(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
13 July 2006 (13.07.2006)

PCT

(10) International Publication Number
WO 2006/072178 A1

(51) International Patent Classification:
F24H 7/02 (2006.01) *F22G 1/16* (2006.01)
F24J 3/00 (2006.01) *F22B 1/02* (2006.01)

(21) International Application Number:
PCT/CA2006/000013

(22) International Filing Date: 6 January 2006 (06.01.2006)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/641,453 6 January 2005 (06.01.2005) US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

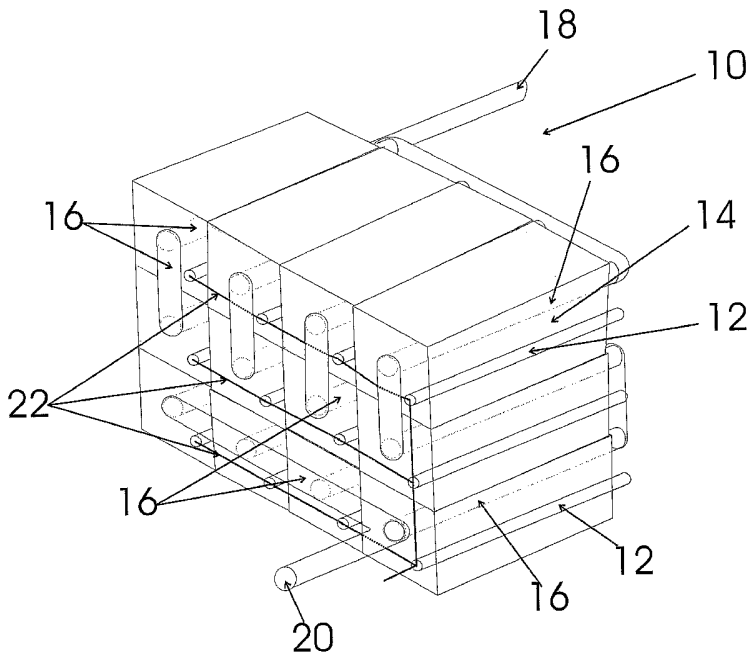
— *of inventorship (Rule 4.17(iv))*

Published:

— *with international search report*

[Continued on next page]

(54) Title: THERMAL STORAGE MEDIUM



(57) Abstract: A heat storage medium has a solid heat storage area and a plurality of channels extending through the heat storage area between an inlet and an outlet. In one embodiment, there are electric heaters embedded in the heat storage area. A fluid flows through the channels to add or remove heat from the heat storage medium. A method of operating the heat storage medium is described.

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— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

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THERMAL STORAGE MEDIUM

BACKGROUND OF THE INVENTION

FIELD OF INVENTION

This invention relates to a solid heat storage medium that is connected to a heat source and has a solid heat storage area with passages extending through the heat storage area. This invention further relates to a method of storing heat energy in the heat storage medium.

DESCRIPTION OF THE PRIOR ART

Power plants for producing electricity from various energy sources including wind turbines, solar energy, nuclear energy hot exhaust gases from industrial plants as well as other sources of electricity are known. The Bellac U. S. Patent Number 5,384,489 describes a wind powered electricity generating system including wind energy storage whereby wind energy is used to heat a heat transfer fluid. After being heated, the heated fluid is added to an insulated storage tank. The heated thermal fluid is used to generate electricity during periods of low wind speed and or high electricity demand. The heated thermal fluid is introduced to a heat exchanger and is used to create steam in a vapourizer chamber. The steam is then directed to a steam powered electricity generator. The thermal dynamic conversion efficiency of the storage and recovery system described in the Bellac Patent is said to be low. Various fluids are suggested as the heat transfer fluid, including water. The storage tank is not pressurized and the heat transfer fluid is in liquid form as the heat transfer fluid is stated to be at atmospheric pressure.

