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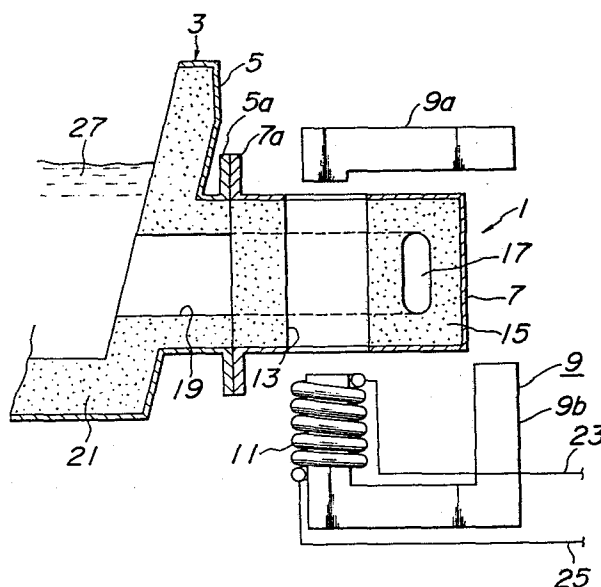
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A tundish provided with a heating device for molten steel.

A tundish for continuous casting of molten steel is disclosed, which is provided at its sidewall with a channeled induction-heating device. In this type pf the induction-heating device, the iron core is a split-type iron core assembly composed of an upper core member and a lower core member and/or the channel is opened at its upper portion to atmosphere, leaving a part of the channel closed.



A TUNDISH PROVIDED WITH
A HEATING DEVICE FOR MOLTEN STEEL

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 channeled induction-heating device for molten steel.

05 In the continuous steel casting, molten steel is poured from a refining vessel such as converter or the like into a ladle, which is transported and poured into a tundish for continuous casting. Thereafter, molten steel is further poured into a mold through an
10 immersion nozzle disposed in the bottom of the tundish. Therefore, the temperature of molten steel necessarily lowers in the course of transporting molten steel from the ladle to the mold through the tundish. Since the pouring temperature is very important in the continuous
15 casting, however, it is desirable to use a tundish provided with a heating device for molten steel taking into consideration that the temperature of molten steel in the tundish may reduce below the predetermined pouring temperature.

20 As the heating device for molten pig iron or molten steel, there is used a low-frequency channeled induction-heating furnace usually called as an Ajax-Wyatt furnace. Such an induction-heating furnace has been known from old in the iron and steel field,
25 which is mainly used as a holding furnace for foundary pig iron. When such a holding furnace is applied to

the tundish used in the continuous casting of molten steel, however, there are fundamentally great differences as mentioned below:

(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 limitedly treated in the tundish for the continuous casting, so that it is necessary to exchange the used tundish into a newly one in order to repair the lining of the tundish.

(ii) The holding furnace is subjected only to the tilting, turning and lifting in the existing place or may be moved by a very short distance. On the other hand, the tundish is largely moved to a pouring position, a preheating position or a repairing position by means of a car or a crane in a short time.

In Fig. 1 is sectionally shown the tundish provided with the conventional channeled 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 channeled induction-heating device 1 is attached to a tundish 3 for the continuous casting at a position near the bottom of the sidewall thereof through a flange 5a of a shell 5 and a flange 7a of a shell 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 receiving that portion of the iron core 9 which is surrounded

with the heating coil 11. Further, the inside of the shell 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 plane surrounding the through-hole 13, both openings of which communicate with an opening 19 of the tundish 3 formed in the shell 5 and a 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, during which 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 the actual operation:

(a) When the used tundish 3 is taken off from a tundish car and transported to a repairing yard, a 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 ventiration and means for preventing intrusion of foreign matter must be taken in the detaching of the cooling water system;

(c) Since the wearing loss of the refractory material 15 defining the channel 17 is conspicuous, it is necessary to inspect the wear state of the channel 17 by inserting an exclusive mirror or fiber scope into the channel 17, which is very troublesome. 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 an exclusive 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.

It is, therefore, an object of the invention to solve the aforementioned problems of the prior art and to provide an effective construction of a tundish for continuous casting provided with a channeled induction-heating device.

According to a first aspect of the invention, there is the provision of in a tundish for continuous casting comprising a tundish body and a channeled induction-heating device attached to a sidewall of said tundish body, said device including a channel communicated with an opening formed in said sidewall of the tundish body, an iron core and a heating coil wound

around said iron core, the improvement wherein said iron core is a split-type iron core assembly composed of an upper core member and a lower core member, and said heating coil is wound around said lower core member.

