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(54) Apparatus for generating a magnetic field in a processing space.

(57) The invention concerns an apparatus for generating a magnetic field in one or two processing spaces. The apparatus comprises a flux generator, which can be a permanent magnet, an electromagnet or a super-conducting magnet. The flux generator is located centrally between two parallel plates, so that the remaining space between the two plates functions as the processing space. By using a hollow flux generator, the space within the flux generator can be used as a second processing space. This configuration leads to a simple construction of both the flux generator an the inner circuit.

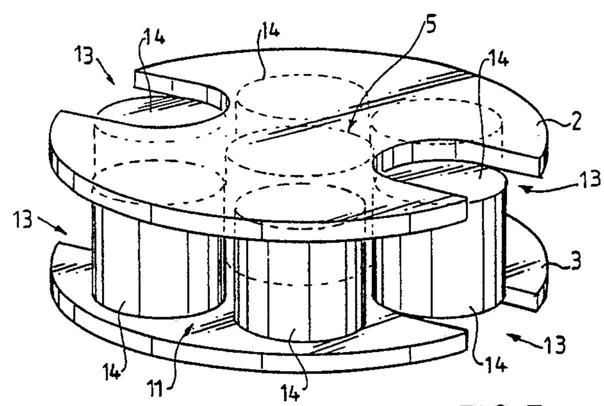

FIG. 7

EP 0 325 313 A1

APPARATUS FOR GENERATING A MAGNETIC FIELD IN A PROCESSING SPACE

The present invention relates to an apparatus for generating a magnetic field in at least one processing space, said apparatus comprising a flux generator.

Said apparatuses are generally known.

For instances apparatusses are known, in which a cilindrical magnet, having for instance a rectangular cross section, surrounds a processing space, so that a magnetic field is generated within said processing space. Such a magnet can be a normal electric magnet, working at room temperature, but can also be a super-conduction magnet or even a permanent magnet.

When such a processing space adopts a considerable size, the problem develops that the use of power of such a electromagnet increases substantially, requiring high costs. In the case of a super-conducting magnet, the size of the cryostat required therefore, will be such that the investments related thereto will be unacceptably high. Also with the application of a permanent magnet, the investments will reach a prohibitive level.

It has already been proposed to surround such an apparatus with a box-shaped magnetic circuit. Although this enables a reduction of the requirements for power in the case of a magnet working with normal temperature, this has the disadvantage that the accessibility of the processing space detoriates. Besides, the size of a cryostat is hardly smaller in the case of a circuit comprising a super-conducting magnet, so that the disadvantage mentioned in connection therewith is maintained.

It is also known to apply a coil for a magnet around an iron yoke, which is for instance C-shaped and to provide pole-shoes on both sides of the processing space. Although the size of the coil for the magnet or the flux generator as a whole can be limited considerably, the application of a certain apparatus in the case of a processing space of substantial size implies that large quantities of iron will have to be used, which increases both the weight and the costs of such an apparatus.

Consequently, the aim of the present invention is to provide an apparatus in which a flux generator with small sizes can be used for generating a magnetic field in a processing space of a large size.

This aim is reached by having the magnetic circuit comprising two substantially flat yokes which are provided at both sides of the flux generator.

As a consequence of this measure, the whole space between the two yokes is used as a processing space, with the exception of the space which is required for the flux generator. Consequently, a magnetic field can be generated in the processing space with substantial size with minimal sizes of both the iron circuit as of the flux generator. The flux generator can be composed of a normal electromagnet, a super-conducting magnet or a permanent magnet.

Subsequently, the present invention will be elucidated with the help of the drawings, wherein:

fig. 1: depicts a schematic cross section of a first embodiment of an apparatus according to the present invention;

fig. 2: depicts a schematic cross section of a second embodiment of the present invention;

fig. 3: depicts a schematic cross section of a third embodiment of the present invention;

fig. 4: depicts a schematic cross section of a variation of the third embodiment of the present invention;

fig. 5: depicts a schematic cross section of a fourth embodiment of the present invention;

fig. 6: depicts a schematic cross section of a fifth embodiment of the present invention; and

fig. 7: depicts a schematic perspective view of a sixth embodiment of the present invention.

