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(71) Applicant: **SIEMENS HEALTHCARE LIMITED** [GB/GB]; Park View Watchmoor Park, Camberley, Surrey, GU153YL (GB).

(72) Inventor; and

(71) Applicant *(for SC only)*: **LONG, Zhiqiang** [CN/CN]; Siemens Shenzhen Magnetic Resonance Ltd., Gao Xin Zhong Er Dao, Gao Xin Qu, Zhong Qu, Shenzhen, Guangdong 518057 (CN).

(74) Agent: **KING & WOOD MALLESONS**; 20th Floor, East Tower, World Financial Centre, No. 1, Dongsanhuan Zhonglu, Chaoyang District, Beijing 100020 (CN).

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(54) **Title:** CRYOGEN COOLING SYSTEM FOR SUPERCONDUCTING MAGNET

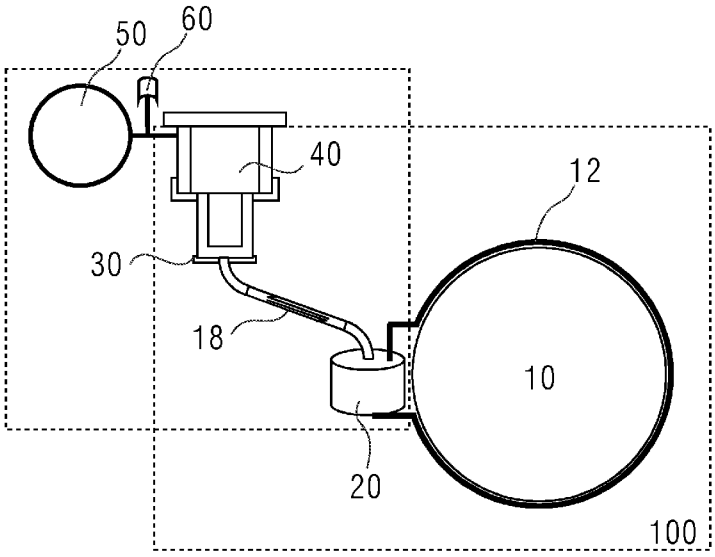


Fig.1

(57) **Abstract:** A cryogen cooling system for a superconducting magnet. The cryogen cooling system comprises: a cryogen chamber (20) connected to a cooling assembly (12) surrounding the superconducting magnet (10); a recondensing chamber (30) disposed higher than the cryogen chamber in a vertical direction; a cryocooler (40) disposed in the recondensing chamber (30) and configured to cool cryogen in the recondesing chamber (30); wherein the recondensing chamber (30) is communicated with the cryogen chamber (20) through a single pipe (18). The cryogen cooling system employ a single pipe (18) for connection and achieves a simple and compact design, which significantly saves the structural space in the cryogen cooling loop, reduces the connection complexity, reduces the risk of pipe leakage, thereby achieving a more steady cryogen cooling system.

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[Continued on next page]

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CRYOGEN COOLING SYSTEM FOR SUPERCONDUCTING MAGNET

FIELD

[0001] The present utility model relates to a cryogen cooling system for a superconducting magnet.

BACKGROUND

[0002] The global helium market triggers the dry magnet (also called the sealed magnet, cryogen free magnet or non-immersed magnet) technology to be the future superconducting magnet platform. In this kind of magnet, there is a cryogen cycling loop between cryocooler and cold mass. In the case of the helium, this helium circuit is functioned for the unidirectional heat transfer with high efficiency from the cold mass to the cryocooler.