Previous systems are inefficient and cannot be used to store heat energy at high temperatures. For example, the system described in the Bellac patent cannot be used to store energy at temperatures exceeding the boiling point of the heat transfer fluid.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a solid heat storage medium that can be repeatedly heated to high temperatures and cooled without failure or reduction in efficiency. It is a further object of the present invention to provide a heat storage medium that can be heated by electricity and the temperature to which it can be heated is not limited by the heat capacity, boiling point or chemical stability of a heat transfer fluid.

A heat storage medium for use with a fluid in storing and supplying heat energy produced by electricity comprises a three dimensional structure. The three dimensional structure contains electric heaters embedded in the structure. The heaters are connected to a source of electricity to provide heat energy to the storage medium. The heat storage medium contains a plurality of passages connected to permit the fluid to flow through the passages to remove heat energy from the heat storage medium.

A heat storage medium for use with a fluid is used to store and supply heat energy. The heat storage medium comprises a heat storage area having a solid heat transfer medium therein, with passages extending through the heat storage medium. The passages are connected to permit the fluid to flow through the heat storage medium to charge or discharge the heat storage medium based on the temperature of said fluid relative to the temperature of said heat transfer medium.

A method of storing heat energy in a heat storage medium comprises embedding electric heaters in said heat storage medium, connecting the heaters to a supply of electricity to provide heat energy to the heat storage medium and activating or deactivating said heaters as required, storing the heat energy in the heat storage medium, the heat storage medium containing a plurality of passages to receive a fluid and causing the fluid to flow through the passages to remove heat energy from the heat storage medium.

BRIEF DESCRIPTION OF THE DRAWINGS

In Figure 1 is a schematic perspective view of a thermal storage medium;

Figure 2 is a schematic perspective view of a further embodiment of a heat storage medium; and

Figure 3 is a schematic perspective view of a further embodiment of part of a heat storage area.

DESCRIPTION OF A PREFERRED EMBODIMENT

In Figure 1, there is shown a heat storage medium, being a high temperature heat reservoir 10 having a plurality of electric heaters 12 located therein in a solid heat storage area 14. Channels 16 having a fluid inlet 18 and a fluid outlet 20 extend through the reservoir 10. The heaters are connected by electrical lines 22 to a source of electricity (not shown). The channels receive fluid that is preferably steam or a combination of steam and water. As the fluid passes through the reservoir, it picks up heat from the heat storage area 14 and exits through the outlet as saturated or superheated

steam. The steam is then used, for example, to power turbines (not shown) to produce electricity during peak power periods. When the high temperature heat reservoir 10 is being charged or heated, no fluid will be flowing through the channels 16.

The solid heat storage medium can be heated to higher temperatures exceeding 100°C and preferably to temperatures in the range of 200°C to 900°C. When fluid is located in the channels and the fluid is at a lower temperature than the heat storage area, heat will flow from the heat storage area to the fluid as the heat storage medium discharges. During discharge, the electric heaters will not be operating. When the heat storage medium is being charged, the electric heaters will be operating and there will be preferably no fluid flowing through the channels.

The flow of fluid through the channels is controlled by a controller (not shown). Preferably, the heat storage area is hot enough to vaporize the fluid and preferably the fluid is water/steam that becomes saturated or superheated between the inlet and the outlet of the heat storage medium. The electric heaters are interspersed throughout the heat storage area. The heat storage medium has insulation on an outer surface thereof, but the insulation has been omitted from the drawings as it is conventional. The heat storage medium is sized and operated at a sufficiently high temperature to convert any water at the inlet into steam at the outlet and, preferably, water, wet or saturated steam enters the inlet and superheated steam exits from the outlet. The solid heat storage area can be constructed of various suitable materials including steel, iron, copper, rocks, soapstone, lava rock, firebrick, alumina brick, magnesia brick, clay brick, brick, manufactured brick, ceramics or other solid material or particulate matter. The electric heaters are preferably electrical resistance heaters but induction heaters, microwaves or other sources of heat from electricity can be used. For example, bricks that are used to store heat in the heat storage area can be designed to be electric heaters. The solid medium can include broken pieces and is chosen to withstand a broad range of temperature change without a phase change and can withstand repeated changes in temperature without breaking down. In addition, the material of the solid heat storage area must be able to receive and store heat energy.

