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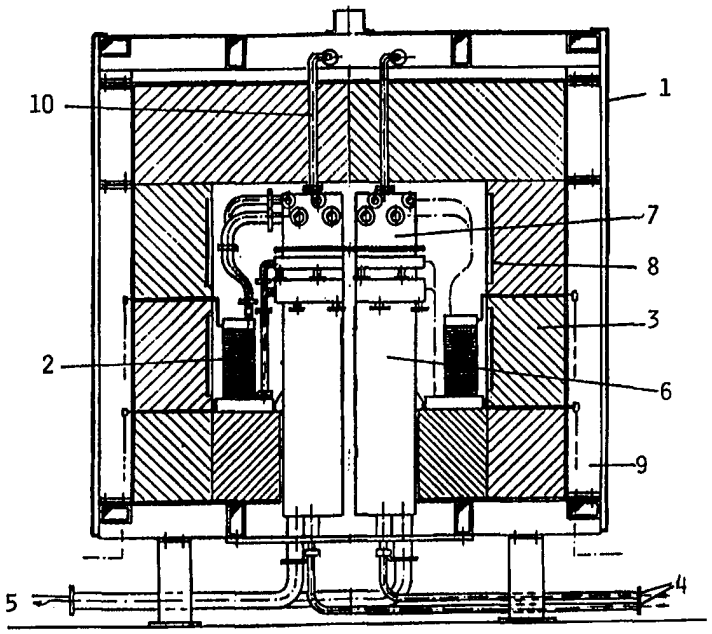

(57) Abstract

Electrochemical installation for exothermic processes comprising a number of reactor modules, especially fuel cells, surrounded by heat insulating wall, top and bottom parts, as well as at least one support unit for treating or affecting of gas during operation of the installation, for example a gas–heat exchanger, and with conducting devices for supplying and outlet of gases to/from the reactor modules. The reactor modules are positioned inside the wall parts for providing a central boom being essentially surrounded by the reactor modules, and at least one support unit being positioned in said central room.

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FUELL CELL ARRANGEMENT

The present invention relates to an electrochemical installation for exothermic processes comprising a number of reactor modules, especially fuel cells, surrounded by heat insulating wall, top and bottom parts, and with conductor devices for supplying and draining of gases to/from the reactor modules, as well as at least one support unit for treating or affecting the gas during the operation of the installation.

Electrochemical techniques are used for a number of purposes, for direct production of electrical energy from chemical energy, and for different precisely controlled chemical processes. Because of their high efficiency and easy handling this type of installations are used in an increasing degree.

Many different embodiments of such electrochemical installations are known. In Norwegian patent 175,712 a plurality of different types are mentioned, especially for converting methane or natural gas to synthesis gas in reactors being provided with membranes leading negative ions of oxygen, where air is provided from one side of the membrane material and causes a transportation of oxygen anions through the material, and where natural is provided on the other side of the membrane material and brought to react with the oxygen. In addition to the production of synthesis gases it is mentioned that electrical power may also be drawn from such processes.

In EP patent application 398,111 an electrochemical high temperature plant is described for converting chemical energy directly into electrical energy. The plant has a cylindrical form where methane gas is supplied into the centre of and thereafter through 4 fuel cells where it reacts with supplied oxygen producing among other things water and carbon dioxide, which is pressed outward and brought out to the outside of the fuel cells. Part of the exhaust gases is brought back and through the fuel cells again, in order to, through a catalyst, pretreat the supplied gases by performing the endothermic reactions

$$CH_4+CO_2 \rightarrow 2CO+2H_2 \text{ and } CH_4+H_2O \rightarrow CO+3H_3,$$

so that the utilization factor in the fuel cells is increased.

It is an object of the present invention to provide an electrochemical installation having a high efficiency, and in addition being compact.

The electrochemical processes are sensitive to temperature. To obtain a stable process in an installation comprising more than one reactor modules it is therefore suitable to obtain as evenly distributed, and relatively high, temperature as possible for each of the fuel cells. It is therefore also an object of this invention to provide an installation which in a simple way obtains a homogeneous distribution of the temperature in the reactor.