According to a second aspect of the invention, there is the provision of in a tundish for continuous casting comprising a tundish body and a channeled induction-heating device attached to a sidewall of said tundish body, said device including a channel communicated with an opening formed in said sidewall of the tundish body, an iron core and a heating coil wound around said iron core, the improvement wherein said channel is opened at its upper portion to atmosphere, leaving a part of said channel near said sidewall of the tundish body closed.

The invention will be described in detail with reference to the accompanying drawing, wherein:

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

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

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

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

Fig. 5A is a partially sectional view of another embodiment of the tundish according to the invention;

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

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

Like parts are designated by like numerals throughout the different figures of the drawing.

In Fig. 3 is sectionally shown a first embodiment of the tundish provided with the channeled 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 at a connected state to the heating coil 11 without requiring the detaching of the cables.

In Fig. 4 is shown an example of mounting the tundish of Fig. 3 onto a tundish car in the actual operation. In this case, the tundish car 30 comprises a car frame 32 provided at its bottom with plural travelling wheels 34, a pair of cylinders 36 arranged upright on both side portions of the car frame 32, and

a frame 38 going 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 a phantom line in Fig. 4. On the other hand, since the upper
05 core member 9a and the lower core member 9b defining the iron core assembly 9 are kept at the assembled state in the 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
10 elevated upward after the use, while the lower core member 9b is kept leaving on a 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 at the connected
15 state in the detaching of the upper core member 9a.

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

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

25 (1) The frame 38 is elevated up to the upper limit position shown by phantom line in Fig. 4 by the driving of the cylinders 36 in the tundish car 30 and thereafter the driving of the cylinders 36 is stopped.

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

05 (3) The frame 38 is descended downward to a predetermined position by the driving of the cylinders 36, whereby that portion of the lower core member 9b which is surrounded with the heating coil 11 is inserted into the through-hole 13 of the induction-heating
10 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 connected to the heating coil 11 at an unworking state.

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

 (5) After the completion of the preheating, the tundish car 30 is moved from the preheating position to
20 a pouring position for the continuous casting, at 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 iron core assembly 9.

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

 (7) After the completion of the continuous casting,

the upper core member 9a is disassembled from the lower core member 9b by means of the crane.

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

05 (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 first embodiment of the invention, the iron core to be used
10 in the channeled 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 in the repairing of the tundish and the like.

15 In Figs. 5A to 5C is shown a second embodiment of the tundish provided with the channeled induction-heating device according to the invention, which has the same construction as the conventional tundish of Fig. 1, except that the channel formed in the induction-
20 heating device is opened at its upper portion to 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 kept at a closed state in
25 the induction-heating device 1 attached to the conventional tundish. On the contrary, according to the invention, a core is first set in the shell 5 at a position corresponding to the formation of a channel 17a

and then the refractory material 15 is filled in the whole of the shell 5 and thereafter the core is dissolved in the refractory material 15 or removed off therefrom, whereby the upper portion of the channel 17a is opened
05 to atmosphere so as to leave only a 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 of y and z enough to support the upper portion of the remaining
10 island-like refractory material 15 having the through-hole 13 for the iron core 9 therein without wobbling. In the actual operation, the channel 17a may be covered with a lid (not shown) without being kept at an opened state or the upper portion of the opened channel 17a
15 may be covered with a refractory wool instead of the lid.

As described above, according to the second embodiment of the invention, the channel is substantially opened at its upper portion, so that the inspection,
20 preheating, local repairing and the like of the refractory material in the channel are very easy. As a result, there is not fear on the poor baking of the refractory material in the induction-heating device due to the poor preheating, so that the durable life of
25 the refractory material can be prolonged. Further, there is no risk of leaking molten steel from the deficit of the refractory material, so that the safety of the operation can be ensured without troubles.

In the preferred embodiment of the invention,
the split-type iron core assembly and the opened channel
are applied to the channeled induction-heating device,
whereby the repair of this device can be performed more
05 easily without difficulties.

