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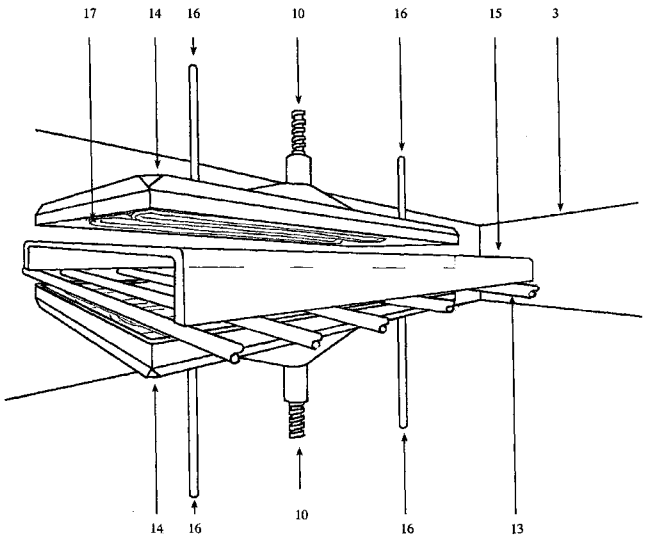
(54) **Title:** TEMPERING APPARATUS



(57) **Abstract:** A Glass tempering furnace has been developed specifically to temper profiled glass. The furnace has been designed to solve the problem of Thermal Shock. This has been achieved by the gradual heating the profiled glass. With the design of adjustable nozzles, the glass can be evenly cooled therefore tempering it.

WO 2007/107791 A1

Tempering Apparatus

The present invention relates to a tempering apparatus, in particular for glass.

A tempering apparatus comprises means for heating an object to a set temperature and means for the rapid cooling of the object. This process is used to strengthen the object, and is commonly used for the strengthening of metal and glass materials.

However, existing tempering furnaces cannot be used for the tempering of profiled glass structures, as the sudden and uneven thermal shock to the glass creates uneven stresses on the glass. When the glass is then cooled rapidly to temper it the stresses react causing a catastrophic failure in the profiled glass structure.

A “profiled” glass structure in this context is taken to mean any glass structure having a non-planar shape. One particular example is a u-shaped

channel glass structure, of the type used for the formation in walls or partitions (either internal or external) in buildings or similar fixed constructions.

There is therefore a need for a tempering apparatus that provides for a gradual and even distribution of heat to a profiled glass structure, and for a gradual and even cooling of a profiled glass structure.

According to the present invention there is provided a tempering apparatus comprising a main furnace provided with a plurality of height-adjustable heating elements.

Preferably, heating elements of differing widths are provided, to be matched with a predetermined shape profile of an object to be tempered.

Preferably, each heating element is provided within a housing member, which comprises means for adjusting its vertical position within the main furnace.

Preferably, said vertical position adjustment means comprises a screw-thread adjustable shaft.

Preferably, the housing further comprises one or more guide rods for constraining motion of the housing transversely to the vertical.

Preferably, the heating elements are arranged to create a temperature gradient within the main furnace.

Preferably, the heating elements are arranged in a specific configuration to ensure even heat distribution over a specific predetermined shape of object.

Preferably, the heating elements are provided to heat an upper and a lower surface of an object to be tempered.

Preferably, the tempering apparatus further comprises a pre-heating furnace arranged to heat an object to be tempered prior to its entry to the main furnace.

Preferably, the tempering apparatus further comprises a cooling chamber provided with a plurality of nozzles which are adjustable to fit with the contours of a predetermined shape of an object to be tempered.

Preferably, the nozzles are arranged to spray a coolant, most preferably water or air.

Preferably, the nozzles are provided to act on both a top and bottom surface of an object to be tempered.

Preferably, a blower is provided at the cooling chamber for supplying air to the object to be tempered.

Preferably, the blower is of a centrifugal type.

Preferably, the blower is controlled through an inverter.

Alternatively, the blower is powered by a compressed air system.

Preferably, the blower comprises at least one of: air ducts, flashboards, distribution boxes and quench nozzles.

Preferably, the tempering apparatus comprises a roller system for guiding an object from the pre-heating furnace to the main furnace and then to the cooling section.

Preferably, the roller system is further arranged to guide an object from a loading table to the pre-heating furnace and from the cooling section to an unloading table.

