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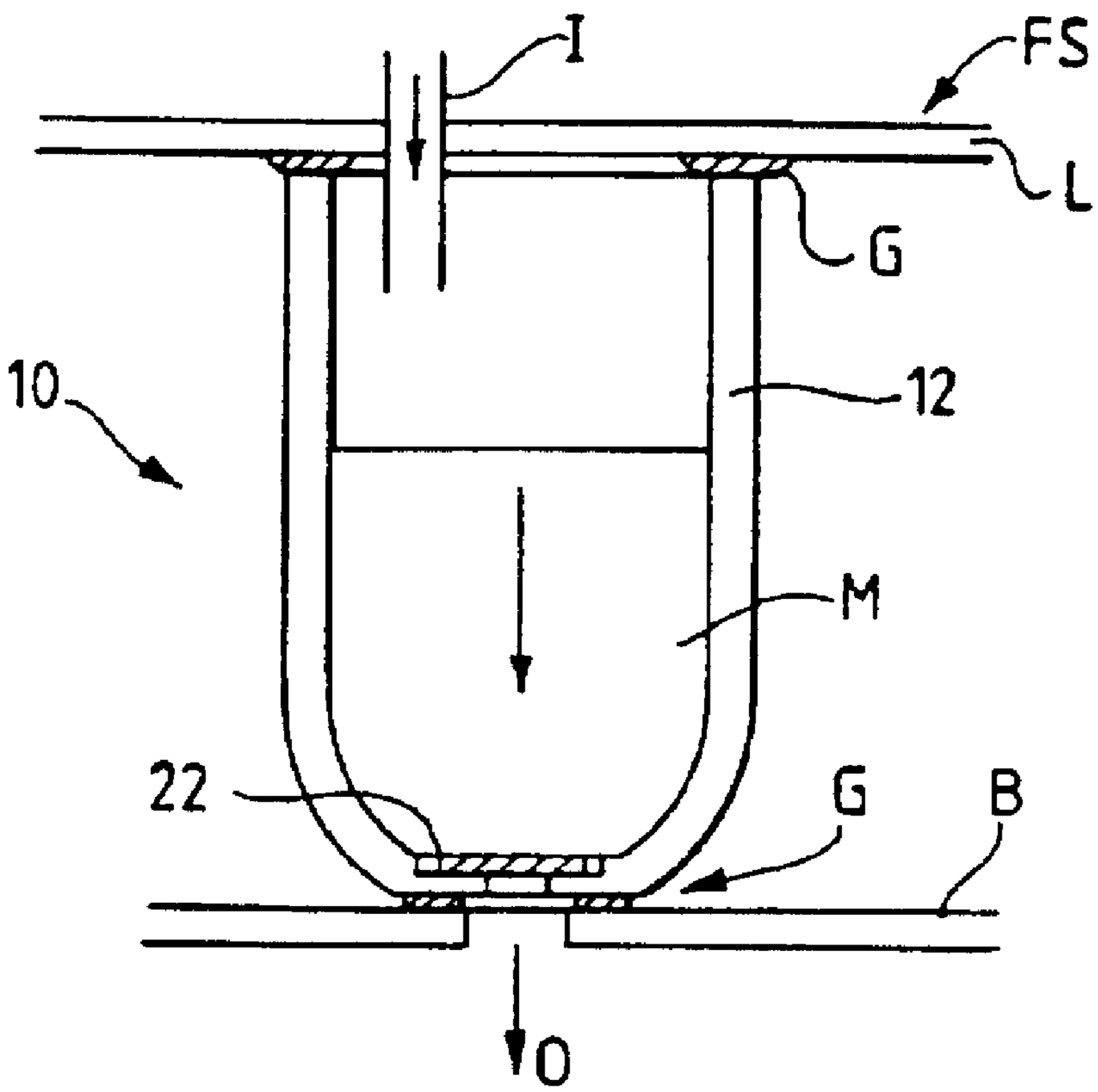
(54) Titre : DISPOSITIF DE FILTRATION POUR METAL FONDU
(54) Title: FILTRATION DEVICE FOR FILTERING MOLTEN METAL



(57) Abrégé/Abstract:
A filtration device for filtering molten metal comprising a body defining a cavity for receiving molten metal, an outlet for the molten metal from the body, and means for holding a filter between the cavity and outlet for concentrating inclusions in the metal in the cavity, characterised in that the body comprises refractory fibrous material. Use of such a filtration device enables the rapid melting of a solid metal sample in the device to form a representative liquid metal sample which can then be filtered.

