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(54) **A tundish provided with a heating device for molten steel.**

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US-A-2 888 506

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Description

This invention relates to a tundish provided with a heating device for molten metal, and more particularly to a tundish for continuous casting provided with a channelled induction-heating device for molten steel according to the preamble of claim 1.

In continuous steel casting molten steel is poured from a refining vessel such as a converter into a ladle, which is transported and poured into a tundish for continuous casting. Then, the molten steel is poured into a mold through an immersion nozzle disposed in the bottom of the tundish. Therefore, the temperature of the molten steel necessarily lowers whilst it is being transported from the ladle to the mold *via* the tundish. Since the pouring temperature is very important in continuous casting, however, it is desirable to use a tundish provided with a heating device for the molten steel considering that the temperature of the molten steel in the tundish may fall below the predetermined pouring temperature.

As the heating device for molten pig iron or molten steel, there is used a low-frequency channelled induction-heating furnace usually called an Ajax-Wyatt furnace. Such an induction-heating furnace has been known for a long time in the iron and steel field and is mainly used as a holding furnace for foundry pig iron. However, when such a holding furnace is used with a tundish in continuous casting of molten steel, the following fundamentally great differences are to be noted:

(i) The holding furnace is continuously used for a long period of time once the operation is started. On the other hand, molten steel contained in one or several ladles is treated for a short time only in the tundish for continuous casting, so that it is necessary to exchange the used tundish for a new one in order to repair the lining of the tundish.

(ii) The holding furnace is subjected only to tilting, turning and lifting in a fixed location or, if moved, is moved over a very short distance only. On the other hand, the tundish is usually quickly moved to a pouring position, to a preheating position or to a repairing position by means of a car or a crane.

In Fig. 1 of the accompanying drawings there is shown a section through a tundish provided with a conventional channelled induction-heating device as mentioned above, which is also shown in Fig. 2 as a plan view. As shown in Figs. 1 and 2, a channelled induction-heating device 1 is attached to a tundish 3 for continuous casting at a position near the bottom of the sidewall by means of a flange 5a of a shell wall 5 and a flange 7a of a shell wall 7. The induction-heating device 1 comprises an iron core 9 and a heating coil 11 wound around the iron core 9. In the central part of the device 1 is formed a through-hole 13 which receives the iron core 9 and which is surrounded by the heating coil 11. Further, the inside of the shell wall 7 defining the device 1 is filled with a refractory material 15 containing a channel 17 therein. The channel 17 has a U-shape in plan surrounding the through-hole 13, both openings of which channel 17 communicate with an opening 19 of the tundish 3 formed in the shell wall 5 and refractory lining 21. Moreover, the heating coil 11 is connected at both ends to water-cooled feed cables 23 and 25.

When molten steel 27 is poured into the tundish 3, the channel 17 is filled with molten steel 27 to form a closed loop (corresponding to a secondary induction coil). Further, molten steel 27 is heated to a predetermined temperature in the channel 17 by applying a voltage to the heating coil 11 (corresponding to a primary induction coil) through the cables 23, 25, while molten steel 27 can be returned back to the tundish 3 through the channel 17 by the convection caused by electromagnetic heating.

However, the conventional tundish of the above construction has the following problems in actual operation:

(a) When the used tundish 3 is taken off from the tundish car and transported to a repairing yard, the cooling water system for the water-cooled feed cables 23, 25 must be detached from the heating coil because it is practically impossible to directly move the tundish 3 to the repairing yard without detaching the cooling water system;

(b) Air ventilation and means for preventing intrusion of foreign matter must be provided for when detaching the cooling water system;

(c) Since considerable wear of the refractory material 15 defining the channel 17 can occur, it is necessary to inspect the channel 17 by inserting a specially designed mirror or fiber scope into the channel 17, which is very troublesome. However, even if a worn portion is confirmed, it is difficult to locally repair this worn portion; and

(d) In order to dry and preheat the inside of the channel 17, it is necessary to use a specially designed burner capable of passing through the channel. Further, the preheating degree can not be judged precisely, so that it is difficult to perform the complete preheating economically.

Tundishes of the above type are disclosed in Japanese Utility Model Laid Open No. 57—182099 upon which the preamble of claim 1 is based, and Japanese Patent Laid Open No. 58—35050. It is an object of the invention to solve the aforementioned problems possessed by such tundishes and to provide an effective construction of a tundish for continuous casting provided with a channelled induction-heating device.