Preferably, the roller system comprises a plurality of rollers arranged to position an object to be tempered at a specific position within one or more component parts of the tempering apparatus.

Preferably, the operation of the tempering apparatus is controlled with a programmable logic controller (PLC) device.

Preferably, the PLC device incorporates a real-time surveillance function.

Preferably, the tempering apparatus is for glass tempering.

The present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Fig.1 shows an orthographic view of a furnace according to a first embodiment;

Fig.2 shows a perspective view of the furnace of Fig. 1;

Fig.3 shows a perspective view of an air box and a centrifugal fan used with the furnace of Fig. 1;

Fig. 4 shows a perspective view of an adjustable heating element for use with the furnace of Fig. 1; and

Fig. 5 shows side and plan views of the heating element of Fig. 4.

A tempering apparatus according to a first embodiment of the invention is shown in Fig. 1. The

following description will be with reference to a furnace which is specifically designed for tempering a profiled glass structure, but it should be borne in mind throughout the reading of the following description that the principles of the present invention could be applied for the tempering of other materials, such as metals.

As a general overview, an object to be tempered, in this example a profiled glass structure, is moved through the tempering apparatus by a roller system 11, in a direction going from left to right as viewed in Figs. 1a and 1b. The glass structure is placed on a loading table 1 before being passed into a pre-heating furnace 2, then the main furnace 3, followed by a cooling chamber 4, before being passed to an unloading table for subsequent processing. A side view of these components is shown in Fig. 1a, a plan view in Fig. 1b, and an end view in Fig. 1c.

The loading table 1 and unloading table 6 comprise powered rollers and a photoelectric sensor and encoder which interacts with the control system described later.

The rollers for the loading table 1 and unloading table 6 can be made from heatproof NBR rubber, or any other suitable heat resistant material. The roller drive system for the tables 1,6 can be powered through a controlled motor.

The pre-heating furnace 2 is used to pre-heat the profiled glass to avoid any possible breakage from thermal shock, which would be likely to occur if the glass was sent straight into the main furnace 3. The pre-heating furnace 2 incorporates a cullet drawer for ease of maintenance.

The main furnace 3 is provided with heating elements 17 (see Figs. 4 and 5) that are individually height adjustable to fit the glass shape. This gives a better heating profile to the profiled glass, as is illustrated in more detail in Figs. 4 and 5.

As can most readily be appreciated from Fig. 4, a profiled glass structure 15 is passed along rollers 13, forming a sub-section of the roller system 11. Heating elements 17 are positioned to apply heat to the structure 15 as it passes through the main furnace 3. The heating elements 17 are housed in housing members 14, which are height-adjustable by virtue of the screw-thread mechanism 10. The vertical motion of the housing with respect to the furnace body (not shown) is constrained by guide rods 16.

Fig. 5 shows some views which give more detail of the structures shown in Fig. 4. Fig. 5a shows a side view of the housing members 14, and Fig. 5b shows an end view of the housing members 14, while Fig. 5c shows an underside view of a heating element 17 within its housing 14.

To adjust the height at which the heating elements 17 are provided, the screw thread element 10 is rotated until the housing 14 is raised or lowered to a desired position. The rotation is achieved through an actuator (not shown), which can be either manually controlled (for example by turning a handle provided integrally with the screw thread member 10) or electronically controlled (for example by employing a servo mechanism whose operation can be controlled by an electronic command signal).

Fig. 4 is for illustration only, and only shows two heating elements 17 arranged to heat a single u-shaped glass structure 15. It will be readily appreciated that the heating elements 17 could be provided in differing numbers, sizes and positions. The size of the main furnace 3 is arbitrary, and it could be designed for the processing of a large number of structures 15 at any time.

In particular, the widths of the heating elements (dimension “x” in Fig. 5c), may be varied according to the shape of the structure to be tempered. In the particular example of a u-shaped glass channel shown in Fig. 4, the lower (as illustrated) heating element 17 could be of a width less than that of the channel, and the channel could be positioned centrally above the heating element, so that heat is evenly distributed across the profile of the channel.

Furthermore, while Fig. 4 illustrates heating elements 17 being provided to heat both a top and a bottom surface of a structure 15, it will be appreciated that the structure could be heated from only one of the top or bottom, or additionally or alternatively from one or more sides.