The channels can be arranged in a continuous serpentine or straight path inside the heat storage area. Instead of one channel extending through the heat storage medium, several channels can be used. Insulation is applied to maintain the heat within the heat storage medium for as long as reasonably possible. While other heat transfer fluids can

be used, water or substantially water is preferred. Additives can be added to the water to maintain the water at a sufficient quality.

In Figure 2, there is shown a solid heat storage medium that is a low temperature heat reservoir 24. The low temperature heat reservoir 24 differs from the high temperature heat reservoir 10 as the low temperature heat reservoir 24 does not contain any electric heaters and has a greater number of channels 26 and therefore a greater heat transfer area. A solid heat storage area 28 of the low temperature heat reservoir 24 is heated by steam that passes through the channels 26 and thereby heats up the heat storage area 28. The low temperature heat reservoir 24 has a fluid inlet 30 and a fluid outlet 32. The heat reservoirs 10, 24 are preferably charged during low peak power periods and discharged during high peak power periods. During high peak power periods, the electric heaters of the heat reservoir 10 are preferably no longer receiving electricity and are therefore shut off. Similarly, the steam entering the fluid inlet 30 of the low temperature heat reservoir 24 during high peak power periods preferably has a lower temperature than the temperature of the heat storage area and increases in temperature between the inlet 30 and the outlet 32. The preheated steam then passes from the outlet 32 to the inlet 18 of the high temperature heat reservoir 10. When the preheated steam passes through the channels 16, the steam becomes superheated. The thermal storage medium 24 has more channels extending through the heat storage area than the thermal storage medium 10 does as the thermal storage medium 24 can be used to receive heat energy from or supply heat energy to the solid heat storage area depending on the temperature of the fluid relative to the temperature of the heat storage area.

In Figure 3, there is shown part of the heat storage medium 10, having a rectangular metal casing 34 with bolts 36 at each corner. This type of heat storage medium is used when the medium contains particulate matter. The same reference numerals are used in Figure 3 as those used in Figures 1 for those components that are identical. The casing has a first end 38 and a second end 40. The second end 40 has a base plate 42 with vents 44 and openings 46 to receive the bolts 36. The heater 12 has a protective coating 48 thereon.

In operation, the heat storage medium 10 is preferably charged when there is no fluid flowing through the channels 16 by electricity heating the electric heaters. The heat generated by the electric heaters is stored in the heat storage area. The heat storage

medium 10 discharges when fluid flows through the channels. Usually, during discharge, the electric heaters do not operate as the heat energy from the heat storage medium is often used to produce electricity or another type of energy during peak power periods.

The thermal storage medium 24 is charged by fluid flowing through the channels 26 where that fluid has a higher temperature than the temperature of the heat storage area 28. The heat is stored in the heat storage area 28. The heat storage medium 24 discharges when a fluid flowing through the channels 26 has a lower temperature than the temperature of the heat storage area 28. Heat from the storage area is transferred to the fluid flowing though the channels 26. Preferably, in the charging cycle, the fluid is steam or a steam/water combination and in the discharging cycle, the fluid in the inlet is water. Unlike a heat exchanger, only one fluid flows through the channels of the heat storage medium 24 at a time and that fluid is either used to charge the heat storage medium or to discharge the heat storage medium.

A controller (not shown) controls the operation of the heat storage medium 10 and another controller controls the operation of the heat storage medium 24. Preferably, the two heat storage media 10, 24 are interconnected and are controlled by one controller. When high temperatures are used in the heat storage medium (ie. equal to or greater than substantially 300°C), the channels 16 are preferably high pressure channels. While the heat storage medium can be heated by electric heaters or by fluid flowing through the channels, heating by electric heaters is preferred.

WE CLAIM:

1. A heat storage medium for use with a fluid in storing heat energy, said storage medium comprising a three dimensional structure containing electric heaters embedded in said structure, said heaters being connected to a source of electricity to provide heat energy to said storage medium, said heat storage medium containing a plurality of passages connected to permit said fluid to flow through said passages to remove heat energy from said heat storage medium.

