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

(11) **EP 3 910 260 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
17.11.2021 Bulletin 2021/46

(51) Int Cl.:
F24H 1/18 *(2006.01)* ***F24H 1/20*** *(2006.01)*
F24H 9/00 *(2006.01)*

(21) Application number: **21171426.6**

(22) Date of filing: **30.04.2021**

(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

(30) Priority: **12.05.2020 SK 762020 U**

(71) Applicants:
- **Protherm Production s.r.o.**
  909 01 Skalica (SK)
- **Vaillant GmbH**
  42859 Remscheid (DE)

(72) Inventors:
- **Necas, Du an**
  90901 Skalica (SK)
- **Má ik, Marián**
  908 63 Lopa ov (SK)
- **Martinek, Jan**
  69701 Kyjov (SK)
- **Hránek, Miroslav**
  90844 Petrova Ves (SK)

(74) Representative: **Popp, Carsten**
Vaillant GmbH
IRP
Berghauser Straße 40
42859 Remscheid (DE)

(54) ELECTRIC WATER HEATER

(57) An electric water heater (100, 200) for a closed-loop heating water system comprising of a water tank connected to a flange, at least one heating element (3) extending from a flange into the water tank and a concentric wall (5) arranged in the water tank, the water tank being connected to the cold water inlet (1) and hot water outlet (2), characterized in that the cover (4) of the water tank consists of a cylindrical part, which is attached to the flange in its upper section, and of a conical part, which is connected to the cylindrical part of the cover (4) of the water tank in its lower section, the shape of the concentric wall (5) corresponds to the cylindrical part of the water tank cover (4) and is located inside the water tank so that an outer circulation channel is defined between the water tank cover (4) and the concentric wall (5). The electric water heater integrates the function of a solid particles separator.

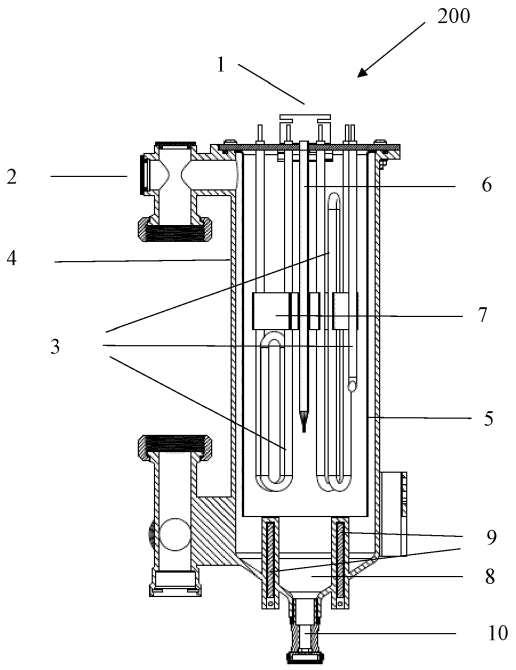

Fig.3

EP 3 910 260 A1

Description

FIELD OF THE INVENTION

[0001] The invention concerns an electric water heater connected to a closed-loop heating water system.

TECHNICAL BACKGROUND

[0002] Electric water heaters in the known state of art are equipped with a watertight water tank made of metal or durable plastic, usually in the shape of a cylinder, inside which at least one heating element, for example in the form of a spiral or rod, and heated water of a certain volume are arranged. The electric water heater can also include heating regulation or control, the control circuits being connected to the safety elements of the electric heater, in particular to temperature sensors of various constructions and similar devices.

[0003] The tank of an electric water heater is generally connected simultaneously to the supply of cold water, to the discharge of hot water and to the electric power supply. The cold water supplied to the inlet of the electric water heater is heated to the desired temperature by means of heating elements and, if necessary, is discharged via the outlet of the heater.

[0004] Such an electric heater is usually part of heating system with closed-loop heating water. It can be used as a backup water heater in heating systems based on heat pumps.

[0005] A problem with closed-loop water heating systems, which requires attention and solution, is the contamination of the heating water with solid particles. The most common sources of impurities in the circulating fluid are corrosion from pipelines and radiators and limescale.

[0006] Therefore, closed-loop heating water heating systems are equipped with a filter device to catch solid impurities, non-magnetic or magnetic in nature, which could cause, for example, damage to the circulation pump. During regular maintenance, the filter unit is cleaned or flushed. Filter devices used so far are used as separate components and are placed in the water circuit of the heating system, most often near the water inlet to the circulation pump. Filtration devices used to catch solid non-magnetic and magnetic impurities include various separators and/or filter inserts.