[0003] In the prior art, referring to FIG. 2, the cryogen cycling loop between the cryocooler and the cold mass usually comprises a recondensing chamber and a cryogen chamber, and two separate pipes connected to the recondensing chamber and the cryogen chamber respectively. One of the pipes, as a liquid pipe, is used to supply the cryogen from the recondensing chamber where the cryogen is cooled by the cryocooler to the cryogen chamber, and the other pipe, as a warm vapor pipe, is used to send the warm vapor from the cryogen chamber where the which warm vapor absorbs heat from the magnet to the recondensing chamber. Interference between two pipes can be avoided since the two pipes are provided separately from each other. The cycling loop usually consists of hose which is usually longer than the distance between the cryogen chamber and the recondensing chamber to allow the relative movement between the cryogen chamber and the recondensing chamber and to meet the design requirement of magnet structure. In the prior art, arrangement of the two separate pipes, namely, the liquid pipe and the warm vapor pipe occupies a lot of structural space. Particularly, in the case that a plurality of cryogen chambers are provided in the cryogen circuit, two times of pipes are required to be connected to the recondensing chamber. Too many pipes would result in high cost and complexity of parts or systems as well as installation, which brings more risks to the cryogen cooling system, such as leakage, unexpected thermal oscillation, eddy current, etc.

[0004] In some cases, the magnet needs to be cooled by the cryocooler. Most of the cool

down time is consumed for the temperature range above cryogen liquification temperature, during which the heat transfer mode is natural convection. The warm vapor is cooled in the recondensing chamber and becomes denser, and it is heated by absorbing heat to be warm in the cryogen chamber. Consequently, the cryogen can also cycle through the liquid pipe and the warm vapor pipe driven by gravity and buoyant force.

SUMMARY

[0005] An object of the present utility model is to provide a cryogen cooling system for a superconducting magnet. The cryogen cooling system employ a single pipe for connection and achieves a simple and compact design, which significantly saves the structural space in the cryogen cooling loop, reduces the connection complexity, reduces the risk of pipe leakage, thereby achieving a more steady cryogen cooling system.

[0006] The object is achieved by the cryogen cooling system for a superconducting magnet according to the present utility model. The cryogen cooling system comprises: a cryogen chamber connected to a cooling assembly surrounding the superconducting magnet; a recondensing chamber disposed higher than the cryogen chamber in a vertical direction; a cryocooler disposed in the recondensing chamber and configured to cool cryogen in the recondesing chamber; wherein the recondensing chamber is communicated with the cryogen chamber through a single pipe.

[0007] As compared with the arrangement of two separate pipes in the prior art, one single pipe is arranged between the recondensing chamber and the cryogen chamber so that upward and downward flows can occur in the single pipe at the same time, whereby this reduces the number of pipes in the cryogen cooling system by half and thus reduces the manufacturing costs. In addition, the single pipe occupies less space, so it is more compact than the double-pipe arrangement, which allows for more space in the cryogen cooling system for other components. Therefore, the design of the cryogen cooling system is more flexible and structurally simpler. Due to the reduction in the number of pipes, the manufacture, transportation and assembling of this simple and compact cryogen cooling system are simpler, and costs in these aspects, as well as labor costs, can be reduced. Furthermore, since this kind of pipe will vibrate during MRI scanning, the reduction in the number of pipes will also reduce the interference of pipe vibration on the magnetic field and RF signals. In addition, the design of the single pipe enables the shortest connection path between the recondensing chamber and the cryogen chamber, so that the cryogen flow resistance is also the smallest,

which is especially important in the case of natural convection. Furthermore, the simple structure design of the single pipe makes it possible to add a larger number of cryogen chambers more flexibly by adding one pipe for each cryogen chamber without complicating the system design.

[0008] According to a preferred embodiment of the present utility model, one end of the single pipe is connected to a bottom end of the recondensing chamber, and the other end of the single pipe is connected to the vicinity of a top end of the cryogen chamber so that a portion of the single pipe connected to the cryogen chamber is higher than a cryogen liquid level in the cryogen chamber.

[0009] By connecting one end of the single pipe to the bottom end of the recondensing chamber, the liquid cryogen or cold dense vapor in the recondensing chamber can flow simply driven by its own gravity through the single pipe from the bottom end of the recondensing chamber into the cryogen chamber. In addition, making the portion of the single pipe connected to the cryogen chamber higher than the cryogen liquid level in the cryogen chamber enables the warm vapor generated in the cryogen chamber to freely enter and exit the single pipe, so as to avoid warm vapor being blocked in the cryogen chamber.