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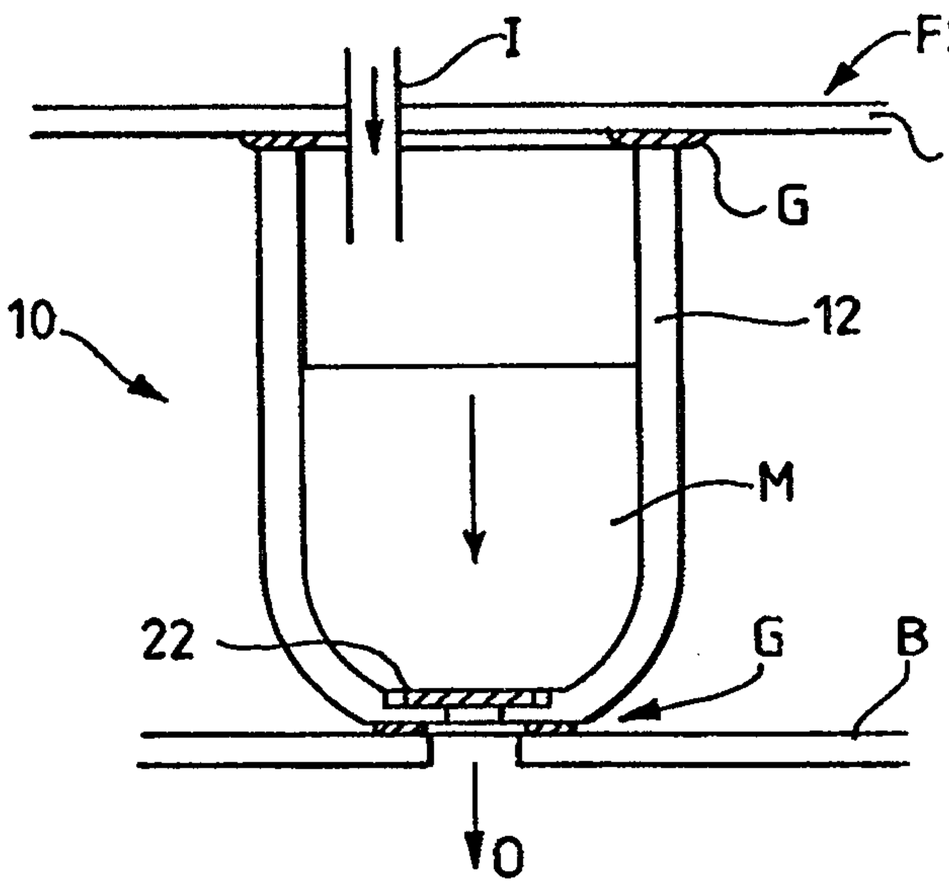
(57) Abstract

A filtration device for filtering molten metal comprising a body defining a cavity for receiving molten metal, an outlet for the molten metal from the body, and means for holding a filter between the cavity and outlet for concentrating inclusions in the metal in the cavity, characterised in that the body comprises refractory fibrous material. Use of such a filtration device enables the rapid melting of a solid metal sample in the device to form a representative liquid metal sample which can then be filtered.



FILTRATION DEVICE FOR FILTERING MOLTEN METAL

The invention relates to a filtration device comprising a sample holder and filter for example for separating inclusions such as oxides and borides from fluids such as molten metal. In particular the invention relates to filtration devices to enable characterisation of molten aluminium.

It is known to provide devices for filtering a sample of molten metal on-line in a foundry. The filtration process allows the molten metal to pass through the device whilst, at any same time, concentrating any inclusions above a filter in the device. By filtering a known quantity of molten metal, it is possible to quantify the concentration of the inclusions present in the foundry process. This quantification can be achieved after filtration for example by optical analysis and quantitative metallography of the inclusions which have built up on the filter surface during filtration.

