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(54) DEVICE AND METHOD FOR UNPLUGGING A MOLTEN METAL DISCHARGE PORT

VORRICHTUNG UND VERFAHREN ZUM OFFENHALTEN EINER AUSGUSSÖFFNUNG EINES
METALLURGISCHEN GEFÄSSES

DISPOSITIF ET PROCEDE DE DEBLOCAGE D'UN ORIFICE DE DECHARGE DE METAL EN FUSION

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- **PATENT ABSTRACTS OF JAPAN vol. 012, no. 269**
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EP 1 472 028 B1

Description

[0001] The present invention relates to the casting of molten metal, in particular of molten steel. The invention relates to a device allowing safe opening of a metallurgical vessel taphole blockage for example of a metallurgical ladle. The invention will be described hereafter with respect to the casting of molten steel from a ladle. It is clear that this should not be seen as a limitation of the scope of protection of the present invention.

[0002] In steel plants, the molten steel is transported in ladles. The liquid steel is poured into the ladle by the top and tapped from the ladle by the bottom, through a taphole which may be regulated by a slide gate valve. Due to the high temperature of the molten steel, the inner wall of the ladle is fully lined with refractory elements (as can be seen on Fig. 1; a), of a thickness which often exceeds 20 centimetres. The Fig. 1 shows a cross section of a steel ladle. In the bottom of the ladle, there is a hole, called taphole (Fig. 1; b), which is controlled by a slide gate valve. This hole is also made from refractory elements. The slide gate valve is located outside the ladle, below the bottom wall. It is also equipped with refractory elements. Fig. 2 shows a cross section of a ladle taphole with the wellblock (Fig. 2; c), the inner nozzle (Fig. 2; d), the fixed (or stationary) plate of the slide gate valve (Fig. 2; e), the mobile plate of the slide gate (Fig. 2; f) and the collector nozzle (Fig. 2; g).

[0003] Before use, when the ladle is empty, this taphole is also empty. When the ladle is filled with steel (at this moment, the slide gate is closed), the taphole is also filled with liquid steel and due to the thermal conductivity of the refractory elements which form the taphole, the liquid steel freezes. As a consequence, when the valve is opened, the liquid steel which is in the ladle does not flow through the taphole, because it is blocked with solidified steel.

[0004] To prevent this to happen, it is conventional to fill in the taphole with sand (called taphole sand) before filling the ladle with molten steel. When the slide gate is opened, first the taphole sand flows, allowing free flowing of the liquid steel.

[0005] It might happen that, when the slide gate is opened, the steel does not flow out. Although the majority of the taphole sand flows out, there is a kind of crust that has been formed at the interface between the liquid steel and the taphole sand. This crust may be resistant enough to withstand the ferrostatic pressure of the liquid steel which is on top of it.

[0006] When this kind of blockage occurs, an operator must introduce into the taphole an oxygen steel lance, up to the blockage level and blow oxygen. The temperature of the sand crust is raised by the combustion of the lance and the crust breaks out, allowing the steel to flow out of the ladle. In turn, the lancing operation creates other problems.

[0007] When the steel is poured from the ladle contacts with air must be prevented to avoid steel reoxidation,

which would lead to the "burning" of the alloys dissolved in the steel by the oxygen of the air and to the formation of "inclusions" which will downgrade the quality of the steel. It is therefore important to prevent the "reoxidation" of the liquid steel during casting. In most of the continuous casters a "ladle shroud" - refractory tube - conducts the steel from the ladle to the tundish while being protected from the air. The ladle shroud has to be removed in order to allow the operator to introduce the oxygen lance into the taphole. Consequently, when the blockage has been removed the steel is poured without any shroud and is largely reoxidised.

[0008] Another problem is that when the steel is not protected from the air, its hydrogen and nitrogen content increases and the steel produced might also be downgraded, because of an improper final quality.

[0009] Another problem is that the operator has only a short period of time to open the ladle: if it takes too much time to be opened, it might happen that the level of the steel in the continuous caster becomes too low and that the casting sequence is to be terminated. This incident leads to a cost of "non-production" since the caster has to be re-prepared for a new start. These types of non-production events are extremely expensive for the steel industry.