[0010] According to a preferred embodiment of the present utility model, one end of the single pipe is connected to the bottom end of the recondensing chamber and the other end is connected to the top end of the cryogen chamber. This further ensures that the portion of the single pipe connected to the cryogen chamber is higher than the cryogen liquid level in the cryogen chamber, so that the warm vapor generated in the cryogen chamber can more easily enter the single pipe driven by buoyant force and flow towards the recondensing chamber.

[0011] According to a preferred embodiment of the present utility model, a thickness of the bottom wall at the bottom end of the recondensing chamber is configured such that the end of the single pipe connected to the recondensing chamber can be welded to the bottom wall at the bottom end of the recondensing chamber. The thicker bottom end of the recondensing chamber enables welding of one end of the single pipe to ensure that no leakage occurs. Moreover, the single pipe reduces the number of connection ports on the recondensing chamber and the cryogen chamber, thereby reducing the cost and the occurrence possibility of leakage and realizing a more stable cryogenic system.

[0012] According to a preferred embodiment of the present utility model, a side wall of the recondensing chamber is configured thinner than the bottom wall at the bottom end of the

recondensing chamber. Compared with the prior art, in the present utility model, the side wall of the recondensing chamber needn't be welded to the single pipe, so the side wall may be constructed relatively thin, so that the heat conduction in the cryocooler is the lowest, then the heat load is the lowest, and the cost may be reduced.

[0013] According to a preferred embodiment of the present utility model, the single pipe is a flexible hose. The flexible hose allows relative movement between the recondensing chamber and the cryogen chamber. In addition, the flexible hose is expensive, so the use of only one single pipe may greatly reduce the cost.

[0014] According to a preferred embodiment of the present utility model, the single pipe is a metallic flexible hose. The metallic flexible hose also allows relative movement between the recondensing chamber and the cryogen chamber.

[0015] According to a preferred embodiment of the present utility model, the single pipe is a rigid tube. The rigid tube improves the strength of the single pipe.

[0016] According to a preferred embodiment of the present utility model, the single pipe is at least partially composed of bellows. Due to the thin and curved wall of the bellows, excellent thermal conductance resistance is provided in the recondensing chamber and the cryogen chamber. This minimizes the heat load of the superconducting magnet especially when the cryocooler is turned off, thereby prolonging the warm up time of the superconducting magnet.

[0017] According to a preferred embodiment of the present utility model, the cooling assembly is a thermal conduction component made of metal or composite material with high thermal conductivity. In this way, the heat of the superconducting magnet can be better conducted out.

[0018] According to a preferred embodiment of the present utility model, the cooling assembly is a thermal conduction component made of copper braid or copper plate. Copper can better conduct the heat of the superconducting magnet.

[0019] According to a preferred embodiment of the present utility model, the cooling assembly is a cooling pipe or a cooling coil. In this way, the cooling circuit is realized in a simple manner.

[0020] According to a preferred embodiment of the present utility model, the cryogen cooling system further comprises a gas buffer for containing gaseous cryogen when the

superconducting magnet warms up or quenches. This ensures the safety of the cryogen cooling system when the superconducting magnet warms up or quenches.

[0021] According to a preferred embodiment of the present utility model, the cryogen cooling system further comprises a safety/operation device. The safety/operation device simplifies the operation of the cryogen cooling system and ensures safety.

[0022] The cryogen cooling system for the superconducting magnet according to the present utility model can be particularly applied to a Siemens MRI magnet. The cryogen cooling system can reduce the risk of leakage inside the system so that the cooling system is more reliable. As the thermal conduction of the metal parts is reduced, the warm up time of the magnet can be prolonged when the cryocooler is powered off, thereby prolonging the operating time of the system. In addition, it reduces the cost in material, manufacturing, assembling, transportation and labor.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] Reference may be made to preferred embodiments shown in the figures to make the above and other objects, features, advantages and functions of the present utility model more apparent. The same reference numbers in the figures denote the same components. Those skilled in the art should appreciate that the figures are intended to illustrate preferred embodiments of the present utility model, not to limit the scope of the present utility model in any way. The parts in the figures are not drawn to scale.