The embodiment depicted in fig. 1 comprises an iron circuit 1 which is formed by two circle-shaped plates 2, 3 which have been provided parallel to each other and which are connected by a core 4. The plates 2, 3 and the core 4 have been formed as one single piece. A substantially cilindrical cryostat 5 surrounding the core 4 has been provided. This cryostat comprises a cilindrical super-conducting coil 6, which is surrounded by a vessel 7, filled with helium. Outside the vessel 7, filled with helium, two radiations screens 8, 9 have been provided, and the whole structure is surrounded by the outside wall 10 of the cryostat.

Without both flat plates 2, 3, outside the cryostat 5, a ring-shaped space 11 is left open, which can be used as a processing space. As a consequence of the configuration of the iron circuit, a magnetic field is generated in the ring-shaped processing space 11. By chosing the exitation of the flux generator or the super-conducting coil, the field strength within the processing space can be chosen, in which it is possible to generate a magnetic field in a large space with only a relative small flux generator. As this space is completely open at its outside, the space is easily accessible, so that the bodies to be subjected to the process can easily be taken into the processing space and can be removed therefrom. However, the magnetic forces have to be taken into account with this operation.

The embodiment shown in fig. 2 deviates

therefrom in that the core 4 has been replaced by a vessel 16 filled with liquid nitrogen. As a consequence thereof the vessel 10 of the cryostat 5 can be executed as a cilindrical box without any aperture.

Some processes require a processing space with a relatively small magnetic flux density and a second, smaller, processing space with a higher flux density. The embodiment shown in fig. 3 aliviates this need.

In this embodiment, in which the core 4 of a first embodiment is missing, this has been replaced by a second processing space 12. Consequently, the cryostat 5 has to comprise a cilindrical vessel 10. The magnetic flux density within the second processing space 12 can, as a matter of course, be different from the magnetic flux density in the processing space 11 mentioned before.

The variation depicted in fig. 4 of a third embodiment deviates by another location of the radiation screens within the cryostat. This offers space for a vessel 15 for liquid nitrogen. Further, this variant does not deviate from the third embodiment.

The fourth embodiment depicted in fig. 5 comprises plates 2, 3 respectively, of which the shape is different; the plates 2, 3 are not flat, but are saucer-shaped so that the volume of the processing space 11 is substantially reduced. As a consequence thereof the magnetic field strength within the processing space 11 is enlarged in accordance therewith. Thus, the dimensioning of the yokes can be used to accomplish the specific requirements of the process to the magnetic field.

The effect reached in the fourth embodiment can be emphasized by the fifth embodiment shown in fig. 6. In this embodiment plates 2, 3 have such a shape that the height of the processing space 12 equals the height of the processing space 11, so that again the field strength has been enlarged. This counts for both the processing spaces 11 and 12. This develops a further possibility of choice of volume, in which the most suitable combination can be chosen for a certain application.

Finally fig. 7 shows a sixth embodiment, in which flat plates 2, 3 have been provided, each comprising two apertures 13. In the processing space 11 six vessels 14 have been provided, in which the required processes can be executed under the influence of the relevant magnetic field. By providing the apertures 13 in the plates 2, 3 two vessels 14 are nearly located outside the magnetic field, present between the plates 2 and 3. Some processes require an intermitting magnetic field, that is to say that a part of the process is executed in the presence of an magnetic field and another part of the process is executed without the presence of a magnetic field.

This effect can be obtained by switching off and on the electrical power supply of the magnetic coil, but this effect can also be obtained by providing a part of the space involved in the process to transform to a space without a magnetic field.

This can be the case when sewage water is cleaned, which process is executed under the presence of a magnetic field, after which the accumulated filters have to be deprived of their contamination, which has to take place without the presence of a magnetic field.