In such systems, it is known to provide a crucible made of refractory material such as plumbago having a filter in its lower end made of porous graphite, alumina or silicon carbide for example. It is also known to provide an over-pressure above the filter using a pressure chamber or an under-pressure below the filter using a suction tube and reservoir, in order to draw the molten metal through the filter into a catchment container.

Several problems exist in the known systems such as that crucibles made of plumbago

require preheating to a temperature in the order of or above the molten metal temperature prior to filtration and therefore do not lend themselves to easy handling in operation. Preheating is generally carried out in a separate furnace which results in a cumbersome and not fully portable operation. Additionally, it is generally the case that only molten metal samples are processed because of difficulties and inconsistencies associated with remelting previously solidified metal samples since using the procedures of the prior art, it is not possible to guarantee the results of the test. That is, additional impurities are added in remelting, for example if carried out in a first crucible in a furnace before transferring the sample to a heated plumbago crucible.

An object of the invention is therefore to avoid or at least mitigate these problems of the prior art. Accordingly, the invention provides a crucible, for filtering and characterising molten metal, having; a body comprising refractory fibrous material defining a cavity for receiving molten metal, an outlet for the flow of the molten metal from the body, means for holding a filter between the cavity and the outlet, and a filter which operably concentrates inclusions from the metal in the cavity wherein the body and filter each comprise a fluid impermeable layer such as a masked or coated region, adjacent the outlet. Beneficially, the fibrous material can be a ceramic such as alumino-silicate fibres which do not absorb very much energy from the molten metal and therefore do not need to be preheated prior to filtration. Furthermore, because of the degree of thermal insulation provided by these crucibles, there is no radiated heat from their outside surfaces and therefore the filtration unit can be more compact and handled more easily

and conveniently.

To ensure that the pressurising gas does not permeate through the body and base of the fibrous crucible and thereby adversely affect the pressurising of the molten metal through the filter, the body comprises an air impermeable layer such as a masked or coated region. This mask or coating should be thick enough to prevent gas leakage and preferably extend at least across the base of the crucible such as to form a complete fillet at the junction between the filter and the base of the body of the crucible and possibly for some distance up the outside edges, or at least to a point beyond any gasket adjacent the base of the crucible. The coating is preferably thin enough and of a material such that it does not crack during drying and generally provides an impermeable and continuous surface layer. A layer in the order of or less than 1 mm thick of diluted Fraxbond™ is preferred.

The thermally insulating' and non-electrically conducting nature of the crucibles can be used to enable the rapid induction melting of a solid metal sample (charge) in the crucible to form a representative liquid metal sample which can then be pressure filtered. It is preferable to provide a lid to the system in order to physically confine the charge during melting and to control the degree of turbulence in the system caused by the electro magnetic forces generated in the melting cycle.

The advantage of such a confined rapid melting procedure is that the quality of the sample with respect to oxide films and other solid inclusions in the metal is not changed significantly during the remelting process and therefore the inclusion measurements after remelting a solid charge are essentially the same as measurements taken from an initially liquid charge taken from the same starting metal. Also, the temperature control in the system is very good because of the low heat capacity of the crucible.

The invention also provides a filter for inhibiting the flow of inclusions in a molten metal passing through the filter thereby to enable characterisation of the molten metal, comprising a first surface which operable contacts the molten metal and has an active region which operably allows flow of molten metal through the filter, and a second surface having an active region through which molten metal leaves the filter and wherein the active regions of both the first and second surfaces are defined by masks, and are unfinished.

The filter can comprise for example, alumina granules, preferably bonded with silicon carbide or sintered metal wherein preferably the surfaces of the filter which contact the filtration material in use are unfinished and not ground. Such a filter is preferably included in a container according to the earlier aspect of the invention. An aspect of the invention therefore provides a filtration device comprising a crucible and a filter according to the other aspects of the invention.