[0024] FIG. 1 illustrates a cryogen cooling system for a superconducting magnet according to the present utility model;

[0025] FIG. 2 illustrates a cryogen cooling system for a superconducting magnet in the prior art

[0026] Listing of reference numbers

[0027] Superconducting magnet 10

[0028] Vacuum chamber 100

[0029] Cooling assembly 12

[0030] Liquid pipe 14

[0031] Warm vapor pipe 16

[0032] Single pipe 18

[0033] Cryogen chamber 20

[0034] Recondensing chamber 30

[0035] Cryocooler 40

[0036] Gas buffer 50

[0037] Safety/operation device 60

DETAILED DESCRIPTION

[0038] The concept of the present utility model will be described in detail below with reference to figures. What are described here are only preferred embodiments according to the present utility model. Those skilled in the art may envisage other modes for implementing the present utility model on the basis of the preferred embodiments, and said other modes also fall within the scope of the present utility model. In the following detailed description, directional terminology such as “up”, “down”, “in” and “out” are used with reference to directions described in the figures. Parts in the embodiments of the present utility model may be arranged in different directions. The directional terminology is used for illustration purpose not for limiting.

[0039] FIG. 1 illustrates a cryogen cooling system for a superconducting magnet according to the present utility model. A cold mass, e.g., a superconducting magnet 10, particularly a superconducting coil is received in a vacuum chamber 100 and surrounded by a cooling assembly 12, and the cooling assembly 12 is connected to a cryogen chamber 20 and configured to transfer heat absorbed from the superconducting magnet 10 to the cryogen chamber 20. The cooling assembly 12 for example may be a cooling pipe or a cooling coil whose both ends are connected to the cryogen chamber 20. Preferably, the cryogen chamber 20 is located in the vicinity of the superconducting magnet 10. The cryogen may be helium, or other proper cryogens known to those skilled in the art.

[0040] As shown in FIG. 1, a recondensing chamber 30 is disposed higher than the cryogen chamber 20 in a vertical direction, i.e., at least a bottom end of the recondensing chamber 30 is higher than a bottom end of the cryogen chamber 20 in the vertical direction. The recondensing chamber 30 and the cryogen chamber 20 may be in staggered arrangement

in the vertical direction. Only a single pipe 18 is provided between the cryogen chamber 20 and the recondensing chamber 30, instead of two separate pipes as in the prior art. One end of the single pipe 18 is connected to the bottom end of the recondensing chamber 30 and communicated with the recondensing chamber 30, and the other end of the single pipe 18 is connected to a top end of the cryogen chamber 20 and communicated with the cryogen chamber 20.

[0041] A cryocooler 40, which is also known as cold head, is provided in the recondensing chamber 30. The cryocooler 40 is configured to cool the cryogen in the recondensing chamber 30, or condense the cryogen into liquid cryogen or cold dense vapor with a higher density relative to warm vapor, and absorb heat brought by relatively warmer cryogen vapor. Thus, the cryogen circuit according to the present utility model includes the cryogen chamber 20, the recondensing chamber 30, the single pipe 18 and the cryocooler 40.

[0042] In FIG. 1, the cryogen in the recondensing chamber 30 is condensed into liquid cryogen or cold dense vapor by the cryocooler 40 arranged in the recondensing chamber 30, and the liquid cryogen or cold dense vapor, driven by its gravity, flows down from the bottom end of the recondensing chamber 30 through the single pipe 18 into the cryogen chamber 20. In the case of using nitrogen as cryogen, for example, liquid nitrogen flows from the bottom end of the recondensing chamber 30 through the single pipe 18 down into the cryogen chamber 20.

[0043] The liquid cryogen or cold dense vapor flowing into the cryogen chamber 20 is evaporated into warm vapor by the heat absorbed from the superconducting magnet 10 by means of the cooling assembly 12, and the warm vapor flows through the single pipe 18 upwards from the cryogen chamber 20 back into the recondensing chamber 30 due to buoyant force.