GB—A—757 152 discloses a low frequency induction furnace comprising a crucible for molten metal which includes an annular chamber at one end for initiating the heat treatment of the metal. The annular chamber surrounds a core including a lower part around which is wound a copper coil and an upper part which can be removed to allow access to the chamber. The annular chamber is an integral part of the crucible.

According to the present invention there is provided a tundish for continuous casting molten metal comprising a tundish body for containing the molten metal and a channelled induction-heating device for heating the molten metal which device includes an iron core and a heating coil wound around said iron core wherein the device it attached to a sidewall of the tundish body and includes a channel which communicates with an opening in the sidewall characterised in that in order to enable removal, for transport, of the tundish from said device which is fixed on a tundish car said iron core is in the form of a split assembly composed of an upper core member and a lower core member with the heating coil wound around said lower core member.

For a better understanding of the invention and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:—

Fig. 1 is a partially sectional view of a tundish provided with a conventional channelled induction-heating device as previously described;

Fig. 2 is a partial plan view of the tundish shown in Fig. 1;

Fig. 3 is a partially sectional view of one embodiment of a tundish provided with a channelled induction-heating device according to the invention;

Fig. 4 is a side view illustrating the mounting arrangement of the tundish shown in Fig. 3 onto a tundish car;

Fig. 5A is a partially sectional view of another tundish;

Fig. 5B is a sectional view taken along line B—B of Fig. 5A; and

Fig. 5C is a sectional view taken along line C—C of Fig. 5A.

Like parts in the different figures are designated by like reference numerals.

In Fig. 3 there is shown a first embodiment of a tundish provided with a chanelled induction-heating device according to the invention, which has the same construction as the conventional tundish of Fig. 1, except that the iron core 9 is divided into an upper core member 9a and a lower core member 9b and the heating coil 11 is wound around the lower core member 9b as shown in Fig. 3. According to the invention, the core members 9a, 9b are assembled with each other to form the iron core assembly 9 in use, so that the water-cooled feed cables 23, 25 can be always kept connected to the heating coil 11 without ever needing to be detached.

In Fig. 4 is shown an example of the manner in which the tundish of Fig. 3 is mounted onto a tundish car in actual operation. In this case, the tundish car 30 comprises a car frame 32 provided at its bottom with a plurality of travelling wheels 34, a pair of cylinders 36 arranged upright on both side portions of the car frame 32, and a frame 38 moveable up and down by the cylinders 36. When the tundish 3 is mounted on the frame 38, it can be elevated up to a highest position as shown by phantom lines in Fig. 4. On the other hand, since the upper core member 9a and the lower core member 9b defining the iron core assembly 9 are kept in the assembled state during operation of the tundish 3, the upper core member 9a is first detached from the assembled state by means of a crane (not shown) when the tundish 3 is elevated upward after use, while the lower core member 9b is kept on the support stand 40 disposed on the car frame 32. Therefore, the water-cooled feed cables 23, 25 connected to the heating coil 11 surrounding the lower core member 9b are kept connected even when the upper core member 9a is detached.

The other ends of these cables 23, 25 are connected to power and water sources (not shown) by a connecting member 42 fixed to one end of the car frame 32 and a pulley 44 supported by a guide rail 46. Since these cables can not be bent to a small radius of curvature, they are properly fixed along the car frame 32.

The operation of the tundish in Fig. 4 will be described below.

(1) The frame 38 is elevated up to the upper limit positions shown by the phantom lines in Fig. 4 by operating the cylinders 36 of the tundish car 30 and thereafter the actuation of the cylinders 36 is stopped.

(2) The body of the tundish 3 affixed to the channelled induction-heating device 1 after repairing is mounted on the frame 38 by means of a crane (not shown).

(3) The frame 38 is taken down to a predetermined position by operation of the cylinders 36, whereby that portion of the lower core member 9b which is surrounded by the heating coil 11 is inserted into the through-hole 13 of the induction-heating device 1. In this case, the lower core member 9b is already placed on the support stand 40 of the car frame 32 by means of the crane and the water-cooled feed cables 23, 25 are already connected to the heating coil 11.

(4) The tundish car 30 is moved to a preheating position, where the tundish 3 provided with the device 1 is preheated to a predetermined temperature.