It will be appreciated in general that the width, height and arrangement of heating elements 17 can be chosen and adjusted to match a specific profile of structure 15 which is to be tempered.

The main furnace 3 can advantageously arranged to provide a temperature gradient across the furnace, creating different heating zones, raising the temperature of the glass to approximately 700 degrees centigrade. As an example, there can be up to 24 heating zones, both top and bottom. The main furnace 3 also incorporates a cullet drawer for ease of maintenance.

After the main furnace 3, there is provided a cooling chamber 4, which comprises a plurality of quench nozzles designed to fit into the contours of the profiled glass, using a coolant such as water or air to rapidly reduce the glass temperature. They can be adjustable to fit any desired shape of object that is being tempered.

The quench nozzles are made from stainless steel or another suitable heat corrosion resistant material, and can be provided to apply coolant to either or

both of the top and bottom surfaces of the profiled glass.

The cooling chamber is further enhanced with an air supply from a blower 8, illustrated in Fig. 3, which acts once the profiled glass has been quenched by the water nozzles as mentioned above. This aspect is used to cool the glass and reduce the temperature to that of the ambient surroundings, helping in the supply of an even coating of air to the profiled glass 12,15.

The blower can be of a centrifugal type, and can be controlled through an inverter or a compressed air system.

In a preferred implementation, the blower 8 comprises at least one of: air ducts, flashboards, distribution boxes and quench nozzles, which are formed from steel. It is provided as part of incorporates a pneumatic air station, which includes an air tank, air pressure adjust valve, and air tubes distribution system.

The glass structure, or other object to be tempered, is guided through the tempering apparatus by a roller system 11. This comprises sub-components of rollers for each of the loading tray 1, pre-heating furnace 2, main furnace 3, cooling chamber 4 and unloading tray 6. The roller system 11 is specifically designed to correctly position the

glass within the main furnace for even heat distribution.

The glass positioning rollers can be formed from ceramic or another suitable heat resistant material, and can be used for the positioning of one or more panels of glass.

The overall operation of the tempering apparatus can be controlled by a PLC control system 7. this controls the inputs for and receives feedback from the loading and unloading tables 1,6 and can be used to control the positioning of the heating elements 17 within the main furnace 3. It can also be used to incorporate a real-time surveillance mode.

Among other features, the tempering apparatus can be provided with insulation of sufficient quality to ensure the outside temperature is bellow 45 centigrade. It can also be provided with an auto pre-heat start up function, heating the furnace for the day's shift.

Also, in the event of a critical power failure of the tempering apparatus, an emergency glass removal system can be incorporated to relieve the operator of manually removing the glass.

Various improvements and modifications can be made to the above without departing from the scope of the present invention. In particular, the invention is not limited to the specific layouts disclosed.

Also, while a preferred embodiment is described with reference to a glass structure, the even heat distribution given by the improved furnace will also have a benefit for the tempering of other materials, such as metal.

CLAIMS

1. A tempering apparatus comprising a main furnace provided with a plurality of height-adjustable heating elements.

2. The tempering apparatus of claim 1, wherein heating elements of differing widths are provided, to be matched with a predetermined shape profile of an object to be tempered.

3. The tempering apparatus of claim 1 or claim 2, wherein each heating element is provided within a housing member, which comprises means for adjusting its vertical position within the main furnace.

4. The tempering apparatus of claim 3, wherein said vertical position adjustment means comprises a screw-thread adjustable shaft.

5. The tempering apparatus of claim 3 or claim 4, wherein the housing further comprises one or more guide rods for constraining motion of the housing transversely to the vertical.

6. The tempering apparatus of any preceding claim, wherein the heating elements are arranged to create a temperature gradient within the main furnace.

7. The tempering apparatus of any preceding claim, wherein the heating elements are arranged in a specific configuration to ensure even heat

distribution over a specific predetermined shape of object.

8. The tempering apparatus of any preceding claim, wherein the heating elements are provided to heat an upper and a lower surface of an object to be tempered.

9. The tempering apparatus of any preceding claim, further comprising a pre-heating furnace arranged to heat an object to be tempered prior to its entry to the main furnace.

10. The tempering apparatus of any preceding claim, further comprising a cooling chamber provided with a plurality of nozzles which are adjustable to fit with the contours of a predetermined shape of an object to be tempered.