2. A heat storage medium as claimed in Claim 1 wherein said three dimensional structure has a solid heat storage area and said heaters are embedded in said heat storage area.

3. A heat storage medium as claimed in Claim 1 wherein said passages are channels extending through said heat storage medium.

4. A heat storage medium as claimed in Claim 3 wherein said channels are high pressure channels.

5. A heat storage medium as claimed in Claim 4 wherein said fluid is located in said channels and said fluid is a high pressure fluid.

6. A heat storage medium as claimed in Claim 3 wherein said heaters heat said heat storage medium to a temperature exceeding 100°C.

7. A heat storage medium as claimed in Claim 6 wherein said heaters heat said heat storage medium to a temperature ranging from substantially 200°C to substantially 900°C.

8. A heat storage medium as claimed in Claim 1 wherein said three dimensional structure has insulation on an outer surface thereof.

9. A heat storage medium as claimed in Claim 3 wherein said solid heat storage area is made from materials selected from the group of steel, iron, rocks, soapstone, lava-rock, fire brick, alumina brick, magnesia brick, brick, ceramics and manufactured brick.

10. A heat storage medium as claimed in Claim 3 wherein said solid heat storage area contains particulate material.

11. A heat storage medium as claimed in Claim 1 wherein there is a controller to control said electric heaters, a temperature of said storage medium, the flow of fluid through said storage medium and a temperature of said fluid.

12. A heat storage medium as claimed in Claim 1 wherein said fluid is water/steam.

13. A heat storage medium as claimed in Claim 1 wherein said medium contains solid material that can withstand a broad range of temperature change without changing phase, repeated changes in temperature without breaking down and can receive and store heat energy.

14. A heat storage medium as claimed in Claim 1 wherein said passages have a fluid inlet and a fluid outlet.

15. A heat storage medium as claimed in Claim 1 wherein said three dimensional structure is a box.

16. A heat storage medium for use with a fluid, said heat storage medium being used to store and supply heat energy, said heat storage medium comprising a heat storage area having a solid heat transfer medium therein, with passages extending through said heat storage medium, said passages being connected to permit said fluid to flow through said heat storage medium to charge or discharge said heat storage medium based on the temperature of said fluid relative to a temperature of said heat transfer medium.

17. A heat storage medium as claimed in Claim 1 where there is a controller to determine the temperature of the heat transfer medium and of the fluid to control the flow of fluid through said passages.

18. A method of storing heat energy in a heat storage medium, said method comprising embedding electric heaters in said heat storage medium connecting said heaters to a supply of electricity to provide heat energy to said heat storage medium and activating or deactivating said heaters as required, storing said heat energy in said heat storage medium, said heat storage medium containing a plurality of passages to receive a fluid and causing said fluid to flow through said passages to remove heat energy from said heat storage medium.

19. A method as claimed in Claim 15 wherein said heat storage medium has a controller, said method including the steps of operating said controller to control said heaters, a flow of said fluid through said passages and a temperature of said heat storage medium and said fluid.

20. A method as claimed in Claim 15 including the step of operating said heat storage medium at a temperature exceeding 100°C.

21. A method as claimed in Claim 17 including the step of operating said heat storage medium at a temperature ranging from substantially 200°C to substantially 900°.