(5) After the completion of the preheating, the tundish car 30 is moved from the preheating position to a pouring position for the continuous casting, where the upper core member 9a is placed on the upper ends of the lower core member 9b by means of the crane to form the assembled iron core 9.

(6) After molten steel is poured into the tundish 3 from the ladle (not shown), the continuous casting is performed while the molten steel is kept at constant temperature by means of the induction-heating device 1.

(7) After the completion of the continuous casting, the upper core member 9a is dissasembled from the lower core member 9b by means of the crane.

(8) The frame 38 is again raised to the upper limit position by operation of the cylinders 36.

(9) The used tundish 3 provided with the device

1 is transported to a repairing yard by means of the crane.

As described above, according to the invention, the iron core to be used in the channelled induction-heating device is a split-type iron core assembly composed of an upper core member and a lower core member, so that the removal of the iron core from the induction-heating device is very easy when repairing the tundish and the heating device.

In Figs. 5A to 5C is shown a tundish provided with a channelled heating device which has the same construction as the conventional tundish of Fig. 1, except that the channel formed in the induction-heating device is opened at its upper portion to the atmosphere, leaving a part of the channel near the sidewall of the tundish body closed.

As shown in Fig. 1, the channel 17 formed in the refractory material 15 is always in a closed state in the induction-heating device 1 attached to the conventional tundish. On the contrary, in the tundish of Figs. 5A to 5C a core is first set in the shell wall 5 at a position corresponding to the formation of a channel 17a and then the refractory material 15 is incorporated in the whole of the shell wall 5 and thereafter the core is dissolved from the refractory material 15 or otherwise removed thereform, whereby the upper portion of the channel 17a is open to the atmsophere so as to leave only part of the channel 17a near the side wall of the tundish closed. As shown in Figs. 5A and 5B, the portion of the refractory material 15 closing the channel 17a has a size denoted by y and z sufficient to support the upper portion of the remaining island-like refractory material 15 having the through-hole 13 for the iron core 9 therein without wobbling. In actual operation, the channel 17a may be covered with a lid (not shown) instead of being kept in the open state or the upper portion of the open channel 17a may be covered with a refractory wool instead of the lid.

As described above, the channel is substantially open at its upper portion, so that for example inspection, preheating and local repairing of the refractory material in the channel are very easy. As a result, there is no fear of poor baking of the refractory material in the induction-heating device due to poor preheating, so that the durable life of the refractory material can be prolonged. Further, there is no risk of molten steel leaking out because of a deficit of the refractory material, so that the safety of the operation can be ensured.

In the preferred embodiment of the invention, the channelled induction-heating device includes both the split-type iron core assembly and the open channel whereby the repair of this device can be performed even more easily.

Claims

1. A tundish (3) for continuous casting molten metal comprising a tundish body for containing the molten metal and a channelled induction-heating device (1) for heating the molten metal which device (1) includes an iron core (9) and a heating coil (11) wound around said iron core (9) wherein the device (1) is attached to a sidewall of the tundish body and includes a channel (17) (17a) which communicates with an opening (19) in the sidewall characterised in that in order to enable removal, for transport, of the tundish (3) from said device (1) which is fixed on a tundish car said iron core (9) is in the form of a split assembly composed of an upper core member (9a) and a lower core member (9b) with the heating coil (11) wound around said lower core member (9b).

2. A tundish (3) according to claim 1, wherein the part of said channel (17) most remote from the tundish body is open at its upper portion to the atmosphere whereas the part of said channel nearer the tundish body is closed to the atmosphere.

Patentansprüche

1. Gießwanne (3) für das Stranggießen eines geschmolzenen Metalls, wobei die Gießwanne einen Gießwannenkörper enthält, um das geschmolzene Metall aufzunehmen, und eine mit Kanälen versehene Induktionsheizvorrichtung (1) enthält, um das geschmolzene Metall zu erhitzen, wobei die Vorrichtung (1) einen Eisenkern (9) sowie eine Heizwicklung (11) aufweist, die um den Eisenkern (9) gewickelt ist, wobei die Vorrichtung (1) an einer Seitenwand des Gießwannenkörpers angebracht ist und einen Kanal (17) (17a) aufweist, der mit einer öffnung (19) in der Seitenwand in Verbindung steht, dadurch gekennzeichnet, daß dazu, um die Gießwanne (3) für einen Transport von der Vorrichtung (1) abnehmen zu können, die auf einem Gießwannenwagen befestigt ist, der Eisenkern (9) einen geteilten Aufbau besitzt, der aus einem ober en Kernteil (9a) und einem unteren Kernteil (9b) zusammengesetzt ist, wobei die Heizwicklung (11) um den unteren Kernteil (9b) gewickelt ist.