A yet further aspect of the invention provides a method of making a filtration device comprising the steps of separating inclusions from molten metals, comprising the step of fabricating a body of refractory fibrous material, defining a cavity for the molten metal and also an outlet therefor, forming means within the body for holding a filter, fixing a filter in the holding means using an adhesive, sealing the body adjacent the outlet thereby to inhibit flow of fluids, such as air, through the body, and temporarily masking an active region of the filter while applying a film to the filter, thereby operably to allow molten metal to flow through the active area but not the film.

Embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings in which;

Figure 1 is a schematic plan view from above a filtration device according to the invention;

Figure 2 is a schematic, cross-sectional, side elevation view of the device shown in figure 1 fitted in part of a filtration system;

Figure 3 is a plan view from below of the device shown in figures 1 and 2; and

Figure 4 is a cross-sectional view of the lower end of the device shown in figures 1, 2 and 3.

A filtration device 10 according to the invention is shown in drawings 1 to 4 comprising a crucible 12 having an open upper end and a lower end 14 containing a relatively narrower outlet 19. The inner surface of lower region 14 comprises a relatively large aperture 16 whilst the outer surface comprises a narrower aperture 18 which define the outlet 10 from the crucible 12. Additionally, the apertures provide a recess region comprising an annular ledge 20 on which a filter 22 can be placed thereby presenting a first surface 24 to the inside of crucible 12 and a second surface 26 to the outlet-side. Filter 22 can be held in position in aperture 16 using a refractory cement 28, preferably Fraxbond™, which is available from Carborundum Corporation, is used.

Additionally, the inner edges of the filter are sealed to prevent flow of molten metal around the filter. A film 30 is applied to the inner surface of crucible 12. The film should be a refractory material impermeable to the molten metal such as aluminium under pressure and preferably contains flake or platelets together with refractory cement. Preferred materials contain mica or kaolin and one such material is micawash™ available from Microfme Minerals Limited.

Beneficially, as well as masking the edge regions of filter 22 to prevent flow of molten metal around the filter, the film 30 enables the active area of filtration of surface 24 to be masked off to a desired shape, such as circular, and size.

Furthermore, a lowermost film 32 is used to mask the lower region 14 of crucible 12 thereby restricting movement of fluid such as air through the bottom end of the crucible. This film should be continuous and extend at least across the base and possibly part way up the side walls. It should form a complete fillet at the junction with the filter 22. The film 32 can extend over the lower radius of the crucible to a point 32o shown in figure 4, thereby restricting any downward flow of gas through the base 14 of crucible 12. Preferably film 32 is made of diluted Fraxbond™.

Preferably, the crucible is made of a fibrous refractory material such as alumino-silicate. A preferred material is procal™ available from Foseco since it is inert to molten aluminium and iron and has a very low thermal conductivity and low heat capacity.

Such material provides a crucible which is readily manually handleable (albeit preferably with gloves) even when full of molten metal at temperatures up to 1000°C.

To form a crucible according to the invention, the alumino-silicate fibres are preferably bonded with an organic binder, moulded into shape and fired to fix or remove the organic binder. The crucible is then dipped to impregnate it with a rigidizer such as sodium silicate and fired in order to give it sufficient mechanical strength in use such as to support the molten metal and facilitate manual handling before and after the filtration process.

In a preferred form the filter comprises alumina granules, or girconia granules, bonded with silica, or silicon carbide, or sintered metal such as stainless steel. Preferably the filter surfaces 24 and 26 are unfinished and not ground since this is found to enhance consistency of flow characteristics. The use of the above materials for the filter and crucible is beneficial not least since one or more of the materials is inert with respect to aluminium, magnesium, iron and nickel based materials. Accordingly, molten metals consisting mainly of these elements can be filtered using the present devices. Preferably the average pore size in the filter is between 50 and 200 micrometres (μm) and more preferably in the order of 90 micrometres (μm).

Referring to figure 2, it can be seen that in use the device can be inserted into a filtration system FS comprising upper lid L, base B and gaskets G positioned against

the upper and lower ends of crucible 12. The gaskets can be attached to the crucible for example by using an adhesive paste. Accordingly, lowermost gasket G can be added at the time of forming film 32. Molten metal may then be added to crucible 12 or alternatively a solidified sample within a crucible 12 can be heated to a desired temperature using an induction coil heater, before allowing the metal M to pass through filter 22 through outlet O of system FS. In the event that an overpressure is used to effect filtration, fluid communication to a compressor can be provided via an inlet I. In the event that molten metal is drawn through filter 22 by an under pressure, inlet I acts as a vent to equalise pressure above the molten metal M within the crucible 12.