[0007] Further solutions in the current state of art are cyclone and hydrocyclone filters, which are increasingly common in the industry due to relatively low production costs and the ability to separate the different phases from each other in phase mixtures. In general, cyclones include an inlet that causes fluid to enter the cyclone in a tangential flow, a conical element, a vortex region where the fluid flows in a helical path, and an exit for solids at the bottom of the cyclone.

[0008] A device for separating both non-magnetic and magnetic solid particles from water circulating in a closed-loop central heating system is disclosed in the publication EP2271432 B1. This device based on the principle of a cyclone filter includes a cover, which is arranged so that the particles entrained in the water are separated by vortex separation when the water flows downwards; the device further includes a sleeve located inside the cover such that an outer circulatory channel is defined between the cover and the sleeve. This device further includes a magnet located inside the cover of the device, through which water from the central heating flows. As water moves around the magnet, the magnet collects magnetic particles entrained in the water.

[0009] A specific disadvantage of an electric water heater is that the scale is formed to a large extent on the heating elements in the tank of the electric heater and forms a continuous layer on them. Its sudden peeling off and flow into the heating water circuit in the system can cause serious system failures.

[0010] A suitable solution would be to filter out solid impurities directly in the tank of the electric heater, thus improving the functionality of the system.

[0011] At the same time, it would be possible to increase the amount of trapped impurities, as they would be trapped directly at the point of origin. At the same time, magnetic impurities generated at various points in the system would be captured.

[0012] No known electric water heater connected to a closed-loop heating water system uses its own volume to capture and remove solid impurities from the closed heating water circuit, all known connections trap solid impurities using filters and separators located outside the heated water tank.

[0013] This drawback is eliminated by the presented invention.

SUMMARY OF THE INVENTION

[0014] The electric water heater according to the presented invention is arranged to consist of a water tank, the outer cover of which has a shape of a cylinder terminated at the bottom by a cone, and a concentric wall inside the tank, the shape of which corresponds to the cylindrical part of the tank cover. By means of the concentric wall, two separate circulation channels are formed inside the tank - an outer circulation channel and an inner circulation channel.

[0015] Heating elements are arranged in the inner circulation channel. This arrangement helps to change the direction and speed of the water flow when moving through one circulation channel from top to bottom and the other circulation channel from bottom to top.

[0016] The upper section of the tank cover has a larger cross-sectional area than the lower section of the tank cover. The upper section of the tank cover is substantially cylindrical and the lower section of the cover is substantially conical.

[0017] In the lower section of the tank cover, the water flow slows down, so that entrained particles can fall out of the water flow more easily, and the conical area, to

which the drain valve can be connected, allows to capture of both magnetic and non-magnetic solid particles.

[0018] The electric water heater according to the described invention, equipped with a concentric wall inside its tank, thus integrates the function of a solid impurities separator.

[0019] One advantageous arrangement comprises at least one magnet (magnetic separator) arranged inside the tank of the electric water heater for separating magnetic solid impurities.

[0020] Another advantageous arrangement comprises a special deflector near the inlet, by means of which cold water is mixed much more slowly in the lower part of the heater, thus maintaining the temperature of the already heated water.

[0021] In another advantageous arrangement, the inlet and the outlet are located near the upper section of the tank cover, in particular in order to maximize the surface areas with which the downward and upward flows can come into contact.

[0022] Although no cyclone flow is formed in the tank space, as it is in a cyclone filter, the change in the direction of flow of water and the solid impurities contained in it is affected by impacting on obstacles such as heating coils and the concentric wall and this allows solid impurities to be separated from the water stream and settled in the area with the lowest flow rate.

[0023] It is assumed that the electric water heater is a part of a closed-loop heating water system and other devices are connected in this system (for example heating controller and control, circulation pump, valves, plate heat exchanger, etc.), which are known to experts in the current state of art and need not be described.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] The invention is described with reference to, but not limited to, the following figures:

Fig. 1 shows a cross section of the electric water heater and the water flow direction in the electric water heater according to the presented invention.

Fig. 2 shows a cross section of the electric water heater in the case of the water inlet oriented from above, through a flange.

Fig. 3 shows a cross section of the electric water heater in the case of the water inlet oriented from the side, near the upper section of the cover

EXAMPLE OF EMBODIMENT

Example 1:

[0025] Fig. 1 schematically shows the electric water heater according to the presented invention with the arrows indicating the water flow direction inside the electric heater.