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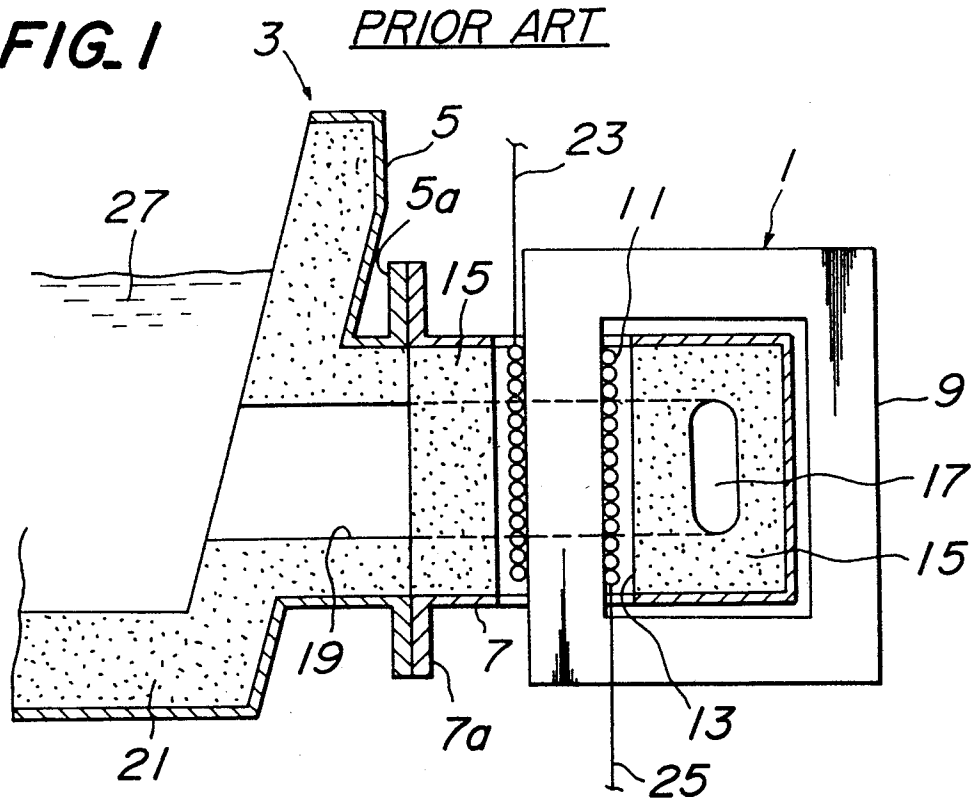
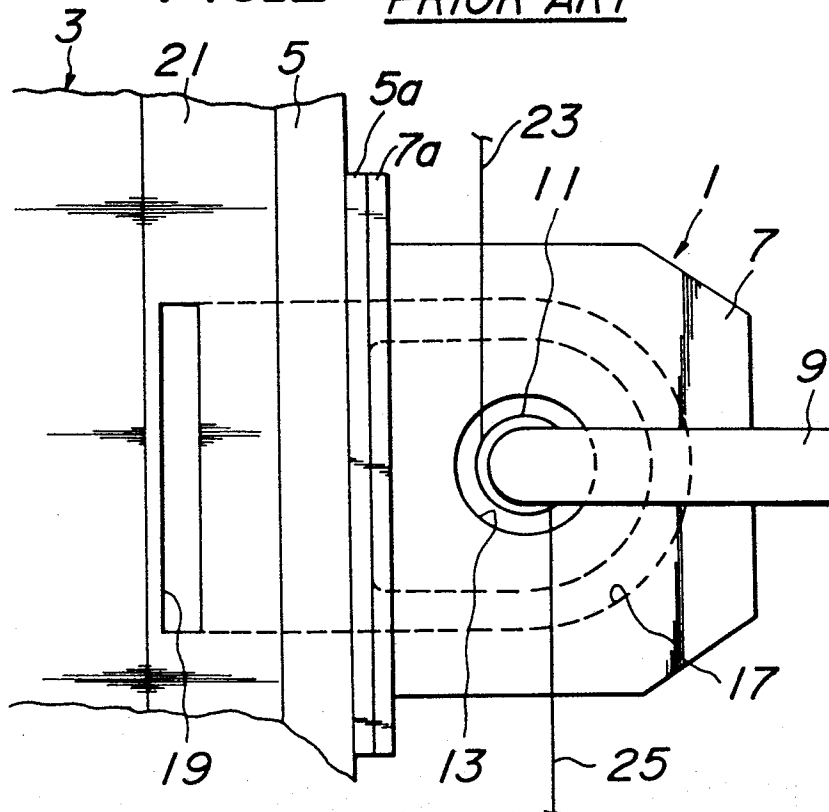
CLAIMS

1. In a tundish for continuous casting comprising a tundish body and a channeled induction-heating device attached to a sidewall of said tundish body, said device including a channel communicated with an opening formed in said sidewall of the tundish body, an iron core and a heating coil wound around said iron core, the improvement wherein said iron core is a split-type iron core assembly composed of an upper core member and a lower core member, and said heating coil is wound around said lower core member.