[0010] Yet another problem is that when the steel starts to flow out after removing of the blockage, the operators has to "run away" in order not to be burned by molten steel splashes. One can understand that this "lancing" operation is very dangerous, and must be avoided whenever possible.

[0011] It is therefore an object of the invention to provide a device allowing a quick, reliable and safe opening of a metallurgical vessel. Another object of the invention is to provide a safe and efficient method for the opening for the opening of a metallurgical vessel.

[0012] Attempts have been made in the past to provide a solution to these problems. For example, the US 5,167,902 describes a dart assembly constituted of a dart-member located in the collector nozzle and actuated by a compression spring. When the mobile plate and collector nozzle openings are in register with the fixed plate and inner nozzle openings, the dart member is fired and projected upwardly towards the sand.

[0013] JP-A-06063729 and JP-A-63052755 also relate to the problem of sand blockage of a taphole and disclose a single rod placed inside the taphole which is expected to move from left to right in aim to break up the solidified sand layer. The amplitude of movement of such system is limited to the length of the rod. In addition, movement of the rod is unpredictable and thus the desired effect is not always achieved.

[0014] Another solution is disclosed in the document FR-A1-2,755,045 which shows a dart-member located in the inner nozzle which is actuated by a pneumatic device placed in the collector nozzle.

[0015] Known systems are either not reliable or complicated and expensive. Some are also difficult to set in

place (once pre-armed) and could even block themselves the taphole. Practically, none of these systems is or has been used on a commercial scale. It is therefore a further object of the invention to provide a simple, safe and cheap device. These objects, and others, are satisfied with a device according to claim 1.

[0016] With such a device since all the energy of actuation of the opening device is supplied by the actuation of the mobile plate in the slide gate valve, it is therefore not necessary to supply said energy under the form of potential energy (pre-armed spring) or from any other expensive and complicated additional source of energy.

[0017] An important part of the energy of actuation of the mobile plate is thereby converted into energy of actuation of the opening device.

[0018] This principle being established, the skilled person will be able to find himself many mechanical solutions to implement it.

For example, the opening device can comprise a rod or any other member which is pushed or slid upwardly, rotated or actuated according to a combination of these movements. The upper end of this rod or member which should be long enough to at least reach the sand crust, at least when actuated, hits and breaks the crust when actuated, allowing therefore the free flowing of the molten steel.

[0019] According to another of its aspects, the invention concerns a process for opening the taphole of a metallurgical vessel equipped with a slide gate valve and with the above described device.

[0020] To help the comprehension of the invention, it will now be described with respect to the accompanying figures.

[0021] Figure 1 represents a schematic view of a ladle;

Figure 2 represents a cross-section of a ladle taphole;

Figure 3 represents a three-dimensional view of a device according to an embodiment of the invention; Figures 4 to 7 show constructional elements of the device of figure 3;

Figures 8 to 12 show the different steps of taphole opening with the device of figure 3;

Figure 13 shows the closure of the slide gate valve;

Figures 14 to 16 show the different steps of taphole opening with a variant of the opening device.

[0022] The device of the invention (see fig. 3) is composed of a tube (1) on which are welded positioning plates, and locking springs. At the lower end of the tube (1), there is a support. A complete description of the tube is given on fig. 4. Inside this tube (1), there is a rod (2). This rod can move up and down and turn inside the tube (1). A complete description of the rod is given at fig. 5. At the upper end of the rod (2), there is a head (3) to break the sintered sand crust by rotation and/or vertical upwards translation. At the lower end of the rod (2), attached to the support (1-4), there is an actuating device,

for example an excentered disk (4) to take advantage of the closing force of the slide gate, and to transmit it to the head (3) through the rod (2).

[0023] The tube is composed of a tube itself (1-1), of 4 positioning plates (1-2a, 1-2b, 1-2c, 1-2d), 2 springs (1-3a, 1-3b) and a support (1-4).

[0024] The positioning plates, the springs and the support are welded on the tube (1-1) as depicted at figure 4, so that the assembly can be simply installed in the refractory inner nozzle from the outside of the slide gate.