2. Gießwanne (3) gemäß Anspruch 1, wobei jene Teil des Kanals (17), der vom Gießwannenkörper am weitesten entfernt ist, an seinem oberen Teil gegen die Atmosphäre offen ist, während jener Teil des Kanals, der näher zum Gießwannenkörper liegt, gegen die Atmosphäre abgeschlossen ist.

Revendications

1. Un entonnoir de coulée (3) pour couler en continu de métal en fusion, comprenant un corps d'entonnoir pour contenir le métal en fusion et un dispositif cannelé de chauffage par induction (1) pour chauffer le métal en fusion, le dit dispositif (1) incluant un noyau en fer (9) et un serpentin chauffant (11) enroulé autour du dit noyau en fer (9), le dispositif (1), dans le dit entonnoir, étant fixé à une paroi latérale du corps d'entonnoir et comprenant une annelure (17) (17a) qui communique avec une ouverture (19) dans la paroi latérale, le système étant caractérisé en ce que pour permettre l'enlèvement, pour le transport,

de l'entonnoir (3) par rapport au dit dispositif (1) qui est fixé sur un véhicule porte-entonnoir, le dit noyau en fer (9) se présente sous forme d'un ensemble fendu composé d'un élément de noyau supérieur (9a) et d'un élément de noyau inférieur (9b) avec le serpentin chauffant (11) enroulé autour du dit élément de noyau inférieur (9b).

2. Un entonnoir (3) selon la revendication 1, caractérisé en ce que la partie de la dite cannelure (17) la plus éloignée du corps d'entonnoir est ouverte sur l'atmosphère à sa partie supérieure, tandis que la partie de la dite cannelure rapprochée du corps d'entonnoir est formée sur l'atmosphère.

