[0048] Normally, said static filtration unit 10 and said dynamic filtration unit 20 are placed in parallel to one another.

[0049] With particular reference to Fig. 3, there is illustrated a series of chillers A1, A2, A3, A4 provided on said apparatus 1, capable of taking the temperature of the diathermic oil from an initial value of 250°C to a final value of 70-80° prior to the filtration process.

[0050] With particular reference to Fig. 4, said static filtration unit 10 comprises:

- a first P1 and a second P2 pump, placed in parallel, for drawing said diathermic oil from said circuit, having a flow rate of 4000 litres/hour and 9000 litres/hour, respectively;
- a first F1 and a second F2 cartridge filter, having a filtering capacity of between 10 and 30 microns, adapted to retain the impurities present in said diathermic oil, placed in parallel to one another and downstream of said pumps P1, P2.

[0051] Upstream of said pumps P1, P2 there are provided filtration means FM and FA of the inflowing diathermic oil, adapted to perform an initial cleaning of the oil and facilitate the subsequent work of the cartridge filters F1, F2.

[0052] Said filtration means comprise a magnetic filter FM for ferrous impurities and a metallic mesh filter FA for sludge with a filtering capacity of 90 micron.

[0053] Said apparatus 1 also comprises an automatic de-aerator DA, placed downstream of said cartridge filters F1, F2 adapted to eliminate any air bubbles present in said circuit.

[0054] With particular reference to Fig. 5, said dynamic filtration unit 20 comprises a centrifugal separator S, which essentially comprises:

- a centrifugal chamber 21 provided with an inlet 22 for said diathermic oil containing impurities and an outlet 23 for treated diathermic oil;
- a drum 24 provided with filter media placed inside said centrifugal chamber 21 and communicating with said inlet 22;
- a collection tank 25 for the impurities separated from said oil placed outside said drum 24.

[0055] Optimal results were obtained with the use of a conventional separator, for example of the type marketed by the company Alfa Laval to separate oil from water, to which appropriate modifications were made:

- the outlet normally used for removal of the water separated from the oil was closed;
- the water tank was eliminated, replacing the volume with a collection tank for sludge and impurities separated from the oil.

[0056] The apparatus 1 described can operate managed by an engineer, entirely in manual mode, who, depending on the information collected on the temperature and on the degree of kinematic viscosity of the oil measured before starting operations, adjusts the chillers A, A1, A2, A3, A4 and chooses the most appropriate filtration process, opening or closing the valves 2, 3 placed upstream of the static filtration unit 10 or of the dynamic filtration unit 20.

[0057] Alternatively, said apparatus 1 can comprise a control unit capable of performing the adjustments described above in completely automatic mode. After entering the data required and the comparison parameters of the various viscosities in said control unit, it can adjust the operating temperature of the oil or the most suitable filtration process directly.

Claims

1. Method for the removal of impurities from diathermic oil in a circuit (100), comprising the following steps:

   - taking a sample of diathermic oil from said circuit (100);
   - subjecting said sample of diathermic oil to a laboratory test to check the aging of the oil and the presence of carbonaceous deposits;
   - drawing said diathermic oil from said circuit (100);
   - subjecting said diathermic oil to a filtration process;
   - re-introducing said diathermic oil into said circuit (100) after said filtration process,

   characterized in that:

   - said laboratory test comprises the step of measuring the kinematic viscosity value of said diathermic oil and comparing the measured value with a reference value;
   - if said measured kinematic viscosity value is greater than said reference value, said step of drawing said diathermic oil from said circuit (100) comprises the step of bringing said diathermic oil to a temperature ≤ 80°C before subjecting said diathermic oil to said filtration process;
   - said step of subjecting said diathermic oil to a filtration process comprises the step of choosing between static filtration or dynamic filtration, depending on the viscosity value measured,

   where:

   - said step of static filtration comprises the step of providing a static filtration unit (10) comprising at least one cartridge filter (F1, F2), and of feeding said diathermic oil to said at least one cartridge filter (F1, F2),
   - said step of dynamic filtration comprises the step of providing a dynamic filtration unit (20) comprising a centrifugal separator (S) provided with an internal drum (24), and of feeding said diathermic oil to said centrifugal separator (S).

2. Method for the removal of impurities from diathermic oil according to claim 1, **characterized in that** said kinematic viscosity reference value is 35 cSt.

3. Method for the removal of impurities from diathermic oil according to claim 1, **characterized in that**, if said kinematic

viscosity value is between 35 and 38 cSt, said filtration process comprises the step of static filtration.

4. Method for the removal of impurities from diathermic oil according to claim 3, **characterized in that**, if said kinematic viscosity value is > 38 cSt, said filtration process comprises the step of dynamic filtration.