Then it is advantageous to locate the vessels as is depicted in fig. 7, so that the plates 2, 3 can be turned around a central shaft of the cryostat 5, so that subsequently a pair of the vessels 14 is without a magnetic field. This turning of the plates 2, 3 can take place without moving the vessels 14 in and out of the magnetic field, which would include the resisting of great forces. The turning of the plates causes only limited forces as with a regular distribution of the vessels 14 in the processing space 11, each time a vessel enters the area of influence of the magnetic field another vessel leaves said area. Thus opposing magnetic forces substantially compensate each other. In such a configuration vessels in the shape of circle-segments could have been provided instead of cilindrical vessels, which would cause the forces to compensate each other for a greater part. Of course, it is also possible to connect the vessels with each other and turning these together instead of turning the plates 2, 3.

For continuous processes a channel can be provided stretching at least partially in the processing space. Such a channel could extend along the whole circumference of the processing space 11, so that the processing space 11 is filled completely.

Claims

1. Apparatus for generating a magnetic field in at least one processing space, comprising a flux generator and a magnetic circuit connecting said flux generator with said processing space, **characterized in** that the magnetic circuit comprises two substantially flat yokes, which are located at both sides of the flux generator.

2. Apparatus according to claim 1, **characterized in** that the flux generator is being formed by a cilindrical magnet.

3. Apparatus according to claim 2, **characterized in** that the space surrounded by the cilindrical magnet is a second processing space.

4. Apparatus according to claim 2, **characterized in** that the space enclosed by the cilindrical magnet offers place to a body with a good magnetic conductivity and which connects both yokes.

5. Apparatus according to one of the claims 1-4, **characterized in** that the flux generator has been provided in the centre of the yokes.

6. Apparatus according to one of the preceding claims, **characterized in** that the flux generator is circle- symmetrical.

7. Apparatus according to one of the preceding claims, **characterized in** that the flux generator comprises a super-conductive magnet.

8. Apparatus according to one of the preceding claims, **characterized in** that in at least one of said processing spaces vessels have been provided, which are suitable for having a process take place in them.

9. Apparatus according to one of the preceding claims, **characterized in** both yokes comprise apertures at a location of at least a number of said vessels.

10. Apparatus according to claim 9, **characterized in** that both yokes can be turned around the central shaft relative to the vessels.

11. Apparatus according to one of the preceding claims **characterized in** that the distance between both yokes at a location of at least one said processing spaces is smaller than the distance between said yokes at a location of the flux generator.

12. Apparatus according to one of the preceding claims, **characterized in** that the apparatus has been dimensioned such that the flux density in the central processing space differs from the flux density in the outer processing space.