[0026] The cold water inlet 1 and the hot water outlet 2 are arranged in the tank of the electric water heater so that the water flowing through the electric heater flows from the cold water inlet 1 to the hot water outlet 2.

[0027] The cover 4 of the electric water heater tank consists of a cylindrical part, which is attached to the flange in its upper section, and of a conical part, which connects to the cylindrical part of the cover 4 of the tank in its lower section. The heating elements 3 protrude from the flange into the tank, and a connection for the cold water inlet 1 is also located in the flange.

[0028] The electric water heater further includes the concentric wall 5 of a shape corresponding to the cylindrical part of the water tank cover, which is located inside the electric water heater tank so that an outer circulation channel is defined between the tank cover 4 and the concentric wall 5. Cold water enters the device through the inlet 1 in the flange and then flows in the inner circulation channel defined by the concentric wall 5, in the direction indicated by the arrows, around the heating elements 3 downwards near the concentric wall 5.

[0029] During the flow, the water encounters obstacles, which are on the one hand the heating elements 3, and also the concentric wall 5. The water flows towards the lowest end of the conical part of the tank cover 4 and the flow rate slows downwards. As the water flows downwards, the entrained solid impurities in the water impinge on the heating elements 3 and the concentric wall 5, separate from the water stream and due to deceleration, they fall to the bottom of the conical part. They settle in the zone 8 for settling solid impurities.

[0030] The hot water outlet 2 is open to the external circulation channel and passes through the cover 4 of the electric water heater tank near its upper section.

[0031] Fig. 1 further shows, by means of arrows, an upward flow of heated water in the electric water heater. As shown, the water flows upwards through the outer circulation channel until it reaches the hot water outlet 2.

[0032] The deflector 11 is located in the tank near the cold water inlet 1, and it ensures that the cold water fed to the inlet 1 is directed towards the heating elements 3 and does not flow directly down into the lower part of the tank of the electric water heater. This advantageous arrangement maintains the temperature of the water already heated.

[0033] When the drain valve, which is connected to the solid impurities settling zone 8, is opened, the settled impurities are removed from the electric water heater and at the same time from the closed-loop of water of the heating system.

Example 2:

[0034] Fig. 2 shows a cross section of the electric water heater 100, which represents an advantageous embodiment of the invention. The cover 4 of the electric water heater tank consists of a cylindrical part, which is at-

tached to the flange in its upper section, and of a conical part, which connects to the cylindrical part of the cover 4 of the tank in its lower section. The heating elements 3 protrude from the flange into the tank.

[0035] The electric water heater further includes a concentric wall 5 according to the presented invention. In this advantageous embodiment, the cold water inlet 1 and the hot water outlet 2 are located near the upper section of the tank cover 4, maximizing the surface areas with which the downward and upward flows can come into contact.

[0036] Water flowing through the heater flows from the cold water inlet 1 to the hot water outlet 2. By means of the connection 10, the drain valve is connected to the zone 8 for settling solid impurities and the impurities can be removed from the system.

Example 3:

[0037] Fig. 3 shows the electric water heater 200, which is in this example a backup (auxiliary) electric heating source for a heat pump system, and it represents an advantageous embodiment of the invention.

[0038] The cover 4 of the electric water heater 200 tank consists of a cylindrical part, which is attached to the flange in its upper section, and of a conical part, which connects to the cylindrical part of the cover 4 of the tank in its lower section. Several heating elements 3 protrude from the flange into the tank, and a connection for the cold water inlet 1 is also located in the flange. Water flowing through the heater flows from the inlet 1 to the outlet 2. The electric water heater further includes a concentric wall 5 according to the presented invention.

[0039] Cold water enters the device through the inlet in the flange and then flows in the inner circulation channel around the heating elements 3 downwards near the concentric wall 5.

[0040] The lower part of the electric water heater 200 tank includes means for inserting two magnets 9, which in this advantageous embodiment separate magnetic impurities from the other solid impurities by attracting them from the water stream. To protect the electric water heater 200 against overheating, a safety temperature limiter 6 is arranged in the tank and it is connected to the heating elements 3 using conduction heat transfer means 7 (for example a metal strip).

[0041] By means of the connection 10, the drain valve is connected to the zone 8 for settling solid impurities and the impurities can be removed from the system. Magnetic impurities are removed by pulling out the magnets.