FIG_1 PRIOR ART

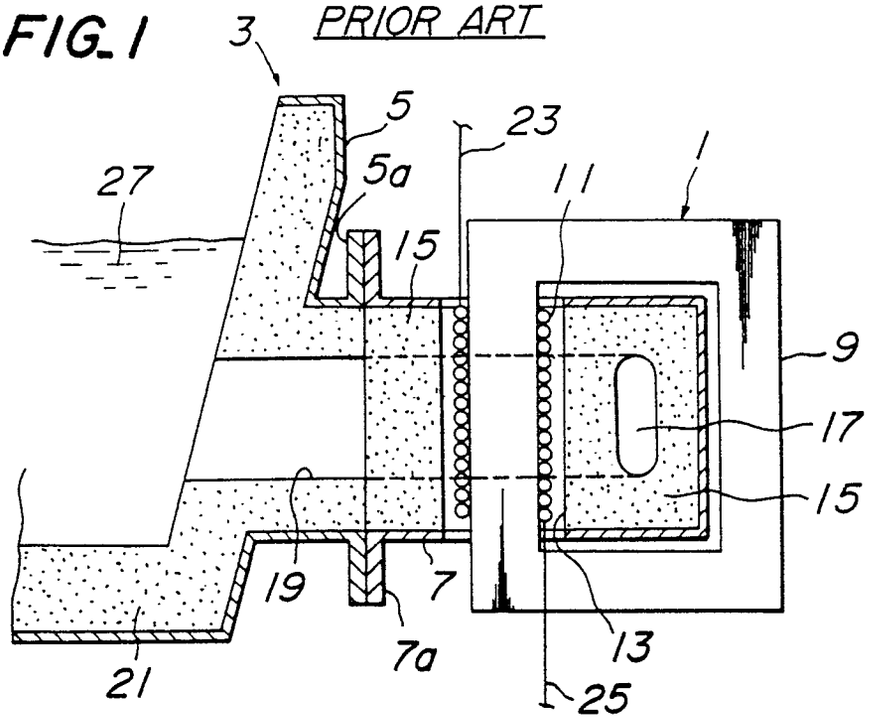

FIG_2 PRIOR ART

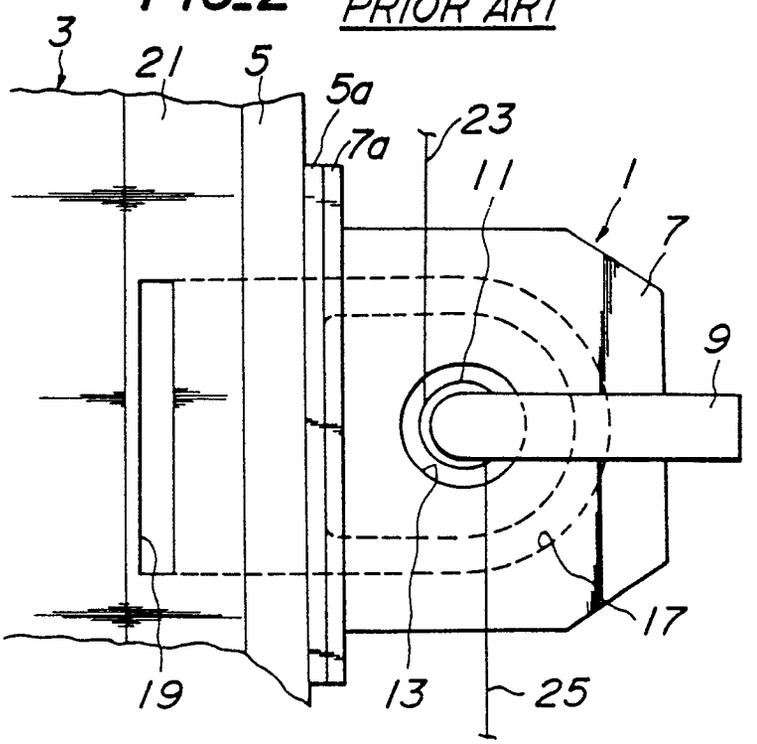

FIG_3

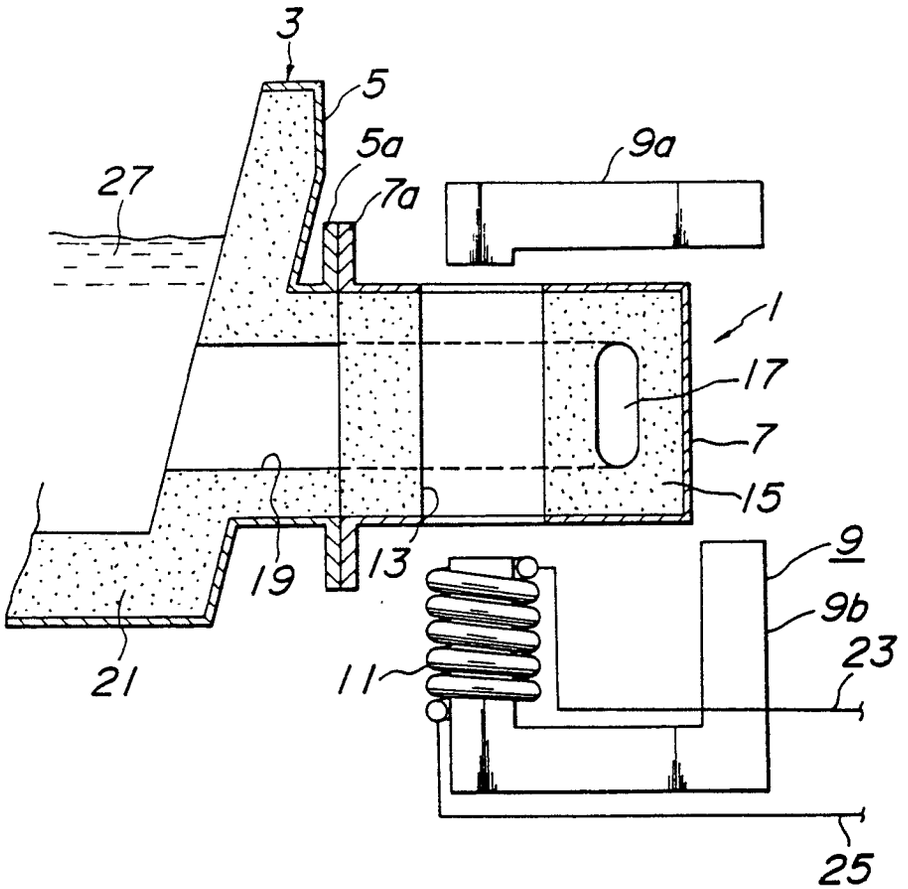