[0025] The effort reaction due to the rotation of the rod (2) inside the tube (1-1) is properly transmitted to the refractory wall of the upper nozzle through the positioning plates (1-2a to 1-2d).

[0026] Around the middle of the tube (1), there is a sloped slit (5), which induces the rotation of the rod when the said rod is pushed upwardly.

[0027] Around the 1/3 lower part of the rod (2), there is a stud (2a) which slides in the slit (5) of the tube (1), when the rod (2) is pushed upwardly. This sliding effect induces the rod (2) to rotate of approximately 45°. The lower part of the rod can be rounded.

[0028] A sand breaking device (the head (3)) is welded at the upper end of the rod (2). This head can be composed of the assembly of a tube (3-1) and some plates (3-x) welded perpendicularly, in the axis direction, on the tube (3-1), (optionally slightly sloped).

[0029] The lower part of the head is designed to cover the main tube (1) so as to avoid sand introduction into the tube.

[0030] The general design of the head (3) is adapted to the customer's refractory profile.

[0031] A disk (4) is attached at the lower end of the tube (1-4) by the means of an excentered axis (4a). The movement of this disk is loose about the axis 4a. However, the axis 4a is well tightened to the support (1-4) of the tube (1).

[0032] The purpose of this disk is to transmit the force of the plate to the rod (2) in order to actuate the head (3) into the sand.

[0033] This disk must be "stored" over the mobile plate of the slide gate before its opening. When the slide gate is opened, the disk falls into working position in the hole of the mobile plate of the slide gate. When the slide gate tends to be fully closed, the excentered disk is raised into an upper position, and thereby, allows the slide gate to be fully closed once again, if necessary.

[0034] Description of the invention in service operation.

The installation of the device is performed at the ladle preparation area of the steel plant, just before the ladle leaves this area. The device is introduced into the upper nozzle of the ladle (i.e. above the slide gate). It is simply pushed into the taphole. Once in position, the slide gate can be closed.

[0035] The ladle is moved into its working position (vertical). At this moment, the disk abuts against the lower plate. The rod (2) is in its lower position, which means

that the sand breaking device is also in its lower position (see Fig. 8).

[0036] Then, the taphole sand is poured into the taphole. The device is so completely surrounded by the taphole sand. Afterwards, the liquid steel is poured into the ladle. Then the steel treatment occurs, until the ladle goes into its casting position. The upper part of the head device is slightly submerged by the taphole sand. Thereby, it is embedded into the crust (see Fig. 9).

[0037] At the casting position, the slide gate is opened. At Fig. 10, the opening of the slide gate corresponds to a movement of the mobile plate from left to right. The taphole sand falls out (see Fig 10). When the slide gate is almost fully opened, the disk (4) falls in its lower position, and is "in the hole" of the mobile slide gate plate (see Fig 11).

[0038] If the steel flows immediately after the taphole sand, the device melts out in the steel flow and does not interfere with the normal casting operation.

[0039] If the steel does not flow out, there is a taphole sand crust that blocks the upper part of the inner nozzle (see Fig. 11). In order to break it, the operator closes back the slide gate, thereby pushing the disk with the slide gate plate (that moves back towards the closing position) and consequently, pushing the rod. The rod moves upwards and slightly turn. Thereby the sand breaking device (head), which is attached to the rod, also moves upwards and turns (see Fig.12). This destroys the sand crust and lets the steel flow.

[0040] If the steel does not flow out, even after closing the slide gate and having the device actuated, the slide gate can return into the fully closed position without interfering with the device (see Fig.13).

[0041] In a variant of the invention illustrated on figures 14-16, the disk (4) is replaced by an articulated assembly of three connecting rods (61,62,63).

[0042] The variant illustrated on figures 14-16 provides a much longer stroke for the vertical movement of the rod (2). The remainder of the device can be similar to the device of figure 3 or, alternatively, the slit (5) in the tube (1) can be linear.