[0044] The warm vapor that already returns back to the recondensing chamber 30 is condensed into liquid cryogen or cold dense vapor again by the cryocooler 40 in the recondensing chamber 30. The liquid cryogen or cold dense vapor again flows through the single pipe 18 into the cryogen chamber 20. This operation will continue cyclically, so as to cool the superconducting magnet 10 in the way of replenishing the cryogen chamber 20 with liquid cryogen or cold dense vapor from the recondensing chamber 30.

[0045] In the single pipe 18, the warm vapor is warmer than the liquid cryogen or the cold dense vapor from the recondensing chamber 30, so that the warm vapor floats to an

upper portion and flows upward, whereas the liquid cryogen or cold dense vapor from the recondensing chamber 30 flows downward into the cryogen chamber 20 due to the gravity. As a result, the downwards and upwards flow occur in this single pipe simultaneously, which is known as counter flow. In the condition of cooling down or normal operation, the liquid cryogen or the cold denser vapor and the warm vapor can achieve a steady self-organized counter flow in the single pipe 18, which can also achieve highly efficient heat transfer between the recondensing chamber 30 and the cryogen chamber 20. Even if this single pipe 18 is arranged completely vertical, a steady counter flow can also be formed because of density difference between the cold and warm flow. Although the counter flow might introduce extra flow resistance, the single pipe can bring greater benefits to the simplification of flow path.

[0046] In addition, the cryogen circuit between the cryogen chamber 20 and the recondensing chamber 30 realizes high efficient heat transfer from the superconducting magnet to the cryocooler, and minimizes the reverse heat load from the cryocooler and other warm parts to the cryogen chamber.

[0047] In addition, it can be seen in FIG. 1 that a bottom wall of the bottom end of the recondensing chamber 30 is constructed fairly thick. The bottom wall of the bottom end is used to connect with the single pipe 18, for example, by welding, so that the bottom wall needs to be constructed thick. Whereas the side walls of the recondensing chamber 30 may be constructed relatively thin to minimize the heat load of the cryocooler. In this way, the weight of the components may also be reduced.

[0048] In the prior art, as shown in FIG. 2, one end of the liquid pipe 14 of the two pipes is connected to the bottom end or the vicinity of the bottom end of the recondensing chamber 30 and communicated with the recondensing chamber 30, and the other end of the liquid pipe 14 is connected to the vicinity of the bottom end of the cryogen chamber 20 and communicated with the cryogen chamber 20. One end of the warm vapor pipe 16 is connected to a top end or the vicinity of the top end of the cryogen chamber 20 and communicated with the cryogen chamber 20, and the other end of the warm vapor pipe 16 is connected to the side wall of the recondensing chamber 30 and communicated with the recondensing chamber 30. This causes the side wall of the recondensing chamber in the prior art also to be constructed thicker, because the side wall is also configured to connect with the warm vapor pipe 16, for example, by welding. Compared with the double-pipe arrangement in the prior art, the single pipe 18 in

the present utility model further saves half of the number of connection ports.

[0049] In FIG. 1, one end of the single pipe 18 is in communication with the top end of the cryogen chamber 20. However, the end of the single pipe 18 may also be connected to the cryogen chamber 20 at other positions, as long as the portion for connection is higher than the cryogen liquid level in the cryogen chamber 20. As a result, the warm vapor in the cryogen chamber can enter the single pipe 18 more freely. The other end of the single pipe 18 is connected to the recondensing chamber 30 at the bottom of the recondensing chamber 30, so that liquid cryogen or cold dense vapor can easily flow into the single pipe 18, driven by gravity.

[0050] The single pipe 18 may employ a flexible hose, for example, a metal hose, a rigid tube, etc. The single pipe 18 may also be constructed partially or totally of a bellows. The thin and curved wall of the bellows provides a good heat conduction resistance in the recondensing chamber 30 and the cryogen chamber 20. This can reduce the heat load of the superconducting magnet to a maximum extent especially when the cryocooler 40 is turned off, thereby prolonging the heating time of the superconducting magnet.