FIG.4

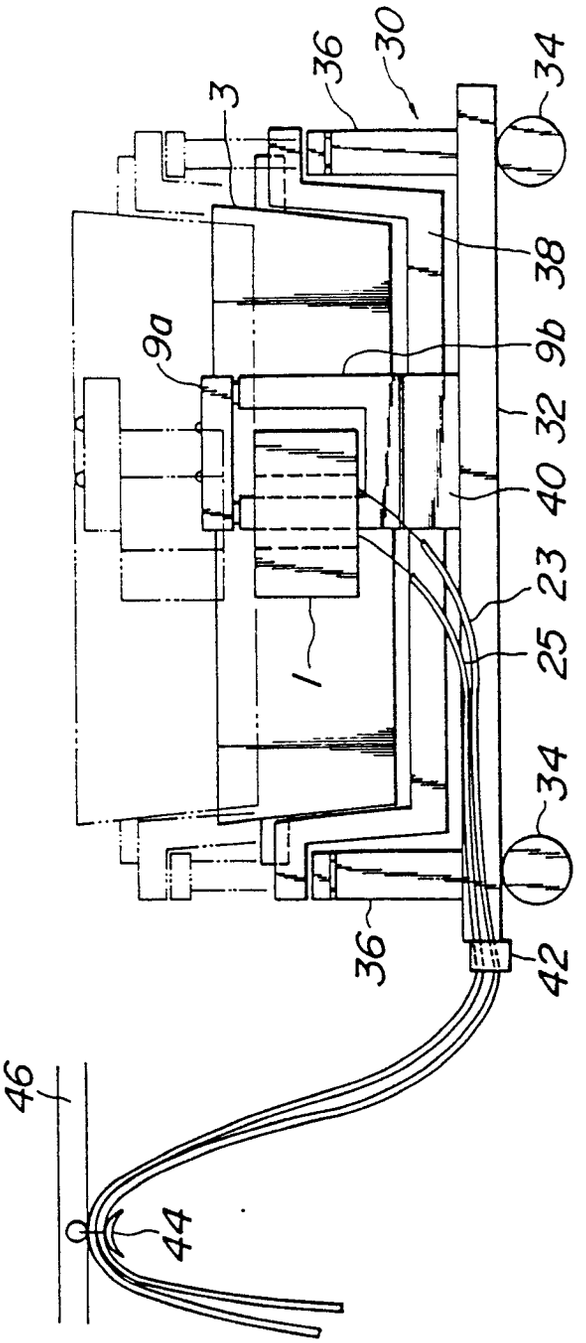

FIG_5A

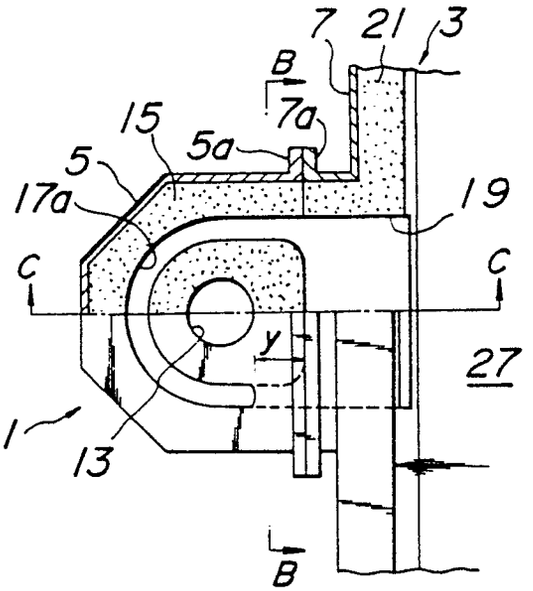

FIG_5B

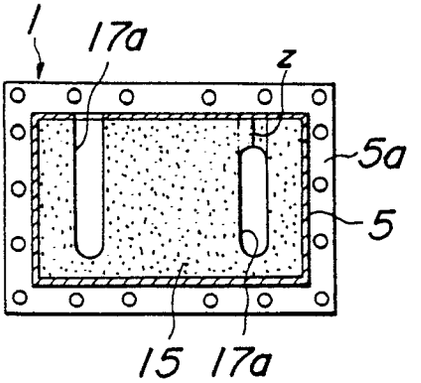

FIG_5C