To generate electrical currents from the supplied gases high temperatures are often used, and the installation must, at least when starting, be supplied with heat. In addition it is advantageous if the supplied gases are heated before they are lead into the fuel cells. The combustion process is in itself an exothermic reaction, so that the process, when it has started, keeps the high temperature. The gases being lead out of the installation will, of the same reason, hold a high temperature. It is an object of this invention to exploit this excess heat in an effective way.

The abovementioned objects are obtained using an electrochemical installation as described above, and characterized as described in claim 1.

The invention will be described below with reference to the accompanying drawings.

Figure 1 shows a vertical section of an electrochemical installation according to the invention.

Figure 2 shows a horizontal section of the same installation as is shown in figure 1.

Figure 3 shows a detail of the installation.

The drawings show an embodiment of an electrochemical installation 1 comprising reactor modules 2, surrounding a central room. In the central room two support units 6,7 are provided, which in this case constitutes an afterburner 7 and a heat exchanger 6. Around the reactor modules insulating wall, top and bottom parts 3 are positioned. The

installation also comprises conductors for supplying of fuel and for outlet of exhaust gases.

The reactor modules may be of different types, for different chemical processes, but in the shown drawings it is assumed that the are adapted to convert chemical energy into electrical energy. Such fuel cells are often mounted in stacks 2. The gases, for example natural gas or methane and air, is lead into the fuel cells through different pipes and react with each other in the fuel cells to, in a per se known way, be converted to electrical current and heat.

To obtain an as even temperature distribution as possible the reactor modules 2 are preferably positioned such that they surround a central room. Preferably they are symmetrically positioned, and preferably with rotational symmetry, in relation to the central axis. The distribution may vary with the number of reactor modules and the total size of the installation, but the chosen distribution is preferably the one being most compact, and at the same time giving room for the support units 6,7 in the central room.

The number of reactor modules will vary depending on the size and use of the installation, but considering the desired geometry of the central room and the support units to be positioned inside it, the smallest suitable number is four. It is, however, possible, and within the scope of this invention, to reduce the number of reactor modules to three. The latter will, however, normally not be optimal, because the size of the central room becomes to small, or the distance between the reactor modules to large, so that thermic convection arises in the reactor, with a resulting cooling effect. This may possibly be compensated for using dividing walls.

Of practical reasons, such as the possibilities for disassembling each reactor module, they will not be positioned close together. This will give a certain circulation inside the reactor, even if the reactor walls are insulated. For this reason the positions reactor modules are adapted to provide an opening area between them being less than 50%, and preferably 30%, of the area of the part of the module facing toward the central room.

The shape of the central room per se into which the support unit(s) is to be placed may preferably be defined in the following way. A line is drawn from the geometrical centre of the, reactor module(s) being positioned closest to te centre, to the geometrical centre of the nearest reactor module in the same horizontal plane, and then further from there around the central room back to the first module.

According to the embodiment shown in figures 1 and 2 the warm exhaust gases are conducted out of the fuel cells to an afterburner 7 which may be provided with its own supply of fuel 10. The afterburner 7 ensures that the combustion of the supplied gases is complete, and thus also an additional heating of the exhaust gases.

The exhaust gases are lead further to a heat exchanger 6, where the warm exhaust gases interact with the gases supplied to the installation in order to increase their temperature. This way the need for other warming of the installation at so called high temperature processes is reduced. The heat exchangers may be of any known kind being suitable for placing in the installation.

The reactor modules are surrounded by insulating wall, top and bottom parts 3 hindering loss of heat to the environment and thus securing control over the temperature in the process. To minimize the inner volume being defined by these parts 3 they are positioned as close to the reactor modules as possible. This gives an octagonal cross section in the drawings. A circular cross section may also be contemplated, but will usually not be suitable because of the shapes of the other elements in the installation, and the requirement for the installation to be compact.

To further increase the control over the installation the wall, top and bottom parts 3 may be provided with electrical heating elements 8. These may be useful when starting high temperature processes.