Additionally, especially if for example the upper end of crucible 12 is sealed against a gasket during filtration, it is possible to provide an aperture or apertures in the upper wall of the crucible to allow fluid flow into the crucible.

In order to form a filtration device according to the invention from basic materials, it is possible to manufacture a crucible 12 as described above or purchase a procal™ 6 crucible from Foseco, i.e. a crucible consisting principally of alumino silicate fibre and silica, and to manufacture a filter as described above. A clean crucible without any internal or external cracks should be used wherein ledge 20 in the base area should be formed and preferably made flat. Cement such as Fraxbond™ 715 should then be added to aperture 16 for fixing the filter in place. For uniform results the filter and the

orientation thereof should be made consistent. Excess cement should be removed from around the filter such as in aperture 18 and no bubbles should be present since this can lead to failure after drying. Region 28 of cement should fill the gap between the filter 22 and crucible 12 without unduly covering too much of the filter. The crucible should then be left to dry, for example for 2 hours at ambient temperature. Lower film 32 can then be added using an air impermeable paste such as Fraxbond™ 715 with 10 per cent water which is painted on the base of the crucible and allowed to dry. The masking surface 30 can then be painted on the inside of crucible 12 using for example one part Mica mixed with three parts water. The inner surface of crucible 12 should be painted together with the adhesive region 28. Preferably a stencil is placed over the centre of filter 22 to prevent painting the wash over the central region of the filter. The crucible should then be left to dry at ambient conditions prior to inspection followed by an oven-drying process at 150°C for half an hour. The method according to the invention includes a method of forming a filtration device comprising any one of the above steps or any combination of the individual steps.

CLAIMS:

1. A filter for inhibiting the flow of inclusions in a molten metal passing through the filter thereby to enable characterisation of the molten metal, comprising a first surface which operably contacts the molten metal and has an active region which operably allows flow of molten metal through the filter, and a second surface having an active region through which molten metal leaves the filter and wherein the active regions of both the first and second surfaces are unfinished and are defined by masks, inhibiting fluid flow between said surfaces.

2. A filter according to claim 1 wherein the active region(s) is (are) underground.

3. A filter according to any one of claims 1 and 2 wherein the mask on the first surface comprises a film impermeable to the molten metal.

4. A filter according to claim 3 wherein the film comprises platelet material.

5. A filter according to claim 4 wherein the platelet material is mica or kaolin.

6. A filter according to any one of claims 1 to 5 wherein the active region of the second surface is defined by a mask comprising a film or fluid impermeable material.

7. A filter according to claim 6 wherein the impermeable material is refractory cement or glue.

8. A filter according to claim 7 wherein the refractory cement or glue is Flaxbond™.

9. A filter according to any one of claims 1 to 8 comprising sintered granules.

10. A filter according to claim 9 wherein the sintered granules are alumina, zirconia, metal or sintered metal.

11. A filter according to any one of claims 1 to 8 comprising a granule bonding agent.

12. A filter according to claim 11 wherein the granule bonding agent is silica.

13. A filter according to any one of claims 1 to 12 wherein the average pore size is in the region of 50 to 200 (microns).