[0043] In the initial (waiting) position (figure 14), the first connecting rod (61) is fixedly attached to a support, which as in the depicted device, might be a tube (7) welded to the tube (1). When the mobile plate is moved and the slide gate is in fully opened position (figure 15), the connecting rods (62,63) fall into the taphole and are just retained by the first connecting rod (61). The end of the last connecting rod (63) is just in contact with the lower end of the rod (2). So that when the slide gate is closed (figure 16), the mobile plate pushes the last connecting rod (63) itself pushing the rod (2) actuating thereby the opening device.

Claims

1. Opening device comprising an elongated pushing

member (2) to be inserted in the taphole of a metallurgical vessel equipped with a slide gate valve comprising a mobile plate, said pushing member to be actuated by the mobile plate of the slide gate **characterized in that** the opening device further comprises a head (3), a guiding tube (1) and transmitting means (4,61,62,63), the head (3) being attached to the pushing member (2), the guiding tube (1) receiving said pushing member (2) and the pushing member (2) being arranged to move axially inside the guiding tube (1), the transmitting means (4,61,62,63) being arranged to move the pushing member (2) once actuated by the actuation of the mobile plate in the slide gate valve.

2. Device according to claim 1, **characterised in that** said device comprises a crank, a lever or a rod, which can move, rotate, or slide, or a combination of these movements, by the use of the force which is given by the movement of the mobile plate of the slide gate.
3. Opening device according to claim 1 or 2, **characterized in that** the transmitting means are comprised of a disk (4) mounted on an excentered axis (4a).
4. Opening device according to any one of the claims 1 to 3, **characterized in that** the transmitting means are comprised of connecting rods (61,62,63).
5. Process for opening the taphole of a metallurgical vessel equipped with a slide gate valve and with a device according to any one of claims 1 to 4, **characterized in that** the mobile plate of the slide gate valve is displaced, actuating thereby the device.
6. Process according to claim 5, **characterized in that** the energy of actuation of the mobile plate is converted into energy of actuation of the opening device.

Revendications

1. Dispositif d'ouverture comprenant un élément de poussée (2) de forme allongée pour être inséré dans le trou de coulée d'un récipient métallurgique équipé d'une valve à tiroir comprenant une plaque mobile, le dit élément de poussée (2) se déclenchant sous l'action de la plaque mobile de la valve à tiroir **caractérisé en ce que** le dispositif d'ouverture comprend en outre une tête (3), un tube de guidage (1) et des moyens de transmission (4, 61, 62, 63), la tête (3) étant attachée à l'élément de poussée (2), le tube de guidage (1) recevant le dit élément de poussée (2) et l'élément de poussée (2) étant adapté à se déplacer axialement à l'intérieur du tube de guidage (1), les moyens de transmission (4, 61, 62, 63) étant adaptés pour déplacer l'élément de pous-

sée (2) une fois actionné par l'action de la plaque mobile dans la valve à tiroir.

2. Dispositif selon la revendication 1, **caractérisé en ce que** le dit dispositif comprend une manivelle, un levier ou une tige, qui peut se déplacer, tourner ou glisser, ou une combinaison de ces trois mouvements en utilisant la force qui est donnée par le mouvement de la plaque mobile de la valve à tiroir. 5
3. Dispositif d'ouverture selon la revendication 1 ou 2 **caractérisé en ce que** les moyens de transmission sont constitués d'un disque (4) monté sur un axe excentré (4a). 10
4. Dispositif d'ouverture selon l'une quelconque des revendications 1 à 3 **caractérisé en ce que** les moyens de transmission sont constitués de tiges de connexion (61, 62, 63). 15
5. Procédé pour ouvrir un trou de coulée d'un récipient métallurgique équipé d'une valve à tiroir et d'un dispositif selon l'une quelconque des revendications 1 à 4 **caractérisé en ce que** la plaque mobile de la valve à tiroir est déplacée actionnant ainsi le dispositif. 20
6. Procédé selon la revendication 5, **caractérisé en ce que** l'énergie pour actionner la plaque mobile est convertie en énergie pour actionner le dispositif d'ouverture. 25

ses exécuter kann.