11. The tempering apparatus of claim 10, wherein the nozzles are arranged to spray a coolant.

12. The tempering apparatus of claim 10 or claim 11, wherein the nozzles are provided to act on both a top and bottom surface of an object to be tempered.

13. The tempering apparatus of any preceding claim, wherein a blower is provided at the cooling chamber for supplying air to the object to be tempered.

14. The tempering apparatus of claim 13, wherein the blower is of a centrifugal type.

15. The tempering apparatus of claim 13 or claim 14, wherein the blower is controlled through an inverter.

16. The tempering apparatus of claim 13 or claim 14, wherein the blower is powered by a compressed air system.

17. The tempering apparatus of any of claims 13 to 16, wherein the blower comprises at least one of: air ducts, flashboards, distribution boxes and quench nozzles.

18. The tempering apparatus of any preceding claim, further comprising a roller system for guiding an object from the pre-heating furnace to the main furnace and then to the cooling section.

19. The tempering apparatus of claim 18, wherein the roller system is further arranged to guide an object from a loading table to the pre-heating furnace and from the cooling section to an unloading table.

20. The tempering apparatus of claim 18 or claim 19, wherein the roller system comprises a plurality of rollers arranged to position an object to be tempered at a specific position within one or more component parts of the tempering apparatus.

21. The tempering apparatus of any preceding claim, being controllable with a programmable logic controller (PLC) device.