14. A filter according to claim 13 wherein the average pore size is 90 (microns).

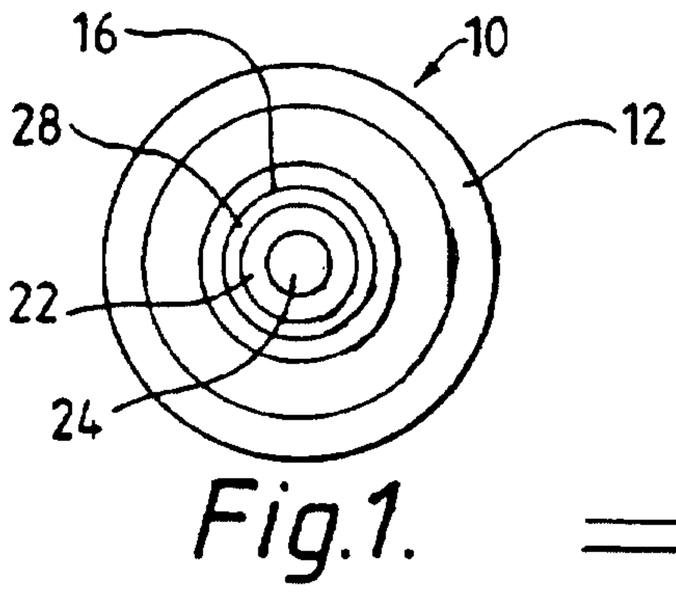


Fig.1.

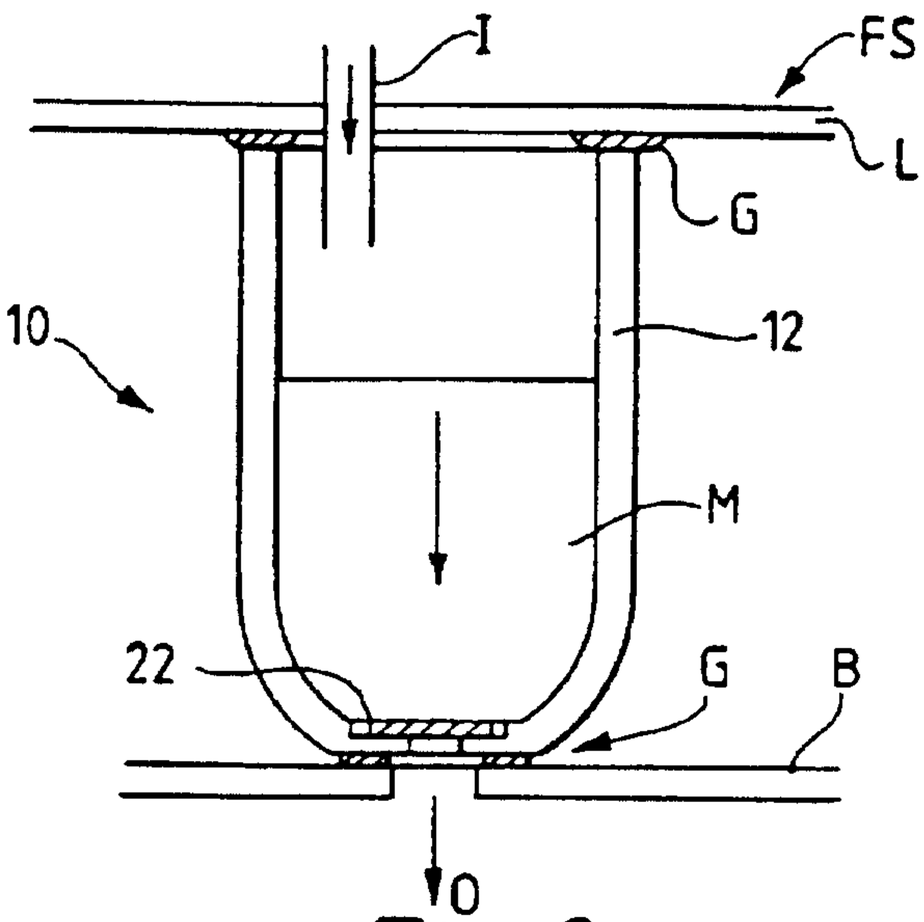


Fig.2.

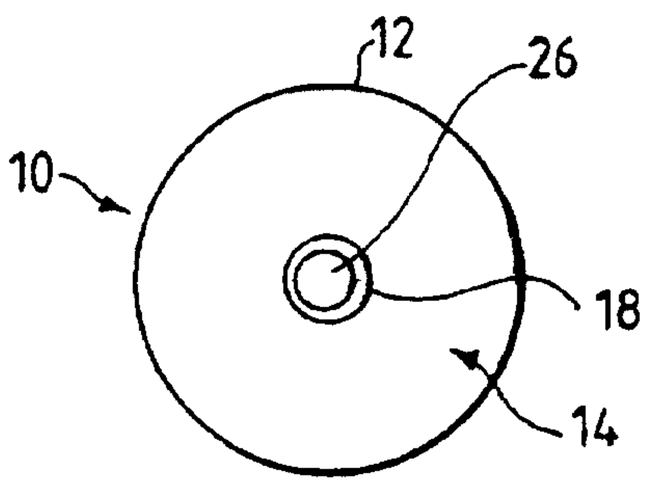


Fig.3.