3. Öffnungs-Vorrichtung nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** am Übertragungselement ein Rad (4) angebracht ist das an einer exzentrischen Achse (4a) befestigt ist. 5
4. Öffnungs-Vorrichtung nach Anspruch 1 bis 3, **dadurch gekennzeichnet, dass** am Übertragungselement Verbindungsstäbe (61, 62, 63) angebracht sind. 10
5. Verfahren für das Öffnen des Ausgusses metallurgischer Gefäße die mit einem Schieberverschluss und einer Öffnungs-Vorrichtung nach den Ansprüchen 1 bis 4 ausgerüstet sind, **dadurch gekennzeichnet, dass** durch das Verschieben der mobilen Schieberplatte des Schieberverschlusses wird die Öffnungs-Vorrichtung ausgelöst wird. 15
6. Verfahren nach Anspruch (6) 5, **dadurch gekennzeichnet, dass** die (horizontale) Bewegungsenergie der mobilen Schieberplatte in Bewegungsenergie für die Öffnungs-Vorrichtung umgewandelt wird. 20

Patentansprüche

1. Öffnungs-Vorrichtung bestehend aus einem verlängerten Druckstab (2) der in den Gießkanal eines metallurgischen Gefäßes, ausgerüstet mit einem Schieberverschluss mit mobiler Schieberplatte, derart eingeführt ist, damit der Druckstab (2) über die mobilen Schieberplatte des Schieberverschlusses ausgelöst wird ist **dadurch gekennzeichnet, dass** die Öffnungs-Vorrichtung bestehend aus dem Kopfteil (3), dem Führungsrohr (1) und dem Übertragungselement (4,61,62,63), der Kopf (3) ist mit dem Druckstab (2) zusammengefügt, das Führungsrohr (1) erhält den so genannten Druckstab (2) und der Druckstab (2) ist derart angeordnet damit er sich im Führungsrohr (1) axial bewegen kann, das Übertragungselement (4,61,62,63) ist derart angeordnet damit der Druckstab (2) durch die Bewegung der mobilen Schieberplatte ausgelöst wird. 35
2. Öffnungs-Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** die besagte Öffnungs-Vorrichtung über eine Kurbel, einen Hebel oder Stift verfügt der sich bewegen, drehen, gleiten, oder eine Kombination dieser Bewegungen mit Hilfe der Kraft der mobilen Schieberplatte des Schieberverschlusses ausführen kann. 40