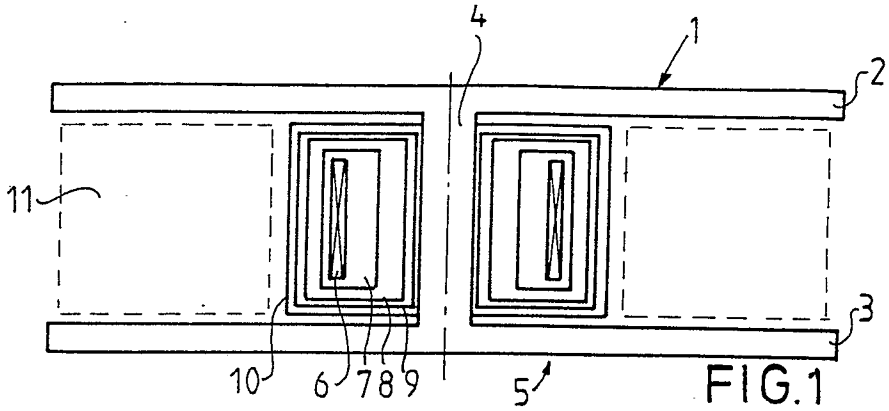

FIG.1

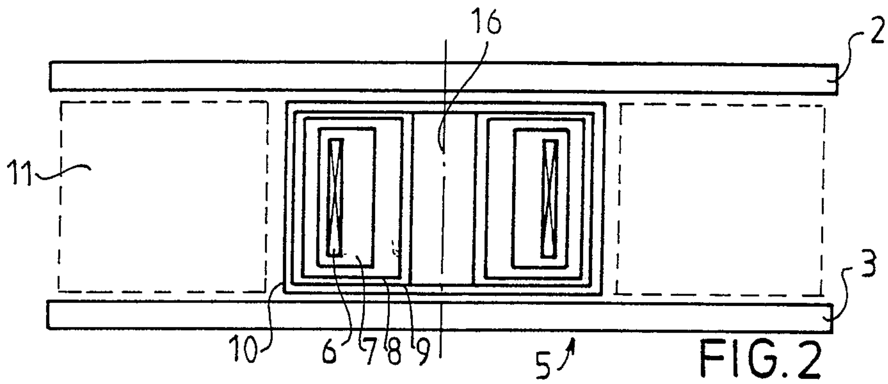

FIG.2

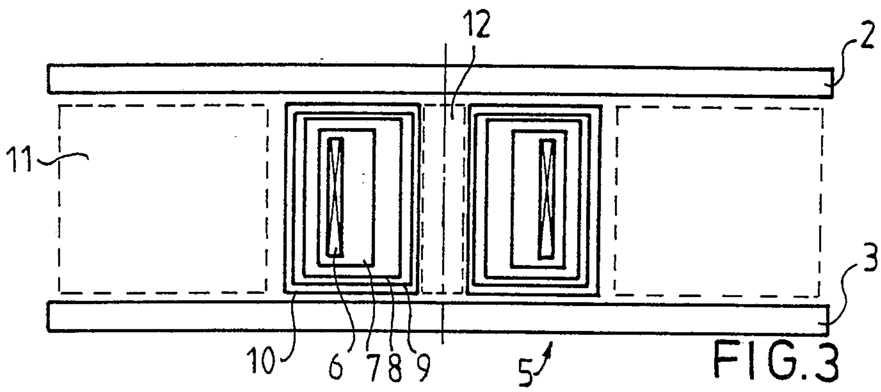

FIG.3

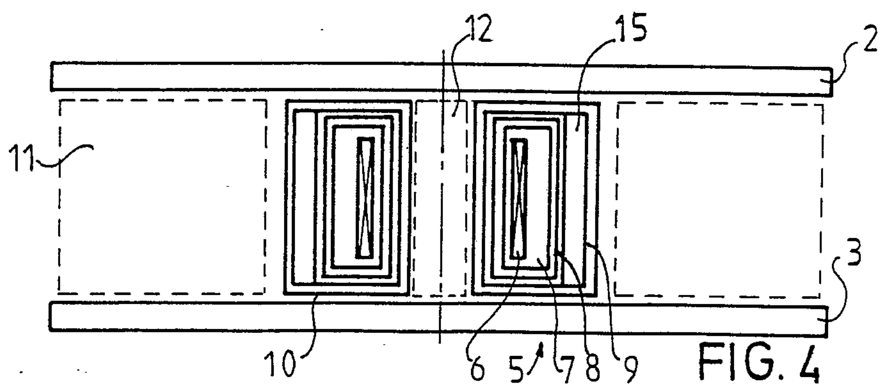

FIG. 4

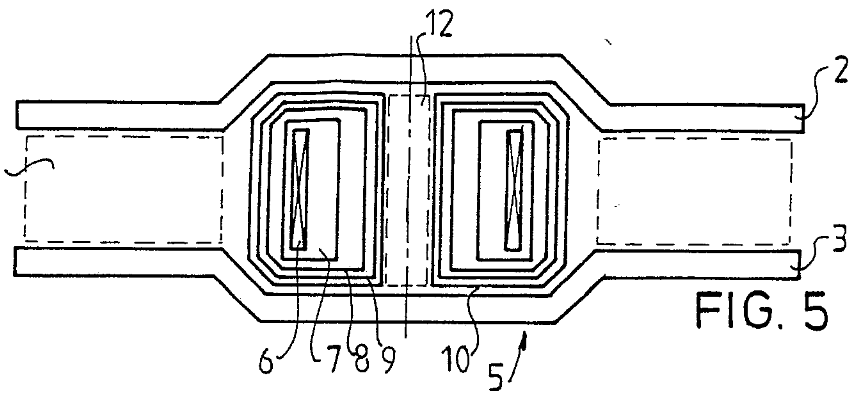

FIG. 5

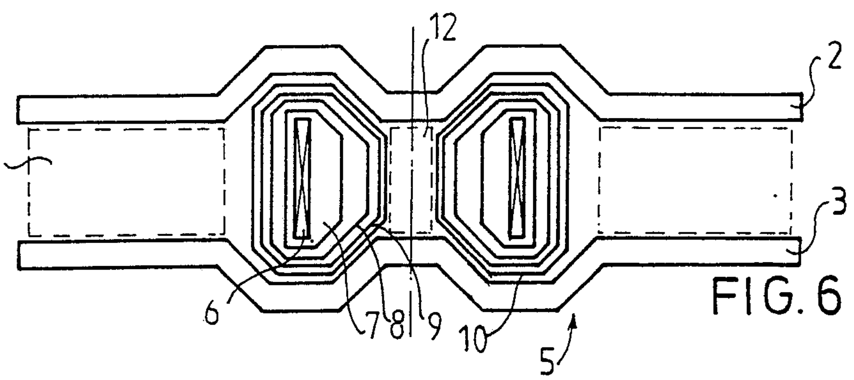

FIG. 6

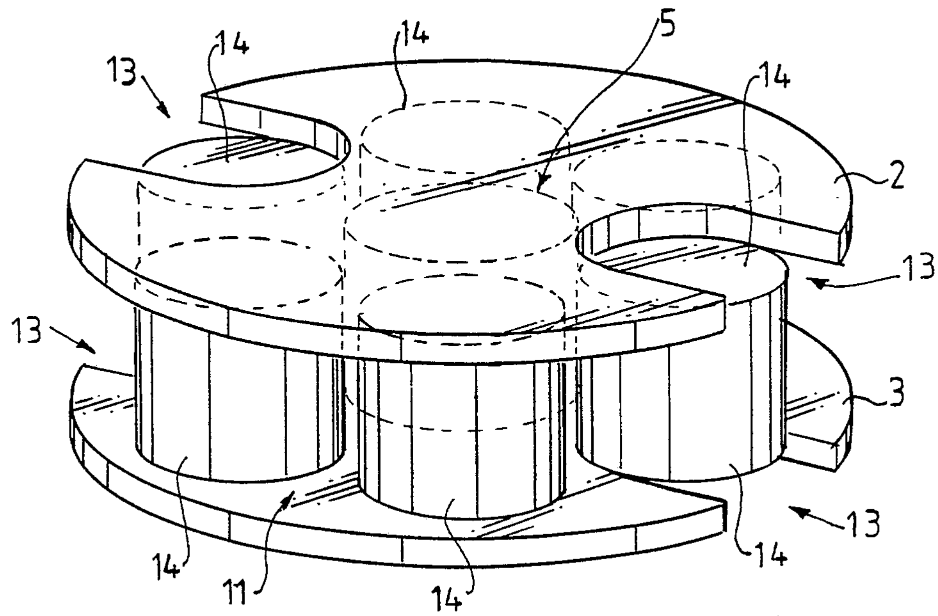

FIG. 7

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European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 89 20 0036

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
Y	PATENT ABSTRACTS OF JAPAN vol. 10, no. 141 (E-406) 2198 24 May 1986, & JP-A-61 5506 (NIPPON DENKI K.K.) * see the whole document *	1	H01F7/20 H01F7/22
A		2, 3, 5, 6	

Y	EP-A-172384 (BOSCH-SIEMENS HAUSGERATE) * figure 2 *	1	
A		2, 4	

A	NL-A-6505044 (NEWPORT INSTRUMENTS LTD.) * page 8, line 22 - line 24 *	1, 2, 4, 7	

A	US-A-3423707 (GENERAL ELECTRIC COMPANY) * figures 1-3 *	7, 8	

A	US-A-3345523 (SIEMENS)		

A	US-A-3500269 (HITACHI LTD.)		
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A	PATENT ABSTRACTS OF JAPAN vol. 12, no. 168 (E-611) 3015 20 May 1988, & JP-A-62 279906 (TOSHIBA CORP.) 04 December 1987, * see the whole document *		H01F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	10 APRIL 1989	VANHULLE R.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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