22. The tempering apparatus of claim 21, wherein the PLC device incorporates a real-time surveillance function.

23. The tempering apparatus of any preceding claim, being for glass tempering.

24. A tempering apparatus as described herein with reference to the accompanying drawings.

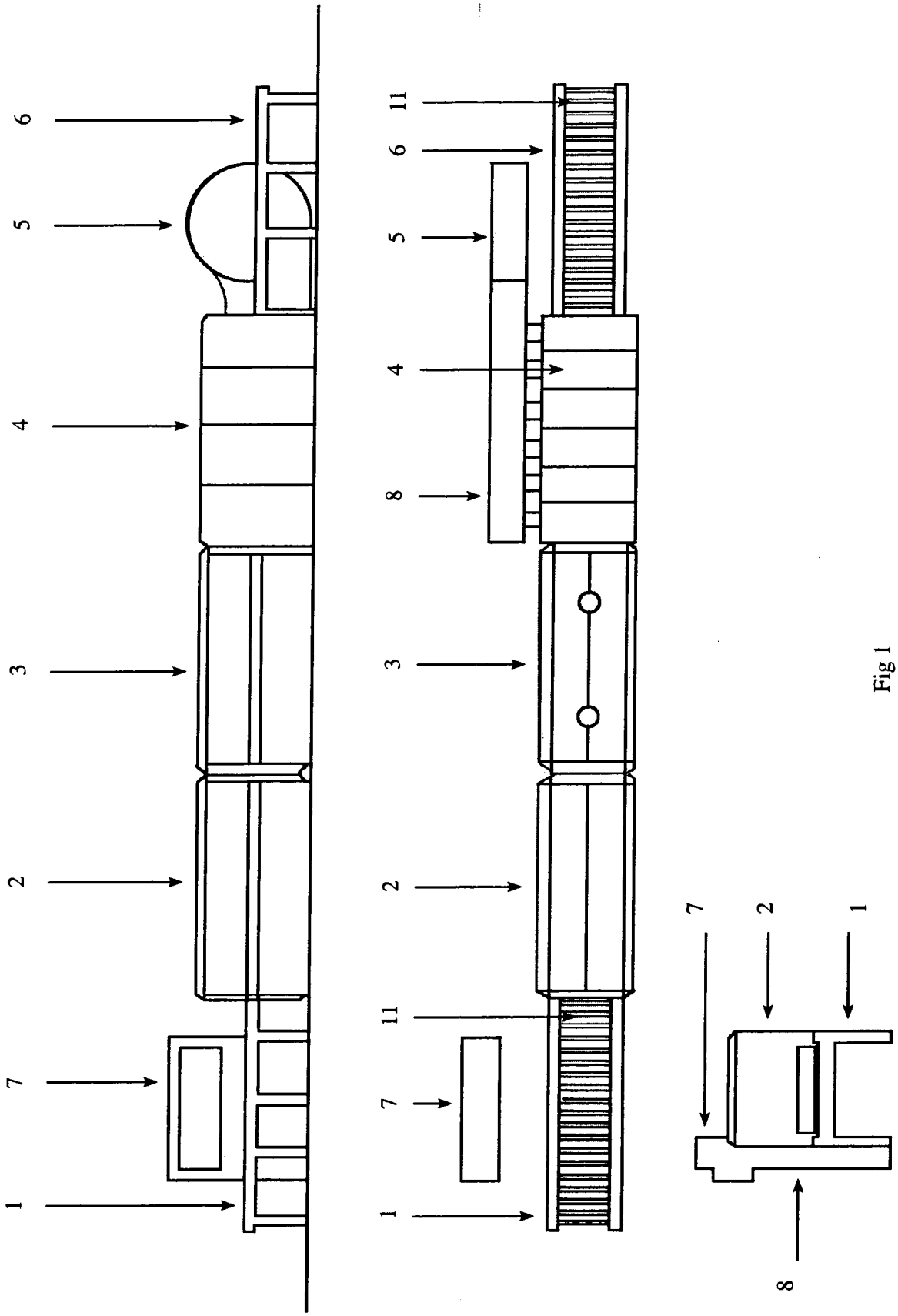


Fig 1

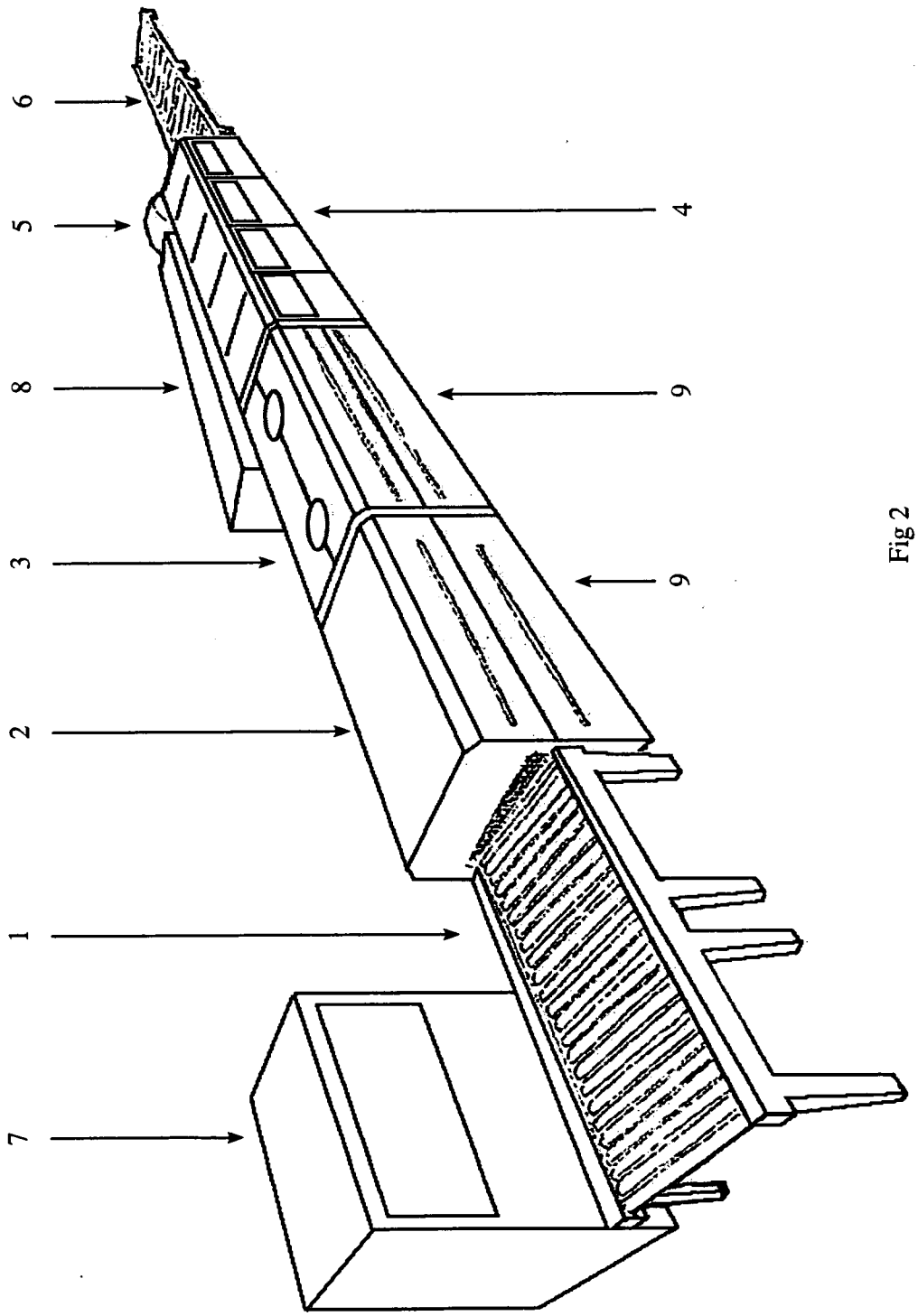


Fig 2

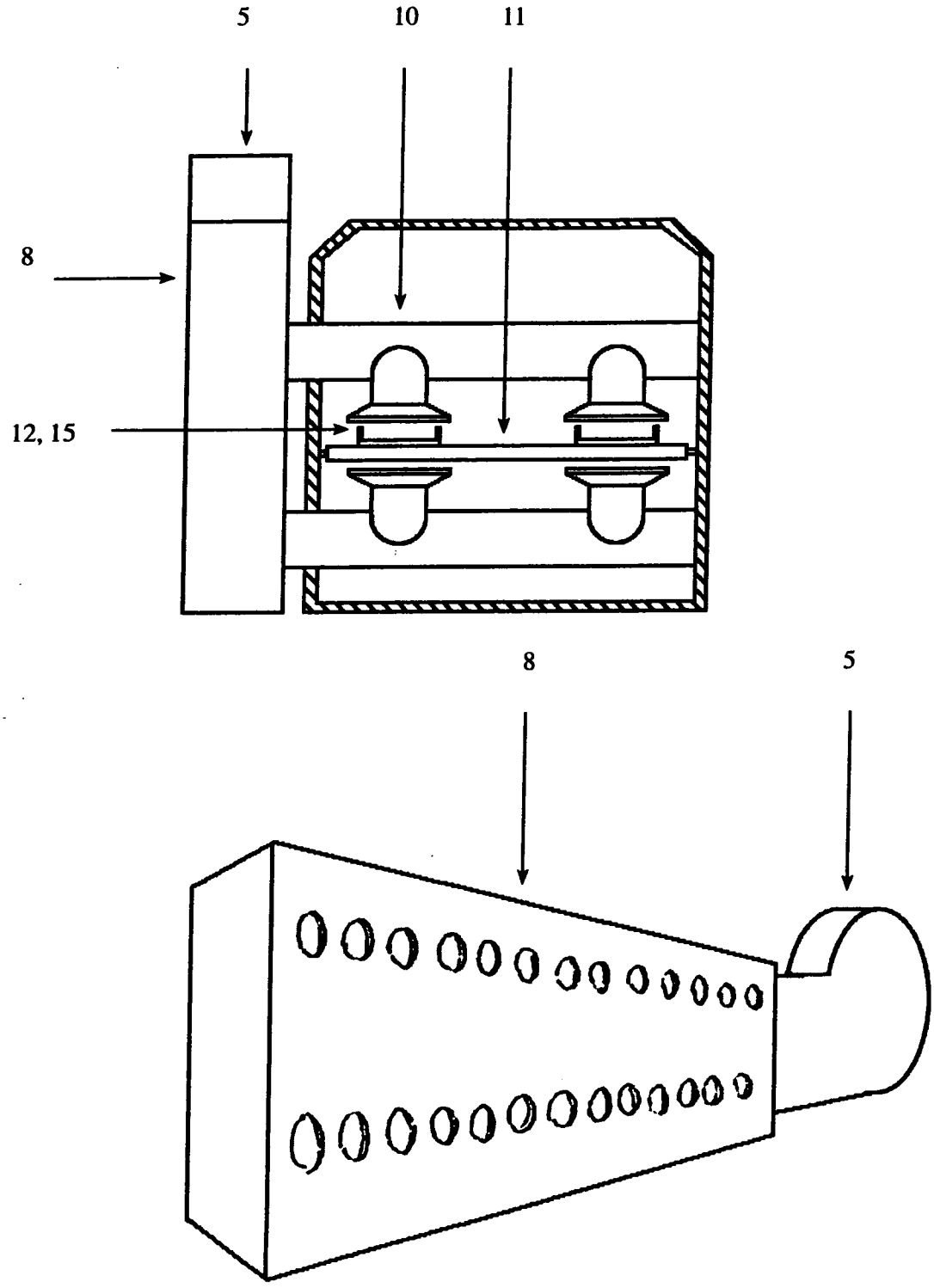


Fig 3

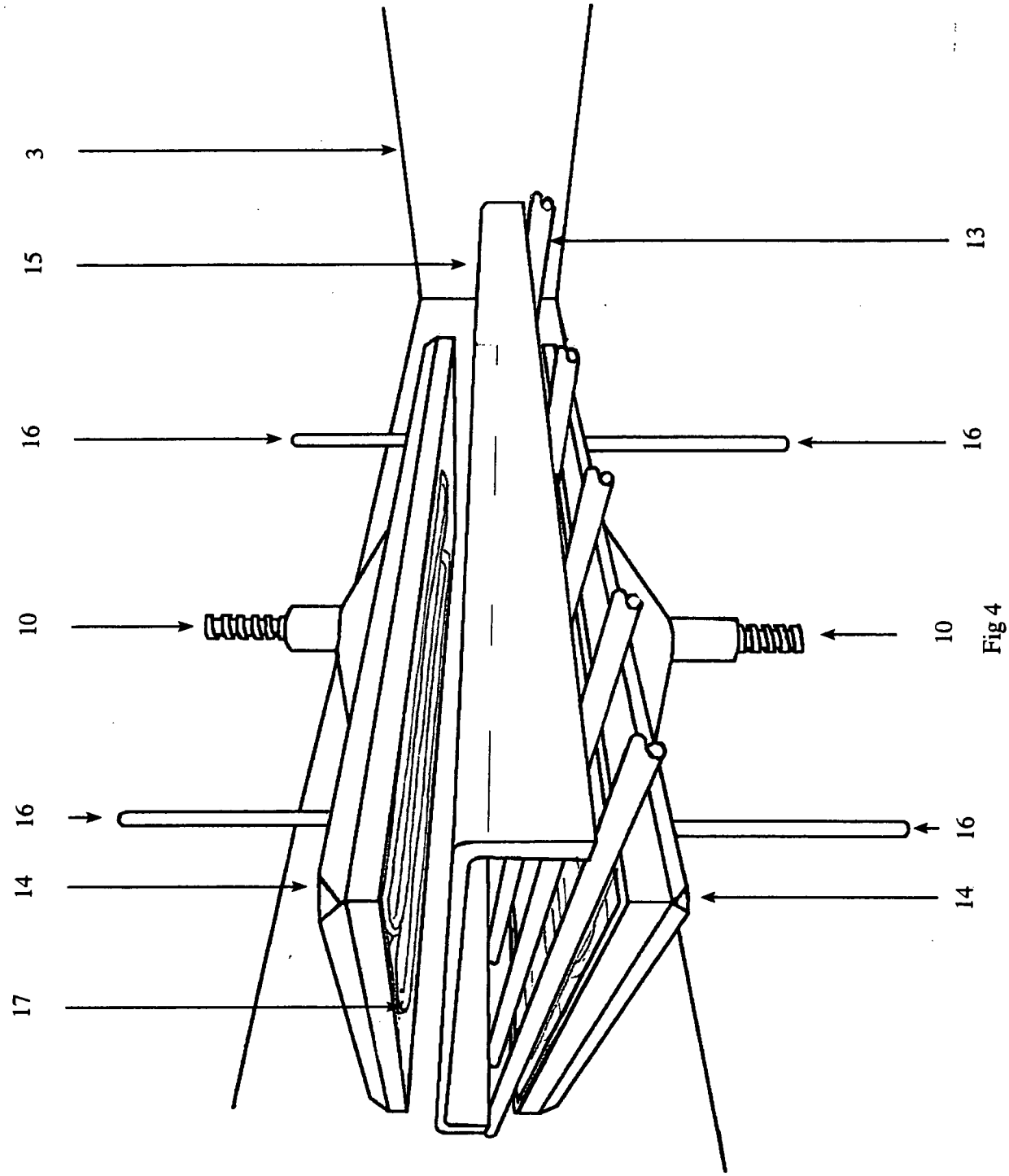


Fig 4