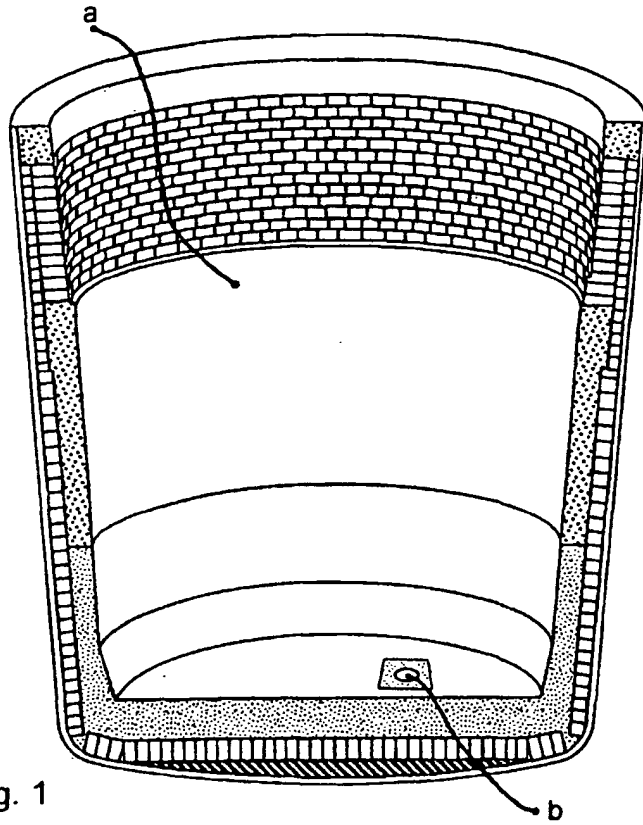


Fig. 1

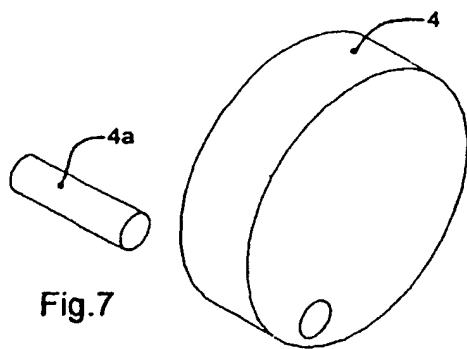


Fig. 7

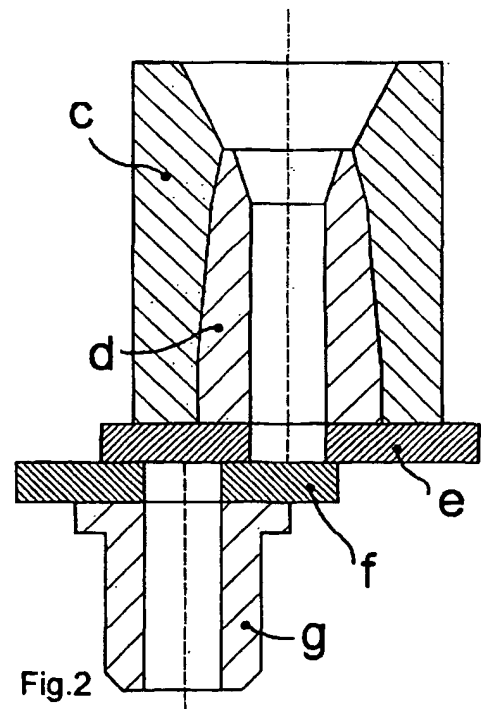


Fig. 2

Fig.3