[0051] The cryogen circuit for superconducting magnets according to the present utility model is further provided with a gas buffer 50 which is connected to the cryocooler 40. Here, the gas buffer 50 is arranged outside the vacuum chamber 100, whereas the cryogen chamber 20, the recondensing chamber 30, the single pipe 18, the superconducting magnet 10 and the cryocooler 40 are arranged inside the vacuum chamber 100 as shown in FIG. 1. The gas buffer 50 is used to contain the gaseous cryogen when the superconducting magnet warms up or quenches.

[0052] The cryogen circuit for superconducting magnets according to the present utility model is further provided with a safety/operation device 60, which is also arranged outside the vacuum chamber 100 and connected with the cryocooler 40 and the gas buffer 50 through an external pipe. The safety/operation device may be configured as a safety valve, a burst disc, a pressure gauge, a cryogen charging port, etc.

[0053] The cooling assembly 12, particularly the cooling pipeline or the cooling coil, may be a thermal conduction component made of various types of metals and composites with high thermal conductivity, such as copper braid, copper plate or other materials with various shapes. Preferably, the cooling assembly 12 is in tight thermal contact with the superconducting magnet 10 and the cryogen chamber 20, so as to absorb the heat load from

the superconducting magnet 10 and transfers the heat load to the cryogen chamber 20. The cryogen is cyclically used through the cryogen circuit.

[0054] The protection scope of the present utility model is only limited by the claims. Thanks to the teaching of the present utility model, those skilled in the art can easily realize that alternative structures of the structure disclosed in the present utility model can serve as feasible alternative embodiments, and the embodiments disclosed in the present utility model can be combined to produce new embodiments, which also fall within the scope of the appended claims.

I/We Claim:

1. A cryogen cooling system for a superconducting magnet, comprising:

a cryogen chamber (20) connected to a cooling assembly (12) surrounding the superconducting magnet (10);

a recondensing chamber (30) disposed higher than the cryogen chamber in a vertical direction;

a cryocooler (40) disposed in the recondensing chamber (30) and configured to cool cryogen in the recondesing chamber (30);

wherein the recondensing chamber (30) is communicated with the cryogen chamber (20) through a single pipe (18).

2. The cryogen cooling system for a superconducting magnet according to claim 1, wherein one end of the single pipe (18) is connected to a bottom end of the recondensing chamber (30), and the other end of the single pipe (18) is connected to the vicinity of a top end of the cryogen chamber (20) so that a portion of the single pipe (18) connected to the cryogen chamber (20) is higher than a cryogen liquid level in the cryogen chamber (20).

3. The cryogen cooling system for a superconducting magnet according to claim 1 or 2, wherein one end of the single pipe (18) is connected to the bottom end of the recondensing chamber (30) and the other end of the single pipe (18) is connected to the top end of the cryogen chamber (20).

4. The cryogen cooling system for a superconducting magnet according to claim 3, wherein a thickness of a bottom wall at the bottom end of the recondensing chamber (30) is configured such that the end of the single pipe (18) connected to the recondensing chamber (30) can be welded to the bottom wall at the bottom end of the recondensing chamber (30).

5. The cryogen cooling system for a superconducting magnet according to claim 4, wherein a side wall of the recondensing chamber (30) is configured thinner than the bottom wall at the bottom end of the recondensing chamber (30).

6. The cryogen cooling system for a superconducting magnet according to claim 1 or 2, wherein the single pipe (18) is a flexible hose.

7. The cryogen cooling system for a superconducting magnet according to claim 6, wherein the single pipe (18) is a metallic flexible hose.

8. The cryogen cooling system for a superconducting magnet according to claim 1 or 2, wherein the single pipe (18) is a rigid tube.

9. The cryogen cooling system for a superconducting magnet according to claim 1 or 2, wherein the single pipe (18) is at least partially composed of bellows.

10. The cryogen cooling system for a superconducting magnet according to claim 1 or 2, wherein the cooling assembly is a thermal conduction component made of metal or composite material with high thermal conductivity.