2. In a tundish for continuous casting comprising a tundish body and a channeled induction-heating device attached to a sidewall of said tundish body, said device including a channel communicated with an opening formed in said sidewall of the tundish body, an iron core and a heating coil wound around said iron core, the improvement wherein said channel is opened at its upper portion to atmosphere, leaving a part of said channel near said sidewall of the tundish body closed.

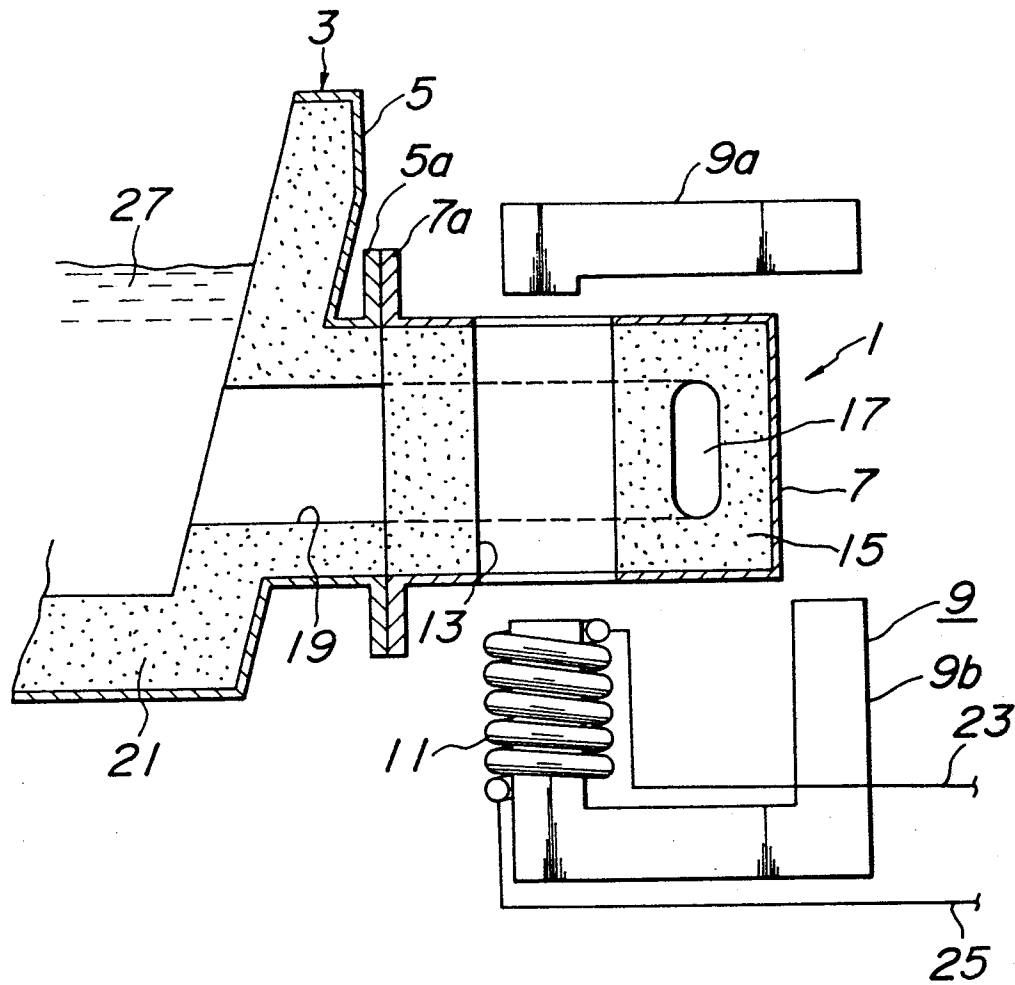
3. A tundish according to claim 1, wherein said channel is opened at its upper portion to atmosphere, leaving a part of said channel near said sidewall of the tundish body closed.

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FIG. 1PRIOR ART**FIG. 2**PRIOR ART