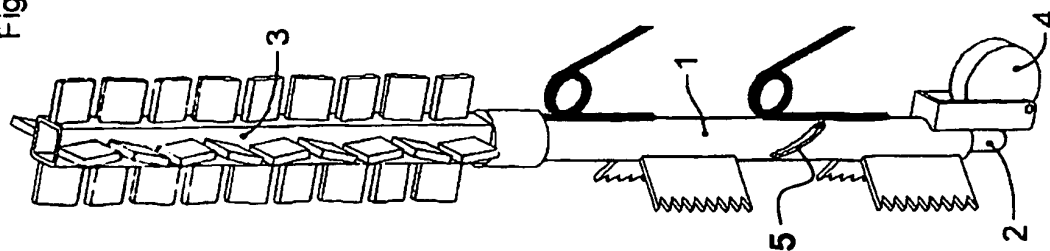


Fig.4

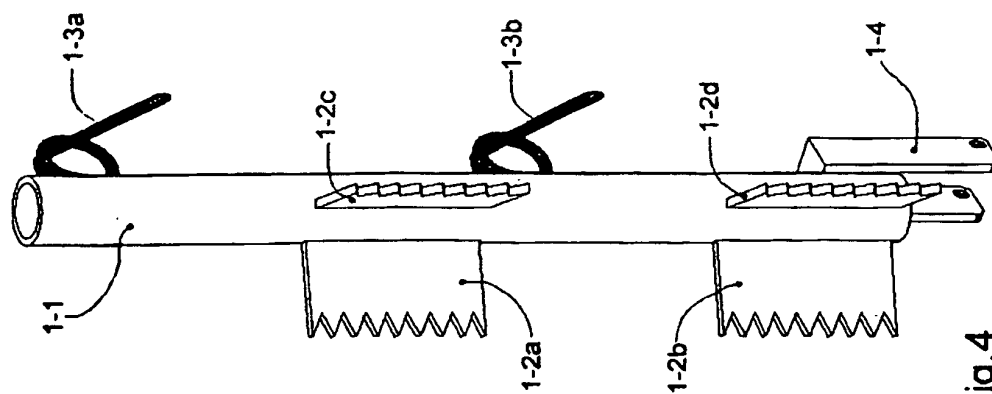


Fig.5

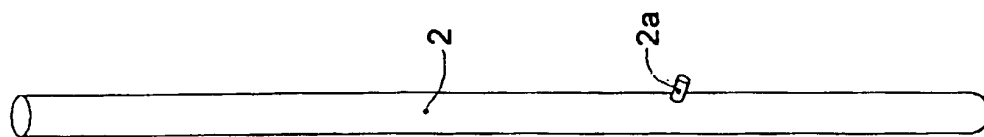
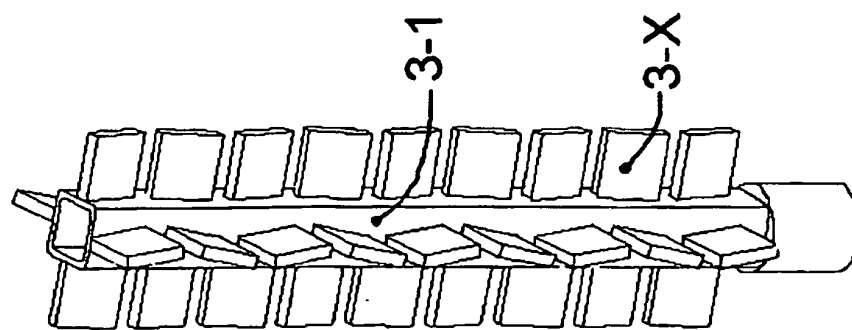