The insulating wall, top and bottom parts 3 are in the drawings surrounded by a frame 9, which may comprise ventilation and pipe system for supply and removal of gases.

Figure 3 shows in detail how the fuel cells 2, the heat exchanger 6 and possibly the afterburner 7 are coupled in an

installation according to the invention, being used to produce electrical energy through burning of gases.

Fuel and air are conducted in through the pipes, 4A and 4B, respectively, to the heat exchanger, which comprises a circuit for heating the fuel 6A, and comprises a circuit for heating air 6B. From the heat exchanger the heated gases are conducted through separate conductors 11,12 to the fuel cell 2. The fuel cell 2 is provided electrical outlet and inlet conductors 15,16. From the fuel cells the exhaust gases from the air and fuel supply through separate pipes 13,14 to a combustion chamber 7, in which the remaining fuel is burnt. The afterburner 7 may possibly be provided with extra fuel through a channel 10 to give a combustion being as efficient as possible. The exhaust gases are then conducted through the heat exchanger 6A,6B for heating of the incoming gases, and is thereafter conducted out of the plant through the exhaust pipe 5.

As indicated in the figures 1 and 2 several fuel cells may be connected to each heat exchanger and possible afterburner.

In addition to the ones shown in the drawings the installation may comprise other support units. For example it may comprise a device for partial recirculation of the exhaust gases, or devices for pre-treating (pre-reformatting) of the provided gases.

C l a i m s

1. Electrochemical installation for exothermic processes comprising a number of reactor modules, especially fuel cells, surrounded by heat insulating wall, top and bottom parts, as well as at least one support unit for treating or affecting of gas during operation of the installation, for example a gas-heat exchanger, and with conducting devices for supplying and outlet of gases to/from the reactor modules,
c h a r a c t e r i z e d in that the reactor modules are positioned inside the wall parts for providing a central room being essentially surrounded by the reactor modules, and

at least one support unit being positioned in said central room.

2. Electrochemical installation according to claim 1, c h a r a c t e r i z e d in that the reactor modules include racks of fuel cells.

3. Electrochemical installation according to claim 1 or 2, c h a r a c t e r i z e d in that the installation includes at least four reactor modules.

4. Electrochemical installation according to claim 1, 2 or 3,
c h a r a c t e r i z e d in that the reactor modules are positioned essentially symmetrically in relation to the vertical axis of the room.

5. Electrochemical installation according to claim 4, c h a r a c t e r i z e d in that the reactor modules are positioned with a polygonal distribution around the axis of the room, especially a regular polygon.

6. Electrochemical installation according to any one of the preceding claims,
c h a r a c t e r i z e d in that the reactor modules are positioned around the central room with a distance between them and thus defining an opening between the edges of the reactor modules, and that each of the openings have an area being less than 50%, and preferably less than 30%, of the area of the part of each reactor module facing the central room.

7. Electrochemical installation according to any one of the preceding claims,
c h a r a c t e r i z e d in that the support units being positioned completely inside the central room are positioned inside lines which may be drawn between the geometrical centre point for a reactor module bordering to the central room and the, in the horizontal plane, closest fuel cell also bordering to the central room.

8. Electrochemical installation according to any one of the preceding claims,
c h a r a c t e r i z e d in that the wall parts of the installation in a horizontal section constitutes a polygonal shape being essentially symmetric around the axis of the central room.

9. Electrochemical installation according to any one of the preceding claims,
c h a r a c t e r i z e d in that inner surfaces of the wall parts comprise electrical heating elements.

10. Electrochemical installation according to any one of the preceding claims,
c h a r a c t e r i z e d in that the reactor modules comprise fuel cells with oxygen anion conducting membranes and that the installation is adapted to convert hydrocarbons to synthesis gases by partial oxidation with oxygen from air.

11. Electrochemical installation according to any one of the preceding claims,
c h a r a c t e r i z e d in that the conducting devices are lead into the central room.

12. Electrochemical installation according to any one of the preceding claims,
c h a r a c t e r i z e d in that the exhaust gases from the reactor modules are conducted through suitable pipes through the heat exchanger for cooperation with the gases supplied to the reactor modules, and that the support units also comprises an afterburner mounted between the outlet of the reactor modules and the heat exchanger.