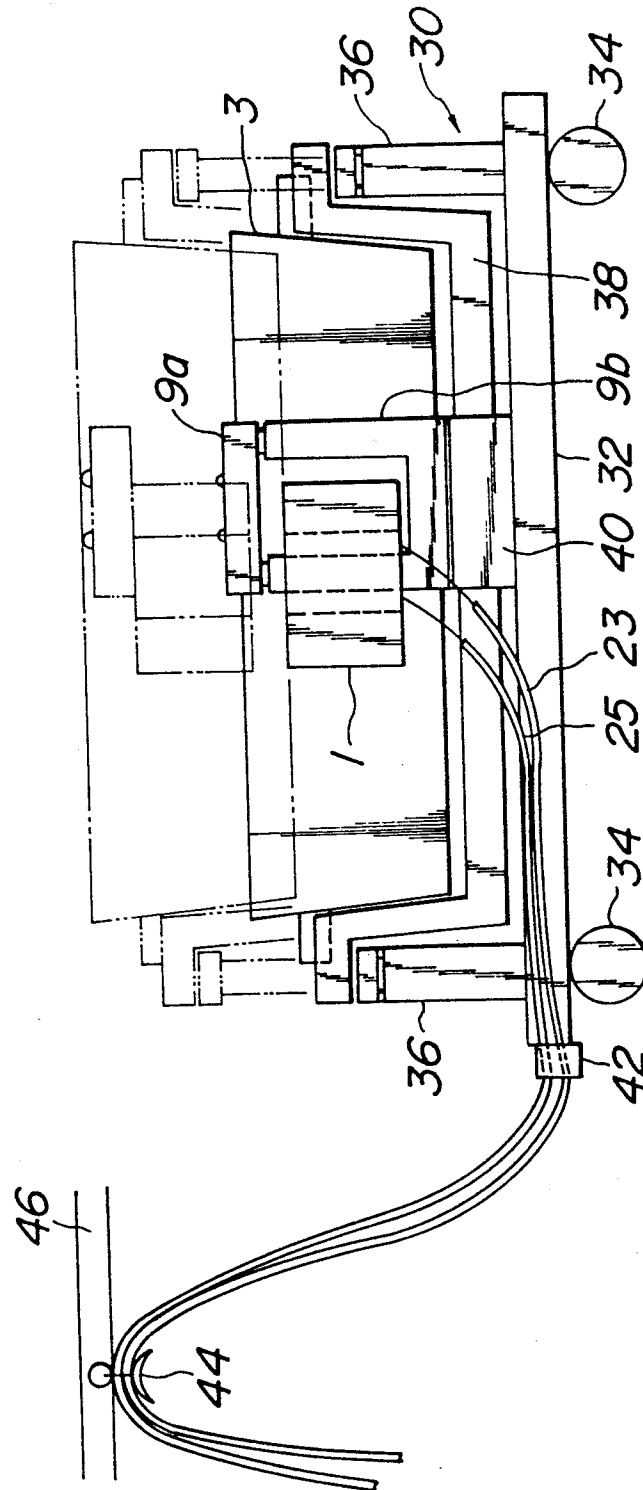
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FIG. 3



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FIG. 4



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FIG. 5A

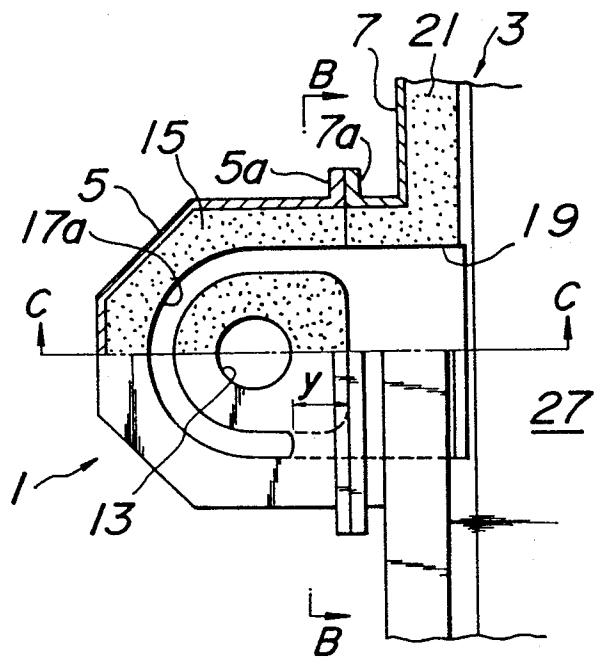


FIG. 5B

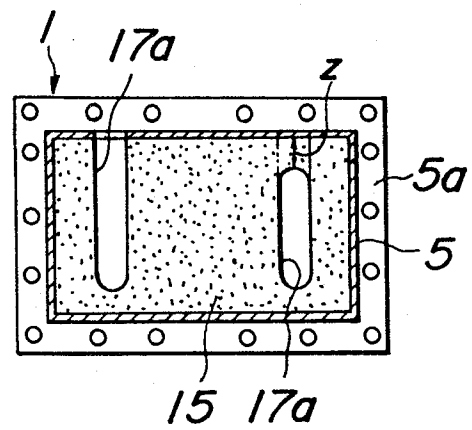


FIG. 5C