[0042] The presented invention integrates the function of a separator (filter) of solid impurities directly in the water tank of a specific arrangement, which is a part of the electric water heater in a closed-loop heating water system. Impurities are easily separated from the water stream, collected in a dedicated zone and removed from the closed circuit. The use of such an electric water heater saves space and costs that would have to be spent on an external filter (separator) to achieve trouble-free water heating in the heating system.

REFERENCE NUMERALS

[0043]

1	inlet
2	outlet
3	heating element
4	tank cover
5	concentric wall
6	safety temperature limiter
7	conduction heat transfer means
8	zone for settling solid impurities
9	magnet
10	connection
11	deflector
100, 200	electric water heater

Claims

1. An electric water heater for a closed-loop heating water system comprising of a water tank connected to a flange, at least one heating element (3) extending from a flange into the water tank and a concentric wall (5) arranged in the water tank, the water tank being connected to the cold water inlet (1) and hot water outlet (2), **characterized in that**
the cover (4) of the water tank consists of a cylindrical part, which is attached to the flange in its upper section, and of a conical part, which is connected to the cylindrical part of the cover (4) of the water tank in its lower section,
the shape of the concentric wall (5) corresponds to the cylindrical part of the water tank cover (4) and is located inside the water tank so that an outer circulation channel is defined between the water tank cover (4) and the concentric wall (5),
heating elements (3) are arranged in the inner circulation channel defined by the concentric wall (5),
the conical part of the water tank cover (4) defines a zone (8) for settling solid particles from the water stream and is provided with a drain valve or a connection (10) for connecting a drain valve.

2. Electric water heater (100) according to claim 1, **characterized in that** the cold water inlet (1) is arranged close to the upper section of the water tank cover (4) and extends into the water tank cover (4) and into the inner circulation channel.

3. Electric water heater (200) according to claim 1, **characterized in that** the cold water inlet (1) is arranged in a flange and extends into the inner circulation channel.

4. Electric water heater according to claim 1, **characterized in that** a deflector (11) is placed at the cold water inlet (1) for even distribution of cold water to heating elements (3).

5. Electric water heater according to any one of the above claims, **characterized in that** means for inserting at least one magnet (9) for separating magnetic impurities are arranged in the lower section of the water tank cover (4).

6. Electric water heater according to any one of the above claims, **characterized in that** the concentric wall (5) and the heating elements (3) are arranged to separate solid particles from the water stream.

7. Electric water heater according to any one of the above claims, **characterized in that** it is arranged as a backup heater in a heat pump water heating system.