13. Electrochemical installation according to any one of the preceding claims,
c h a r a c t e r i z e d in that the support units comprises pre-treating means for pre-treating the supplied gases.

14. Electrochemical installation according to claim 13,
c h a r a c t e r i z e d in that the pre-treating means includes recycling means for at least partial recycling of the exhaust gases.

15. Electrochemical installation according to claims 13 or 14,
c h a r a c t e r i z e d in that the pre-treating means includes means for reformatting of the gases.

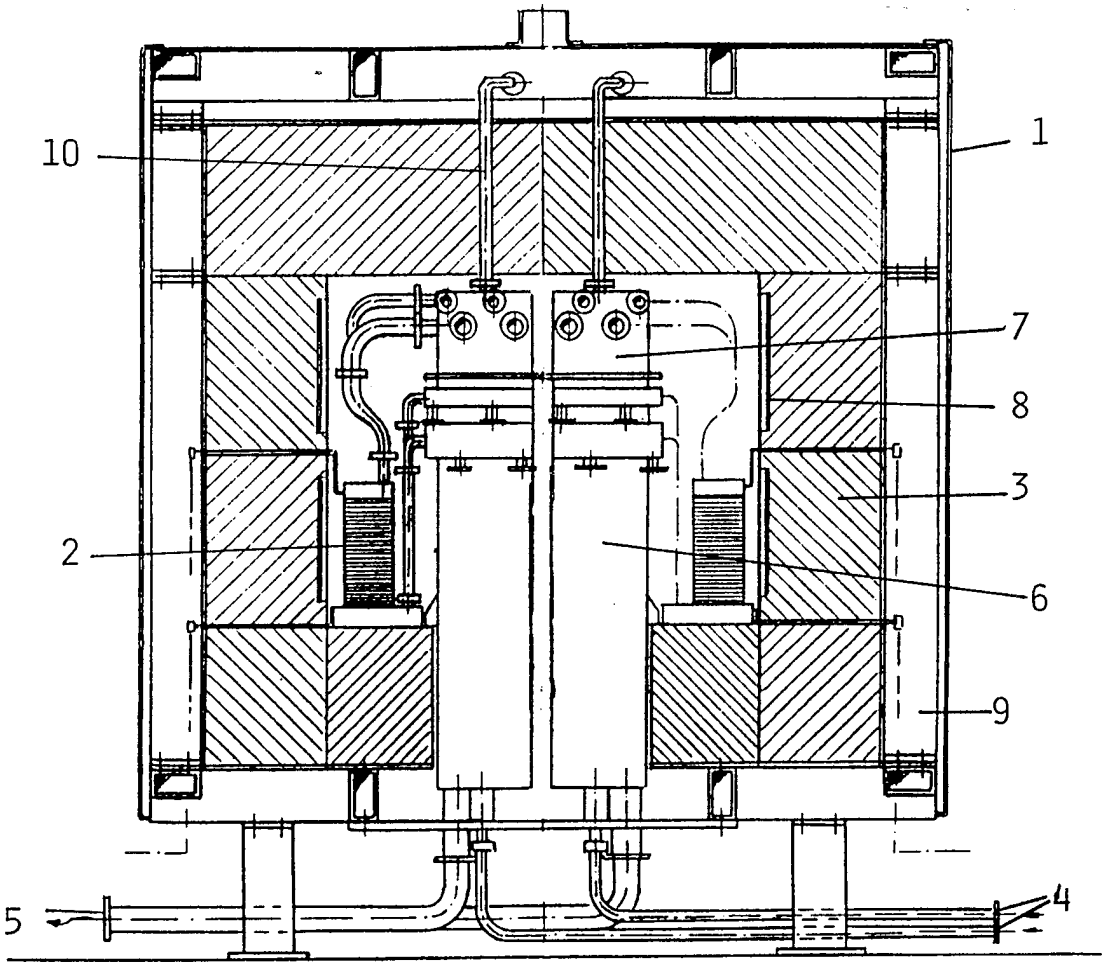