Fig. 1

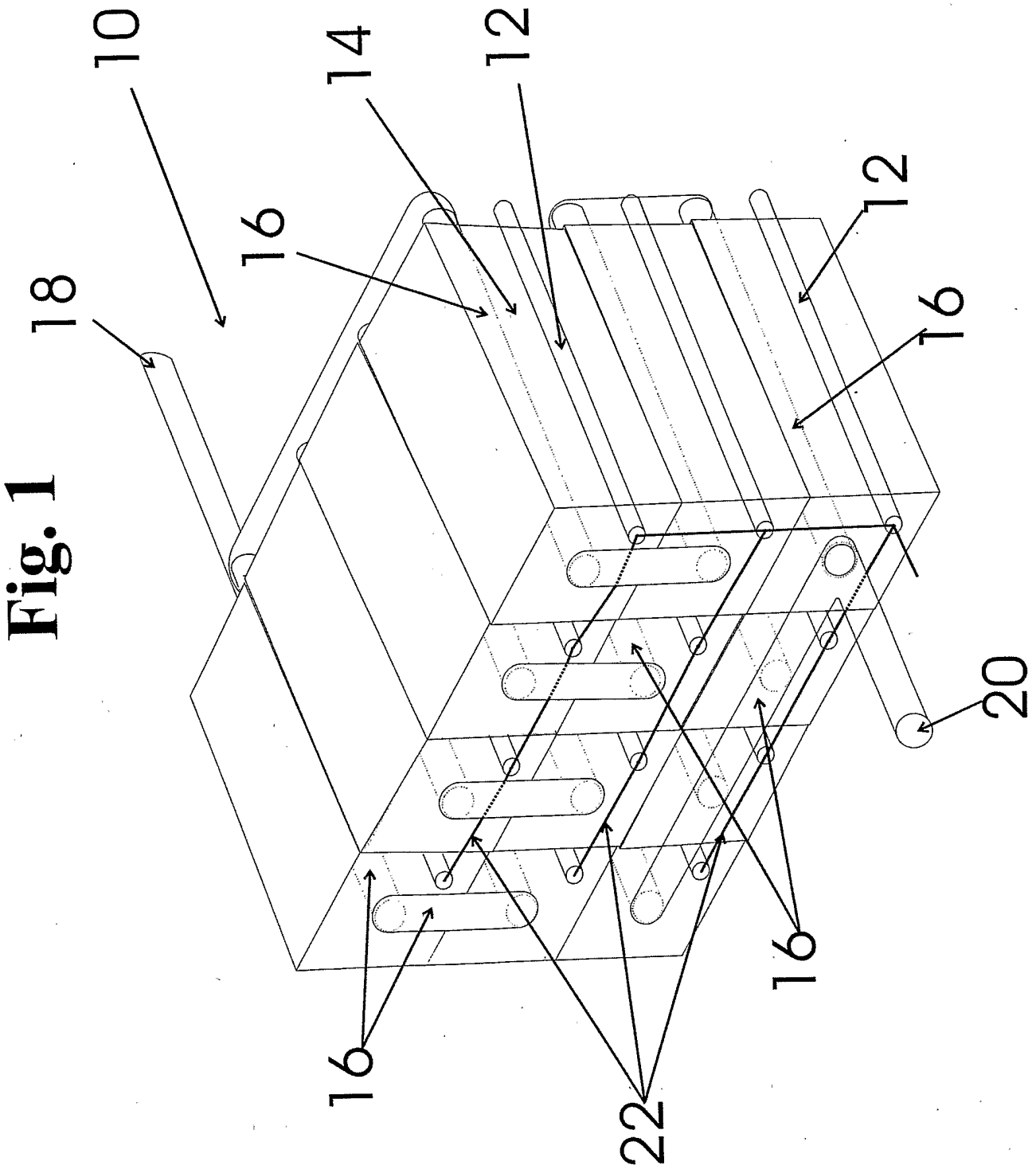


Fig. 2

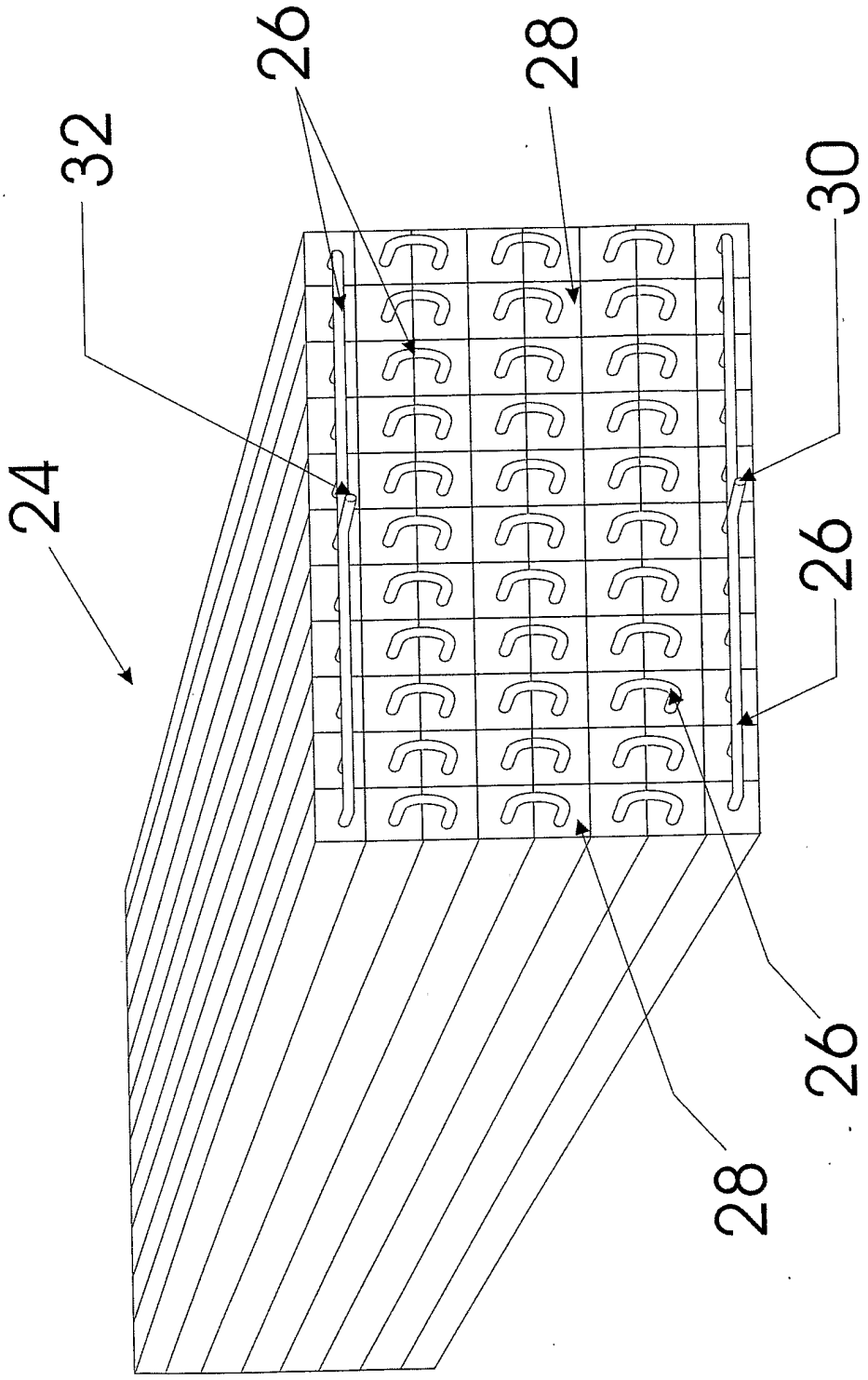
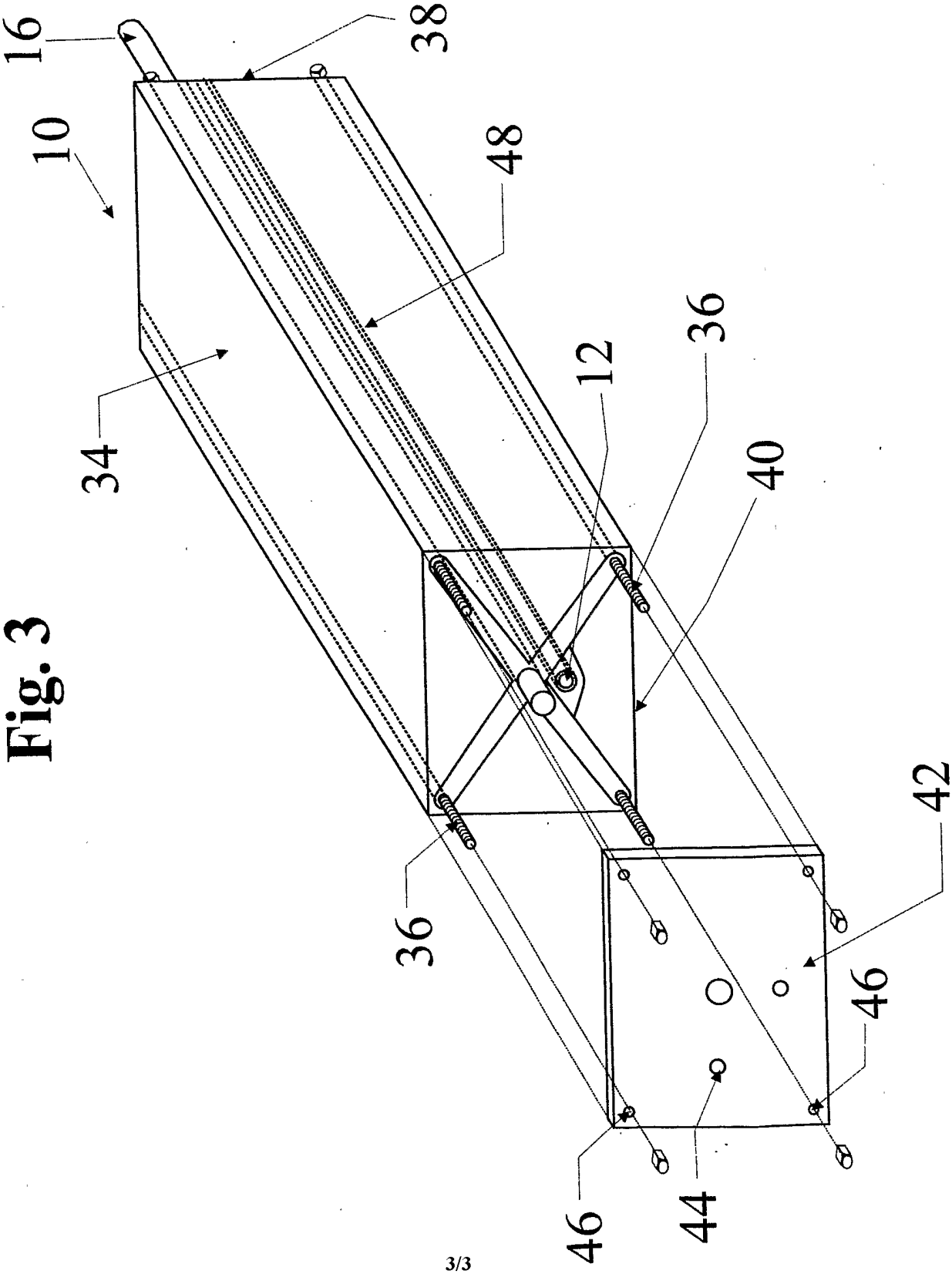


Fig. 3



INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2006/000013

A. CLASSIFICATION OF SUBJECT MATTER

IPC: ***F24H 7/02*** (2006.01) , ***F24J 3/00*** (2006.01) , ***F22G 1/16*** (2006.01) , ***F22B 1/02*** (2006.01)

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)

IPC: ***F24H 7/02*** (2006.01) , ***F24J 3/00*** (2006.01) , ***F22G 1/16*** (2006.01) , ***F22B 1/02*** (2006.01)

CPC: 31/103, 126/14, 165/14, 237/5, 309/39, 309/107; USPC: 165/45, 219/213

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

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

Delphion, Canadian Patents Database, Internet. solid heat storage medium elect* furnace latent

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CA 2001505 A (Jakobsson) 23 October 1989 (23-10-1989) See the whole document.	1-21
A	US 4369629 A (Lockwood) 25 January 1983 (25-01-1983)	

[ ] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 April 2006 (21-04-2006)	2 May 2006 (02-05-2006)

Name and mailing address of the ISA/CA	Authorized officer
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Patent Document Cited in Search Report	Publication Date	Patent Family Member(s)	Publication Date
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		IE63981 B1	28-06-1995
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