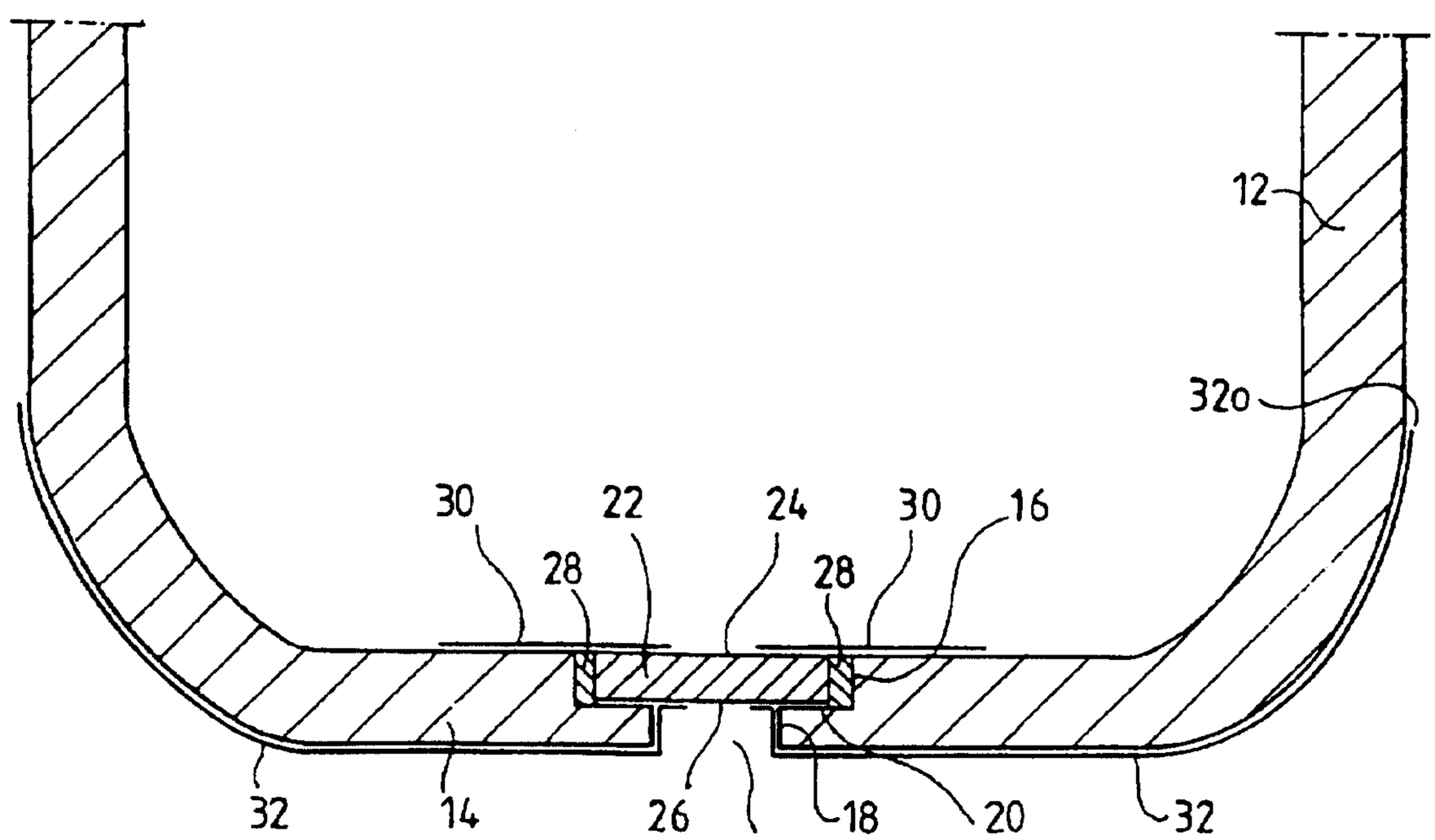
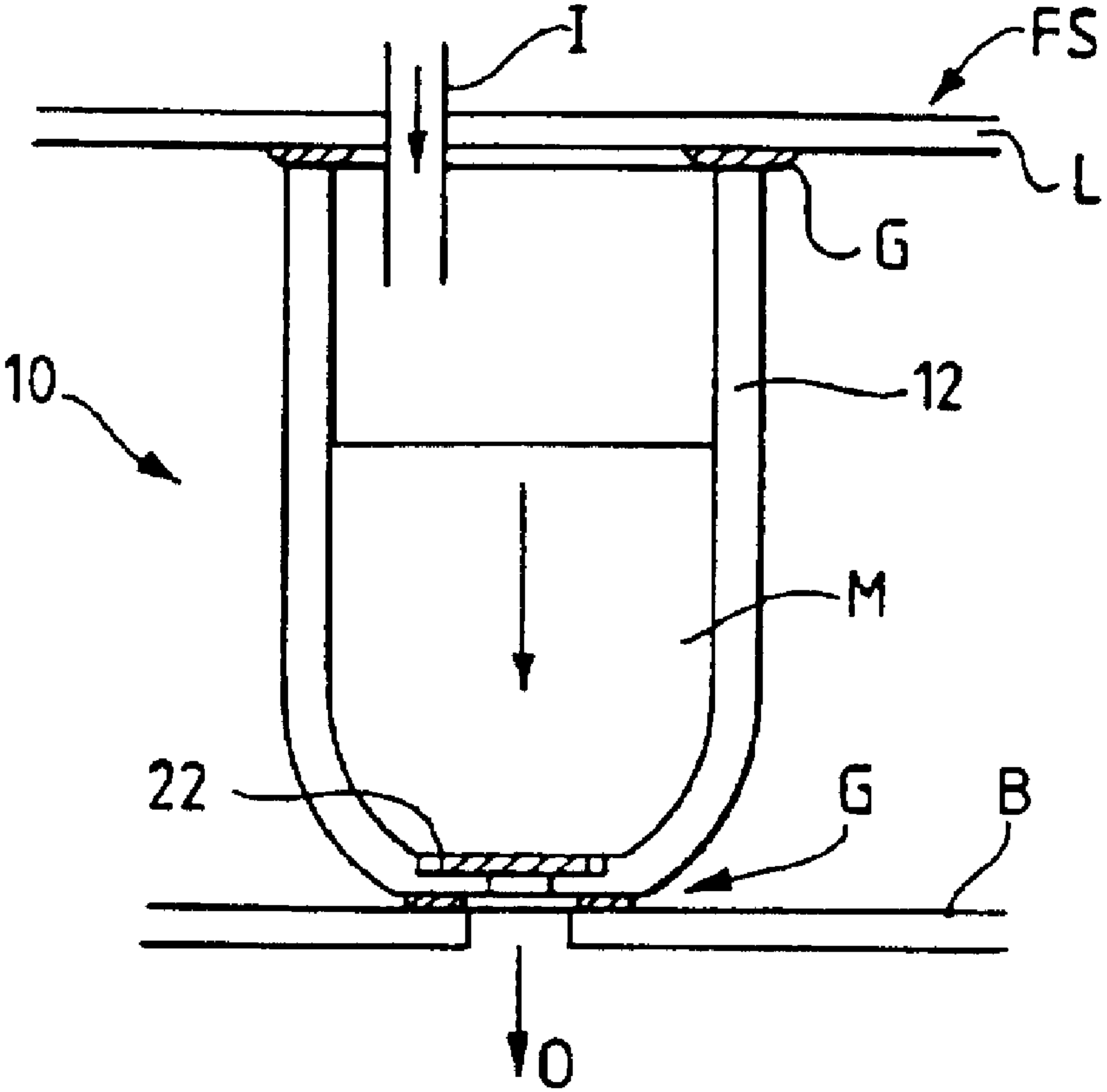


Fig.4.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