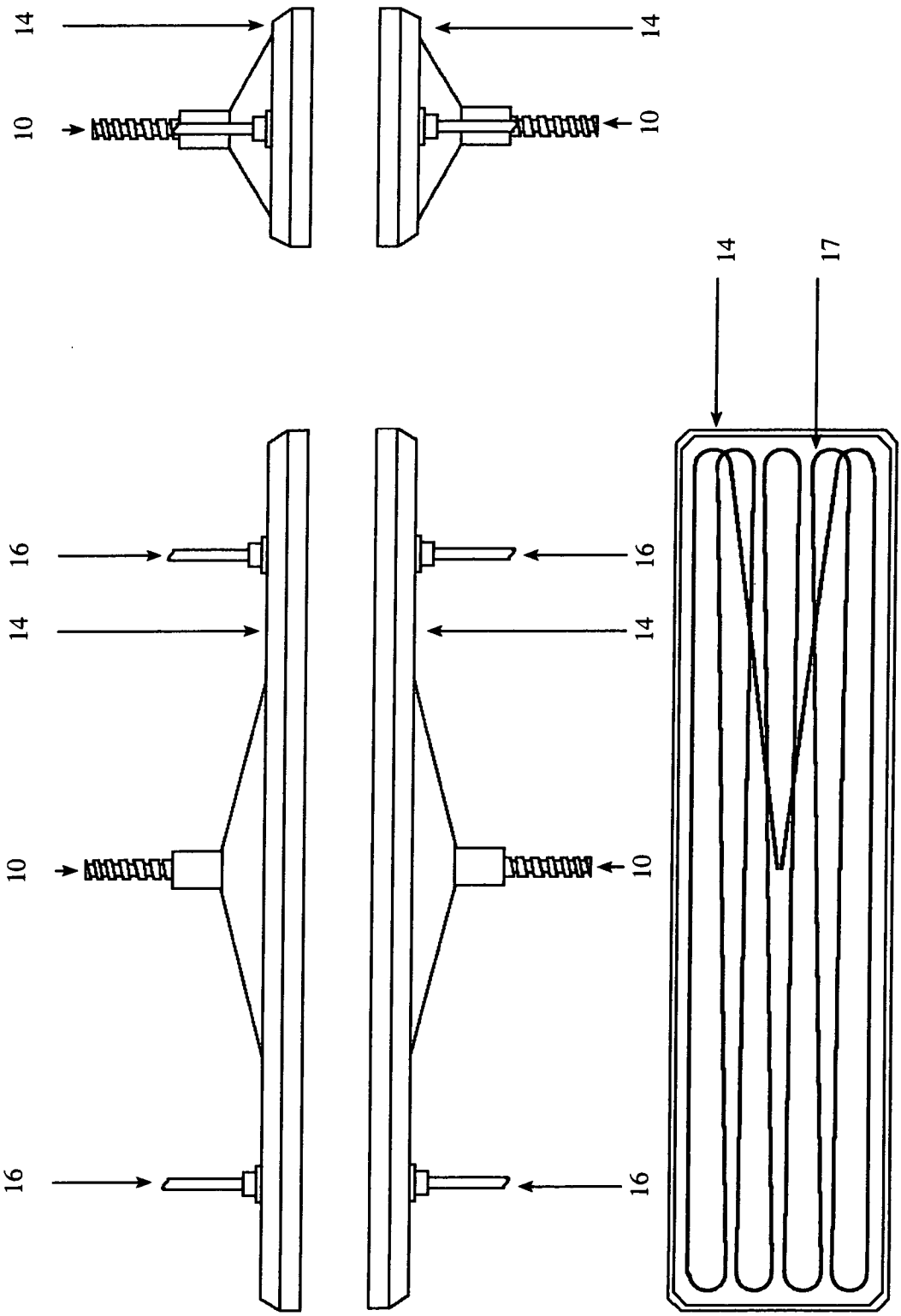


Fig 5

INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER
INV. C03B27/00 C03B27/012 C03B27/02 C03B27/06 F27B5/14
F27B9/36 C03B27/044

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)
C03B F27B F27D

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 practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
14 August 2007	28/08/2007

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No
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