FIG. 1

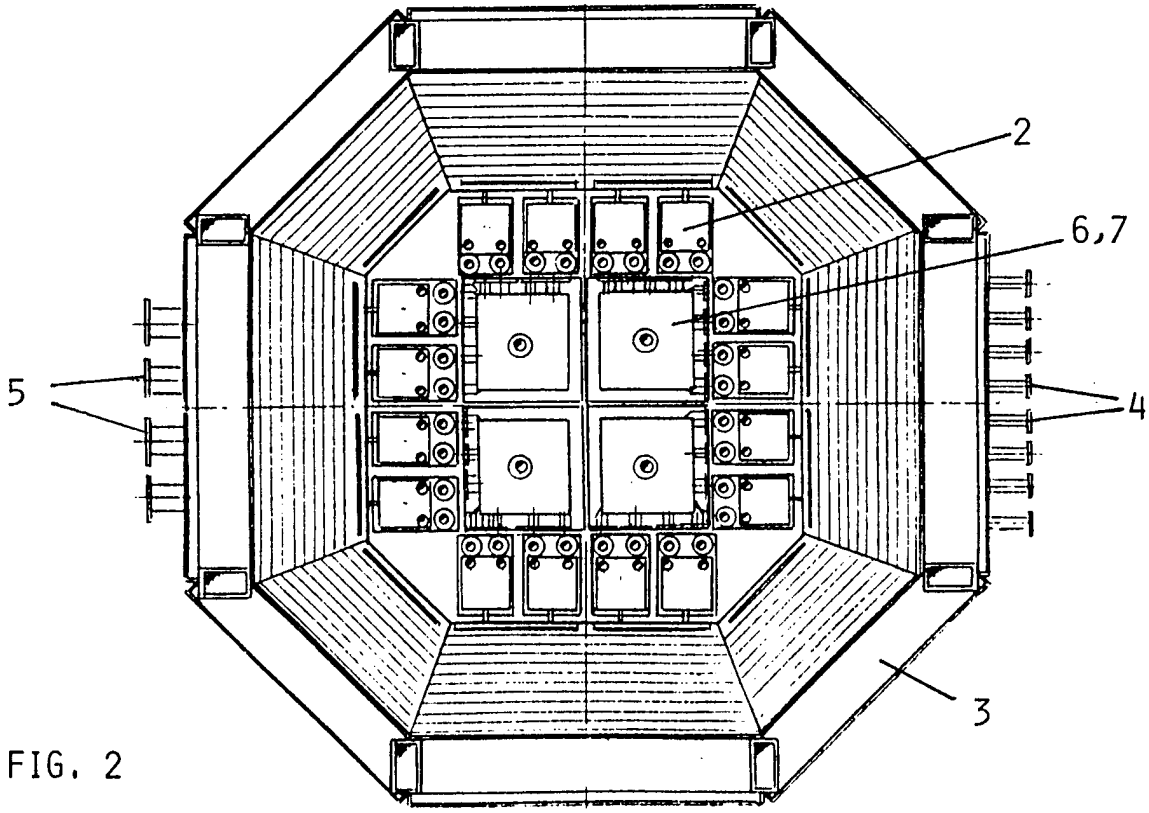

FIG. 2

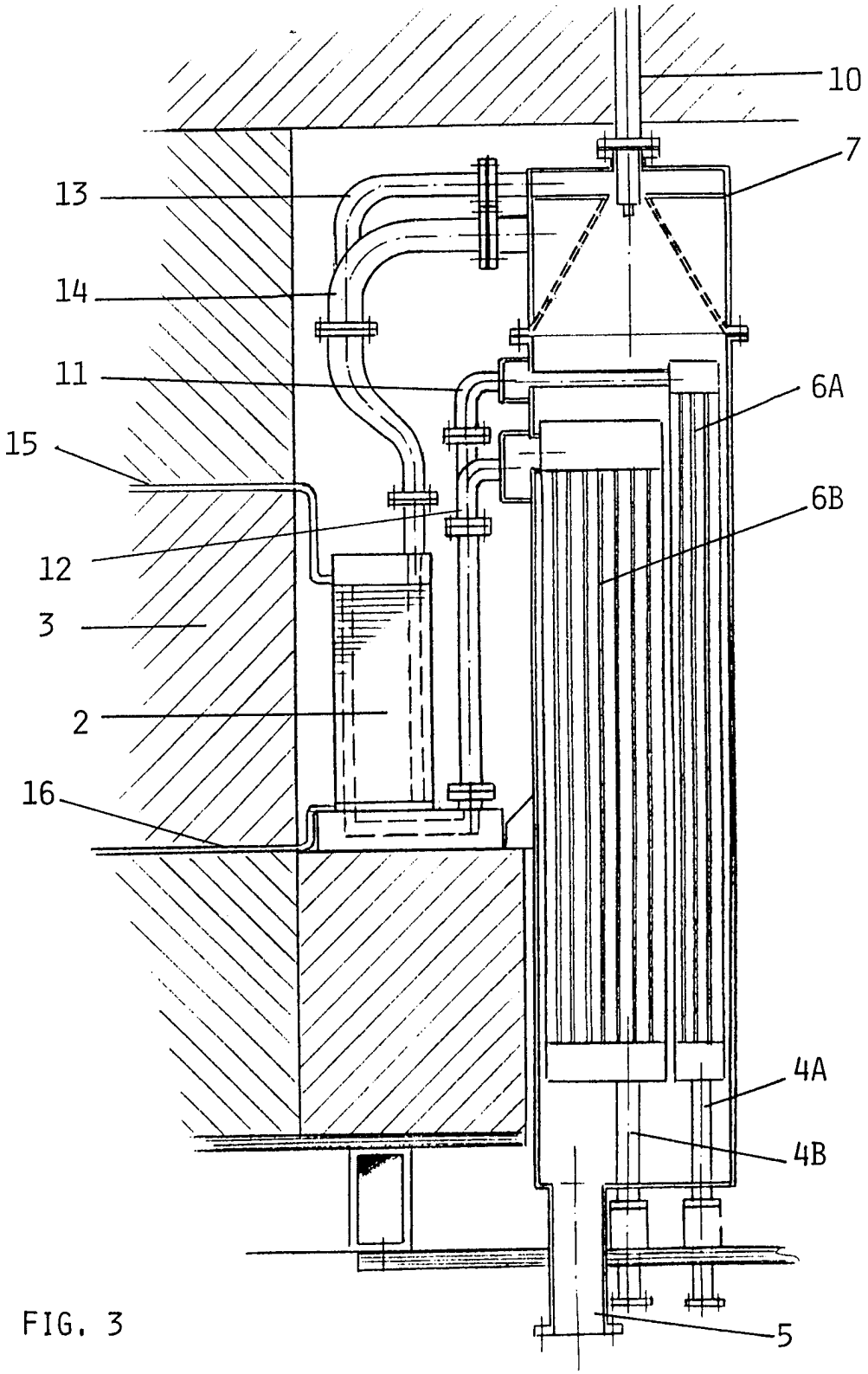

FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO 97/00303

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H01M 8/24
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)

IPC6: H01M

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

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5330858 A (HIROYUKI SHUNDOU ET AL), 19 July 1994 (19.07.94), column 14, line 3 - column 15, line 25, figures 8,9 --	1-4,6,7,11, 13
X	GB 2156575 A (WESTINGHOUSE ELECTRIC CORPORATION), 9 October 1985 (09.10.85), page 2, line 44 - page 3, line 31 --	1-5
X	US 3160528 A (H.P.DENGLER ET AL), 8 December 1964 (08.12.64), column 2, line 68 - column 3, line 45 --	1-7

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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A	Patent Abstracts of Japan, Vol 7,No 27, E-156 abstract of JP 57-182976 A (HITACHI SEISAKUSHO K.K.), 11 November 1982 (11.11.82) -- --------	1-15

INTERNATIONAL SEARCH REPORT

Information on patent family members

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