5. Apparatus (1) for the removal of impurities from diathermic oil in a circuit (100), comprising:

- at least one pump (P1, P2) for drawing said diathermic oil from said circuit (100);
- at least one filtering machine adapted to retain the impurities present in said diathermic oil, placed downstream of said at least one pump (P1, P2),

characterized in that:

- said apparatus (1) comprises at least one chiller (A, A1, A2, A3, A4) for said diathermic oil provided upstream of said filtering machine (10);
- said filtering machine comprises a static filtration unit (10) and a dynamic filtration unit (20), placed in parallel to one another, where:
- said static filtration unit (10) comprises at least one cartridge filter (F1, F2) with a filtering capacity ≤ 30 microns;
- said dynamic filtration unit (20) comprises a centrifugal separator (S) comprising:

  - a centrifugal chamber (21) provided with an inlet (22) for said diathermic oil containing impurities and an outlet (23) for treated diathermic oil;
  - a drum (24) provided with filter media placed inside said centrifugal chamber (21) and communicating with said inlet (22);
  - a collection tank (25) for the impurities separated from said oil placed outside said drum (24).

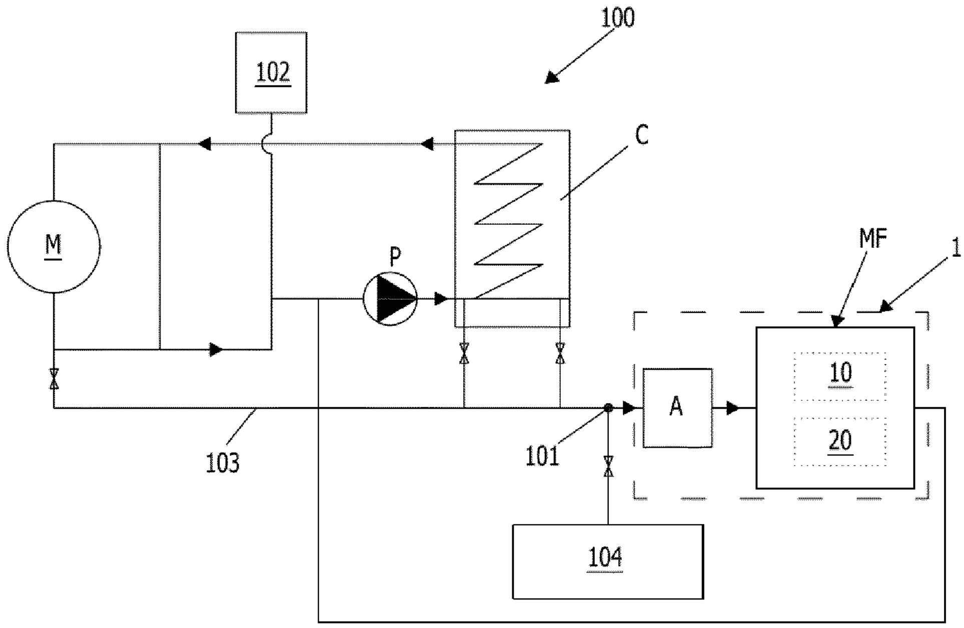
6. Apparatus (1) for the removal of impurities from diathermic oil according to claim 5, **characterized in that** it comprises a first (P1) and a second (P2) pump, placed in parallel, for drawing said diathermic oil from said circuit (100), having a flow rate of 4000 litres/hour and 9000 litres/hour, respectively
and **in that** said static filtration unit (10) comprises a first (F1) and a second (F2) cartridge filter, with a filtering capacity of between 10 and 30 microns, adapted to retain the impurities present in said diathermic oil, placed downstream of said pumps (P1, P2).

7. Apparatus (1) for the removal of impurities from diathermic oil according to claim 5, **characterized in that** it comprises a magnetic filter (FM) to retain the ferrous impurities of said diathermic oil provided upstream of said at least one pump (P1, P2).

8. Apparatus (1) for the removal of impurities from diathermic oil according to claim 5, **characterized in that** said it comprises a metallic mesh filter (FA) with a filtering capacity of 90 microns, provided upstream of said at least one pump (P1, P2).

9. Apparatus (1) for the removal of impurities from diathermic oil according to claim 5, **characterized in that** it comprises an automatic de-aerator (DA), placed downstream of said filtering machine, adapted to eliminate any air bubbles present in said circuit (100).