11. The cryogen cooling system for a superconducting magnet according to claim 10, wherein the cooling assembly is a thermal conduction component made of copper braid or copper plate.

12. The cryogen cooling system for a superconducting magnet according to claim 10, wherein the cooling assembly is a cooling pipe or a cooling coil.

13. The cryogen cooling system for a superconducting magnet according to claim 1 or 2, wherein the cryogen cooling system further comprises a gas buffer (50) for containing gaseous cryogen when the superconducting magnet (10) warms up or quenches.

14. The cryogen cooling system for a superconducting magnet according to claim 1 or 2, wherein the cryogen cooling system further comprises a safety/operation device (60).

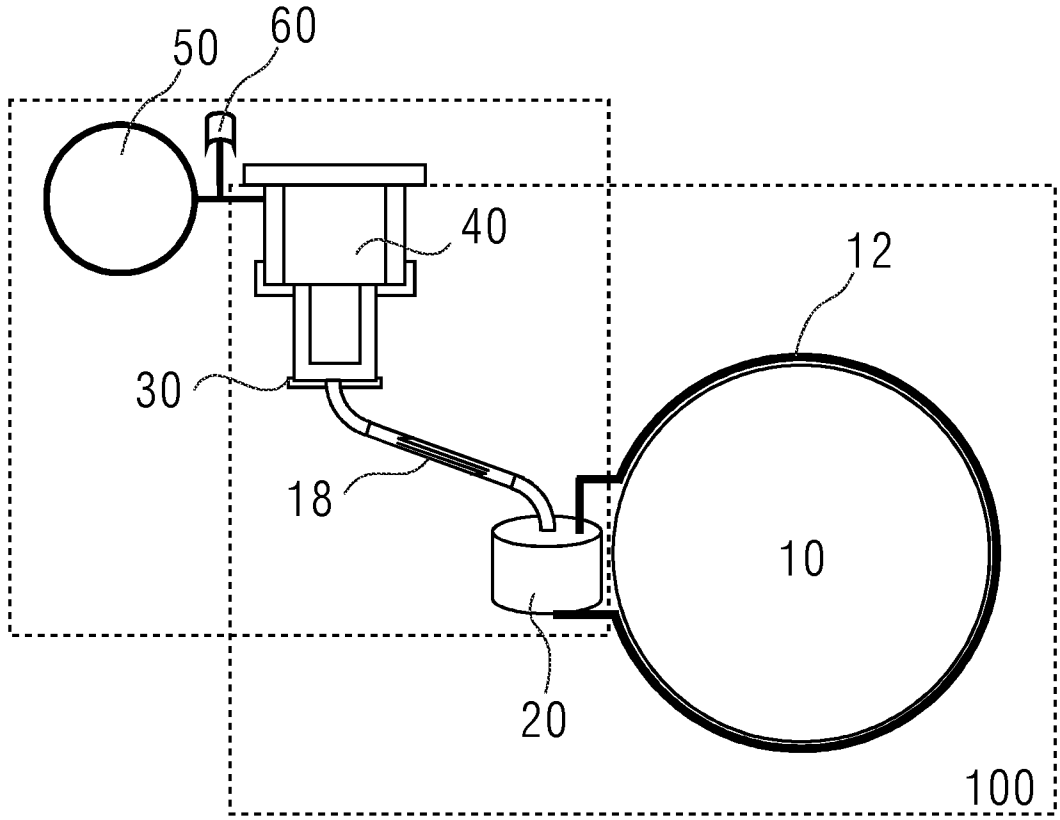


Fig.1

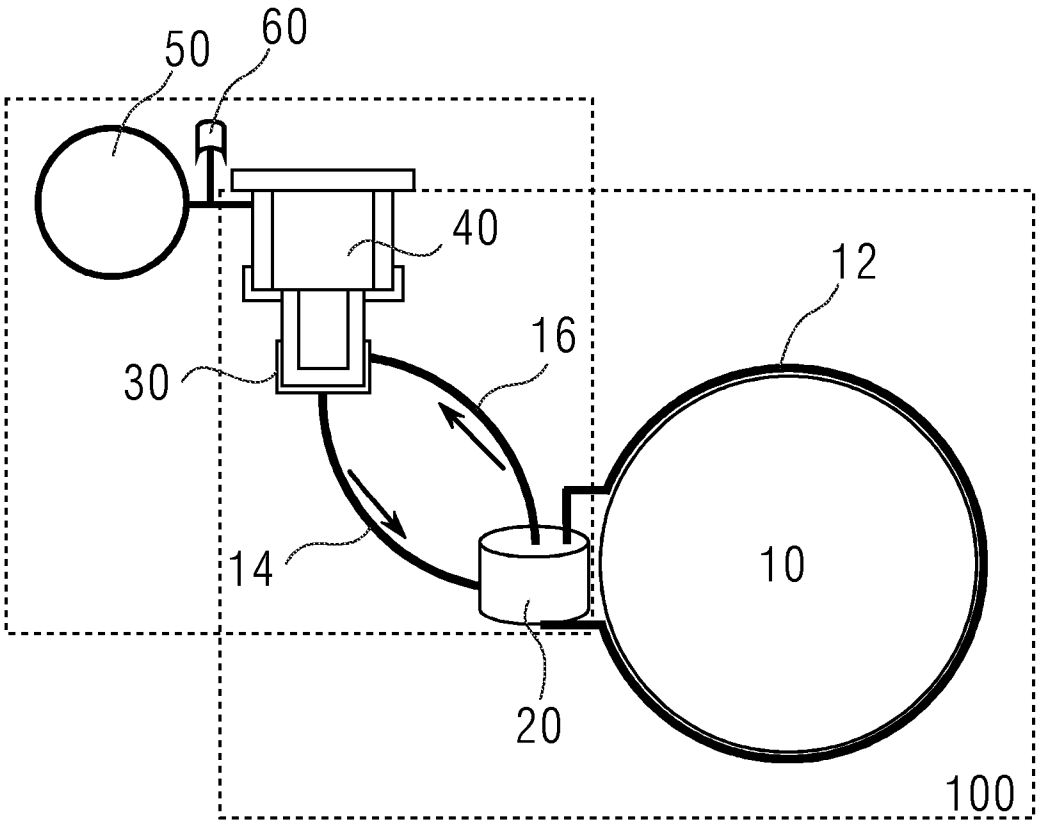


Fig.2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2021/113911

A. CLASSIFICATION OF SUBJECT MATTER

H01F 6/04(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H01F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNPAT,WPI,CNTXT,CNKI,IEEE:self organilz+,counter,flow,same,single,pipe,cryogen,gas+,superconducting magnet, cool+, channel,liquid,pipeline

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 213483505 U (SIEMENS HEALTHCARE GMBH) 18 June 2021 (2021-06-18) claims 1-14	1-14
Y	CN 103842746 A (KONINKLIJKE PHILIPS ELECTRONICS N.V.) 04 June 2014 (2014-06-04) description, paragraphs [0023]-[0035] and figure 1	1-14
Y	CN 2501188 Y (TAISHUO ELECTRONIC CO., LTD.) 17 July 2002 (2002-07-17) description, page 3, line 1 to page 4, line 11 and figures 3-4	1-14
A	CN 103781325 A (YUANDENG METAL CO., LTD.) 07 May 2014 (2014-05-07) the whole document	1-14
A	JP 2019212748 A (HITACHI LTD.) 12 December 2019 (2019-12-12) the whole document	1-14
A	CN 109442798 A (HUNAN MAGTECH MEDICAL TECHNOLOGY CO., LTD.) 08 March 2019 (2019-03-08) the whole document	1-14

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
05 November 2021	**19 November 2021**
Name and mailing address of the ISA/CN **National Intellectual Property Administration, PRC** **6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088** **China** Facsimile No. **(86-10)62019451**	Authorized officer **LU,Ran** Telephone No. **86-(10)-53961226**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2021/113911

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