Fig.6



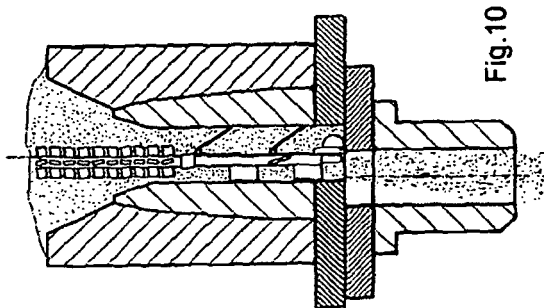


Fig. 10

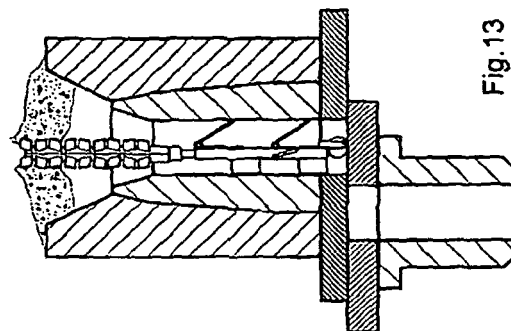


Fig. 13

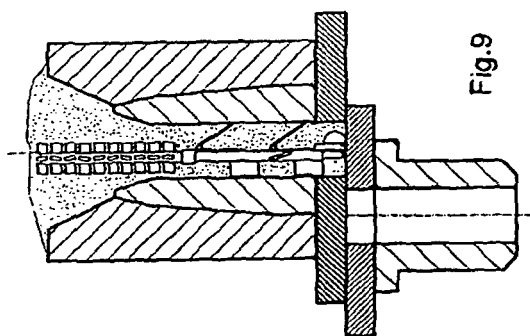


Fig. 9

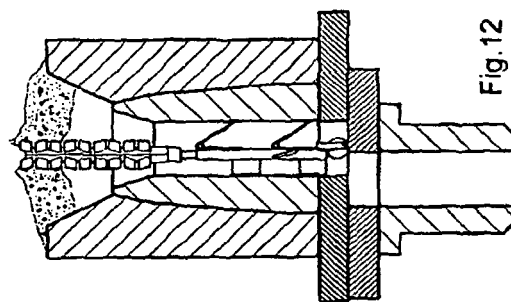


Fig. 12

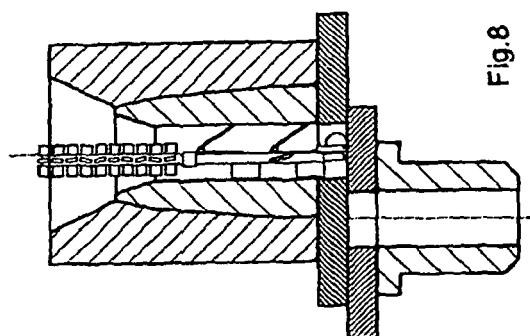


Fig. 8

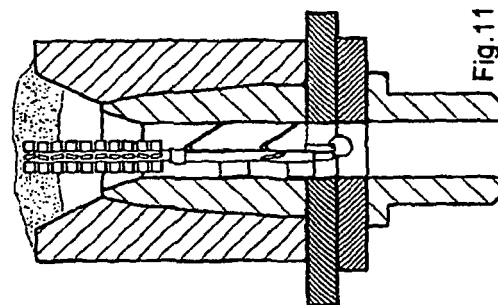


Fig. 11

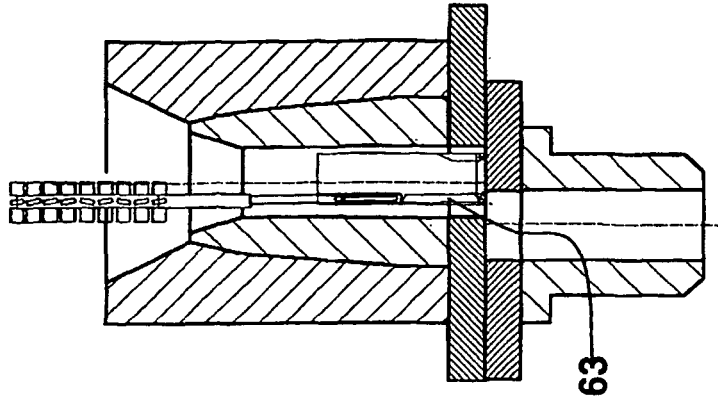


Fig. 16

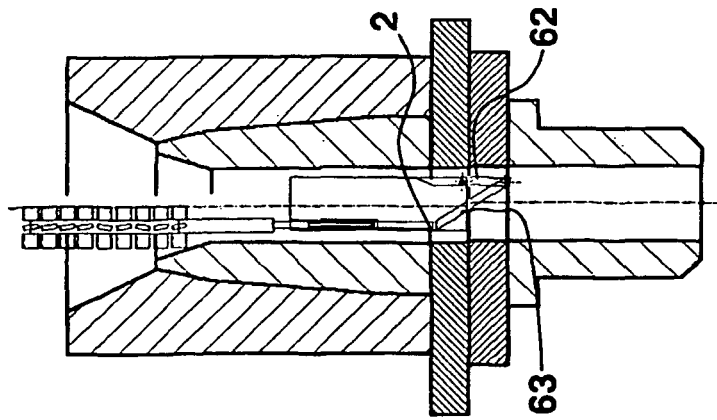


Fig. 15

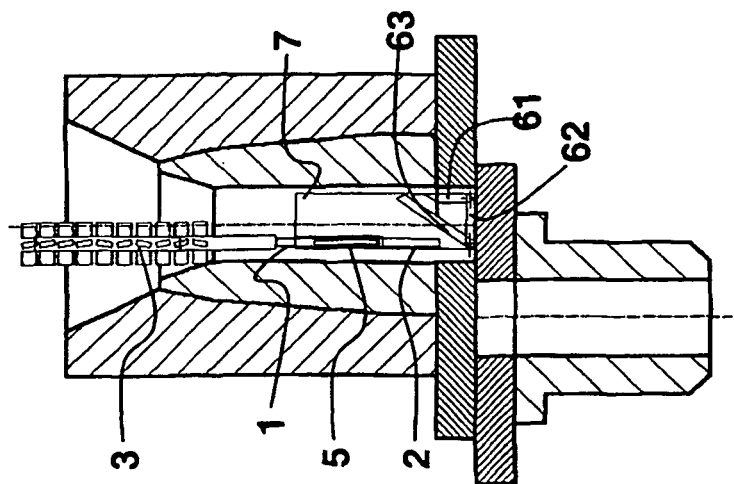


Fig. 14