Fig. 1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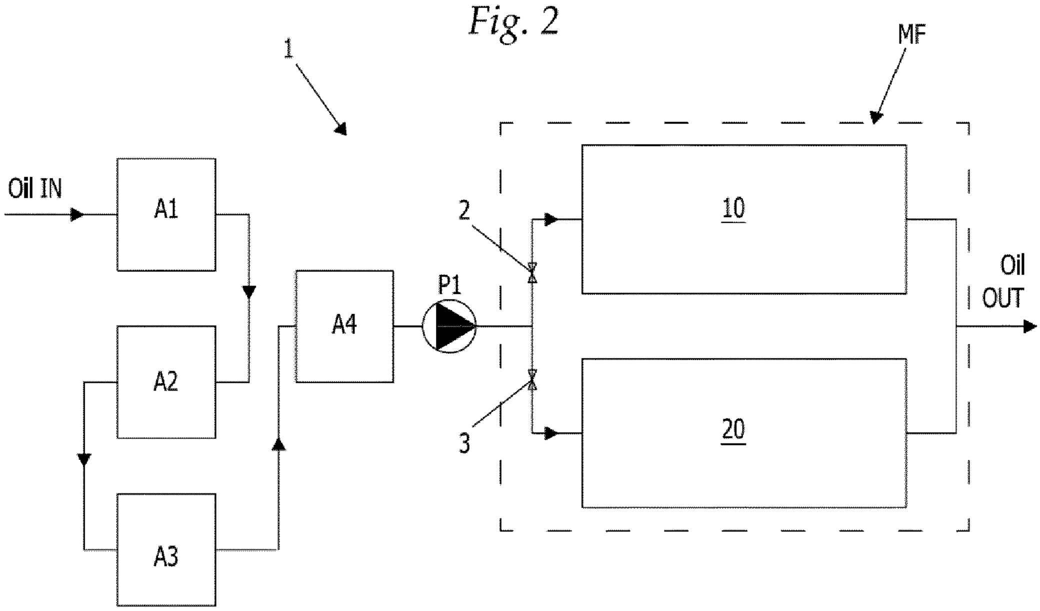
103
101
104

Fig. 2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OUT

Fig. 3

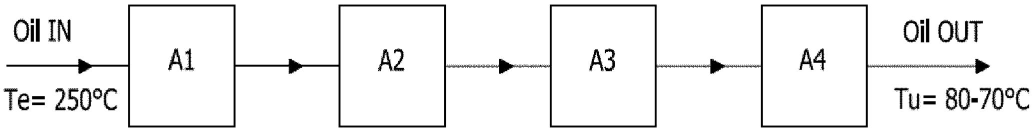
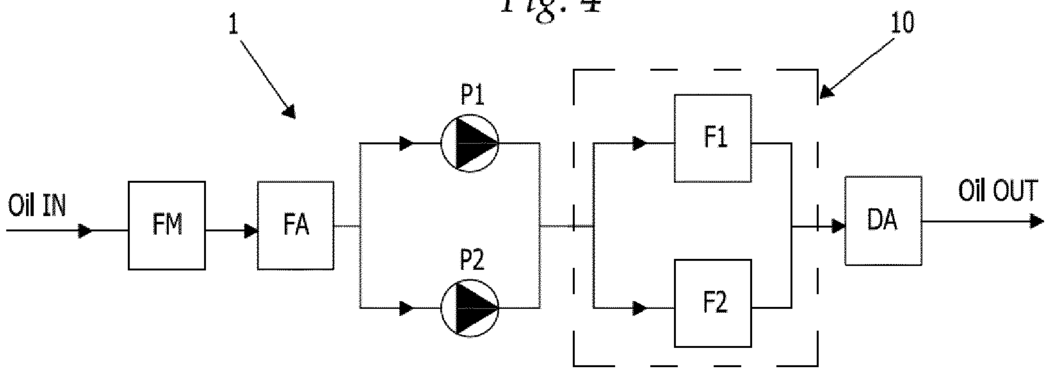


Fig. 4



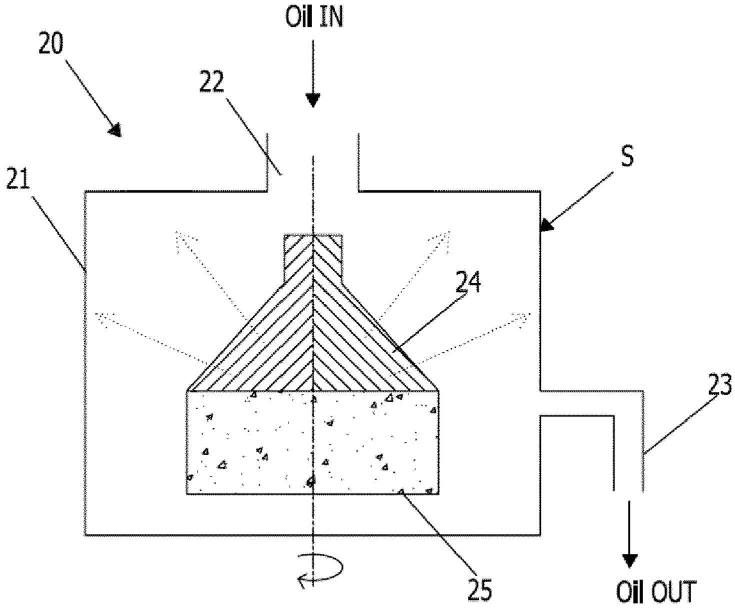


Fig. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 20 21 1199

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	US 2016/076415 A1 (KEMPER MARKUS [DE]) 17 March 2016 (2016-03-17) * claims 1, 3, 11, 14, 15, 23-25; par. 34, 72; fig. 8 *	1-9	INV. C10M175/00 C09K5/10 ADD. C10N30/02
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			TECHNICAL FIELDS SEARCHED (IPC)
			C10M C10N

The present search report has been drawn up for all claims

2

Place of search	Date of completion of the search	Examiner
Munich	29 March 2021	Greß, Tobias

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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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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29-03-2021

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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