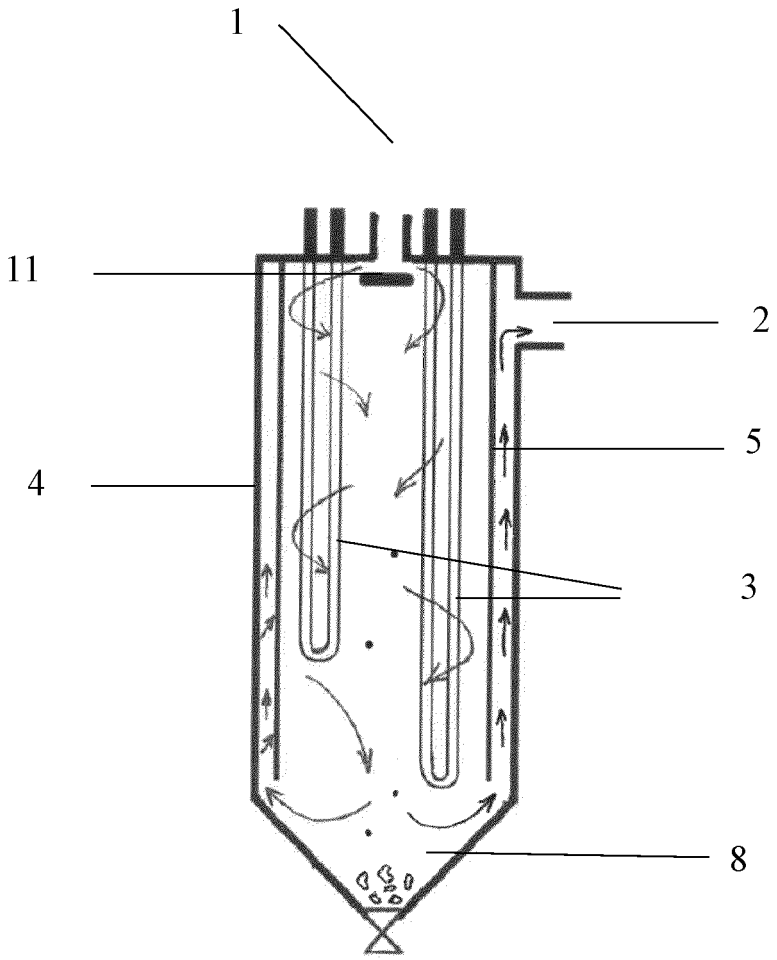

Fig. 1

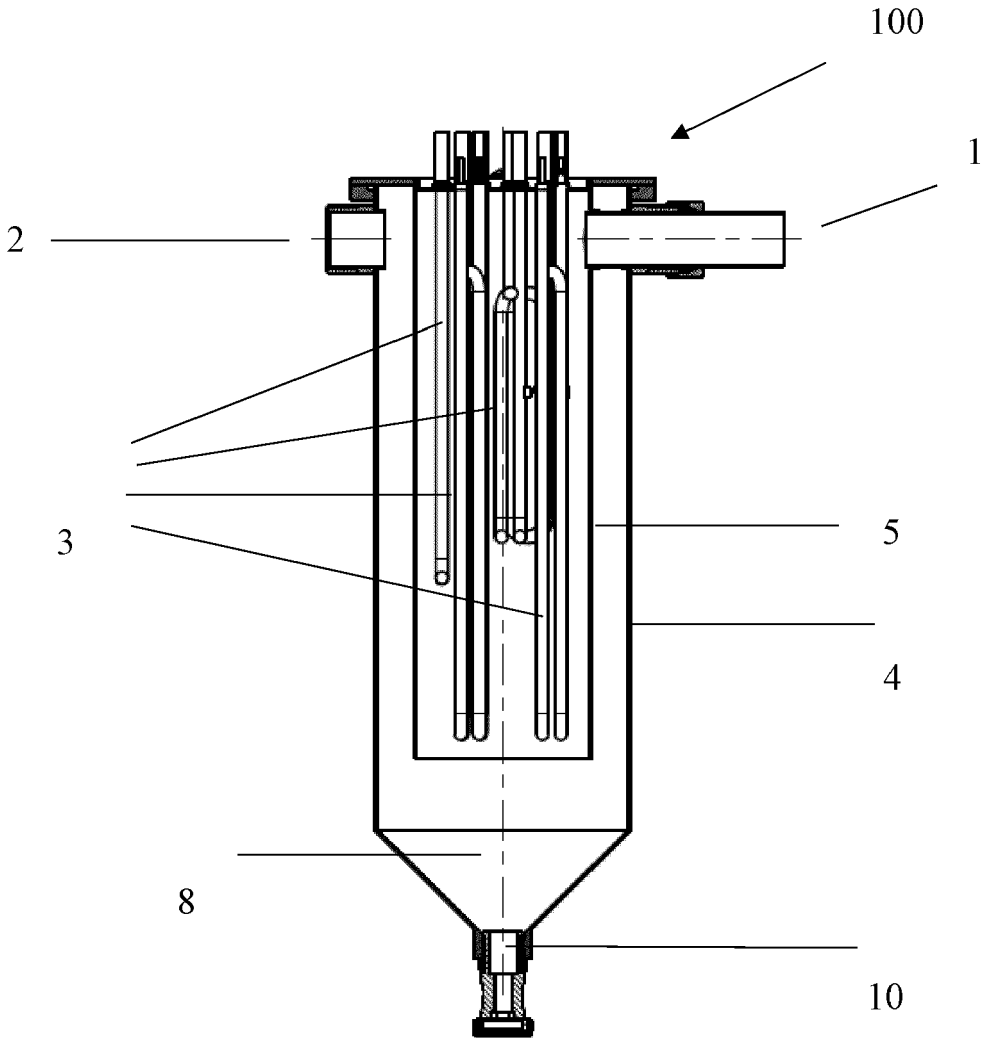

Fig. 2

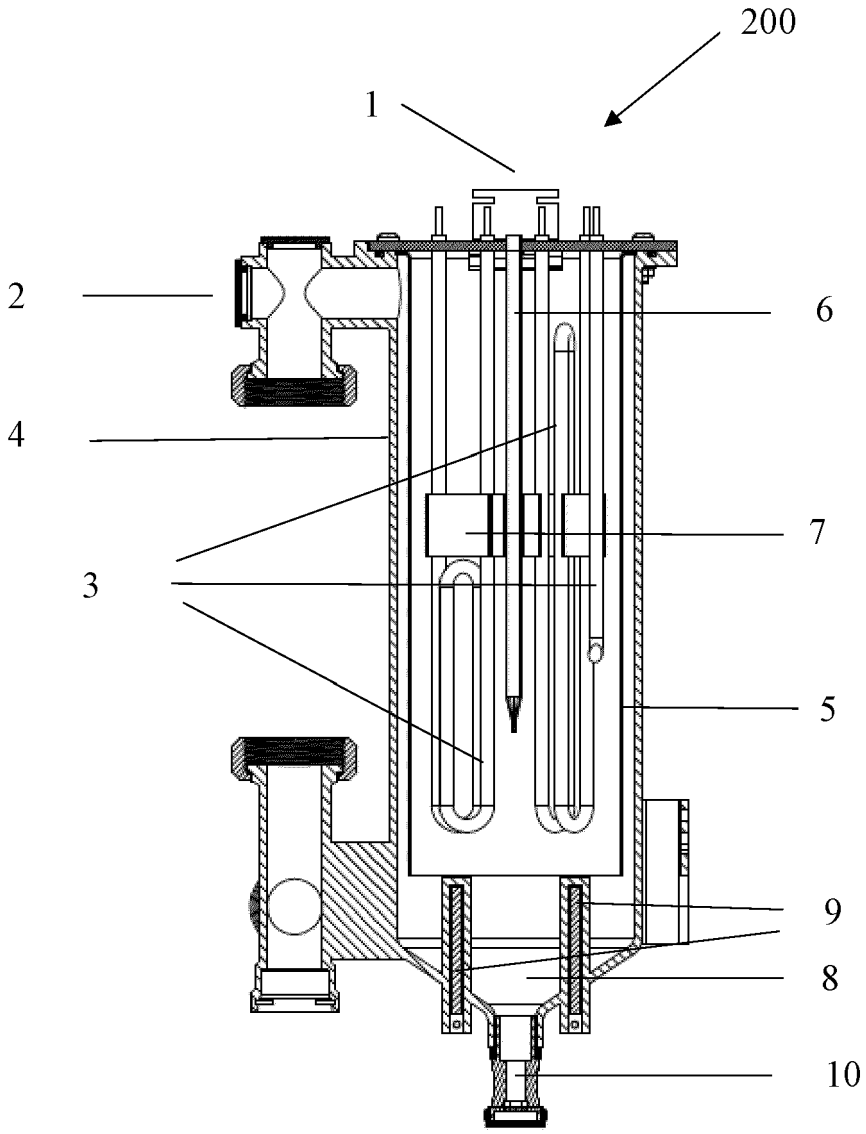

Fig.3

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 21 17 1426

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	WO 2010/128497 A2 (ABRAHAM MOSHE [IL]) 11 November 2010 (2010-11-11) * pages 2, 3, 7 - pages 11,13, 1; figures 1A, 1B, 3 *	1-7	INV. F24H1/18 F24H1/20 F24H9/00
Y	WO 99/39139 A1 (FRASURE CHARLES J [US]; FRASURE GREG A [US]; FRASURE BLAKE D [US]) 5 August 1999 (1999-08-05) * pages 1, 2, 7; figure 1 *	1-7	
A	WO 97/14502 A1 (WOLFS PAULUS [NL]) 24 April 1997 (1997-04-24) * page 3; figure 1 *	5	

TECHNICAL FIELDS SEARCHED (IPC)

F24H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	30 September 2021	Riesen, Jörg

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)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 21 17 1426

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
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

30-09-2021

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2010128497 A2	11-11-2010	AU 2010245622 A1	15-12-2011
		US 2012051724 A1	01-03-2012
		WO 2010128497 A2	11-11-2010
WO 9939139 A1	05-08-1999	AU 2479499 A	16-08-1999
		WO 9939139 A1	05-08-1999
WO 9714502 A1	24-04-1997	AU 7149396 A	07-05-1997
		DE 69608697 T2	04-01-2001
		EP 0859665 A1	26-08-1998
		ES 2148797 T3	16-10-2000
		JP H11514292 A	07-12-1999
		NL 1001427 C2	17-04-1997
		PT 859665 E	30-11-2000
		US 6077333 A	20-06-2000
		WO 9714502 A1	24-04-1997

EPO FORM P0459

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

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- EP 2271432 B1 **[0008]**