United States Patent [19]

Le Moyne

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[54] **POURING VESSEL-CAISSON FOR TREATING MOLTEN METAL IN A REGULATED ATMOSPHERE**

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[52] **U.S. Cl.** ..... **266/34 V,** 266/34 T, 266/38

[51] **Int. Cl.** **C21c 7/10**

[58] **Field of Search** ..... 75/49, 59; 164/61, 164/256; 222/7, 12, 13, 15; 266/34 A, 34 T, 34 PP, 34 V, 38

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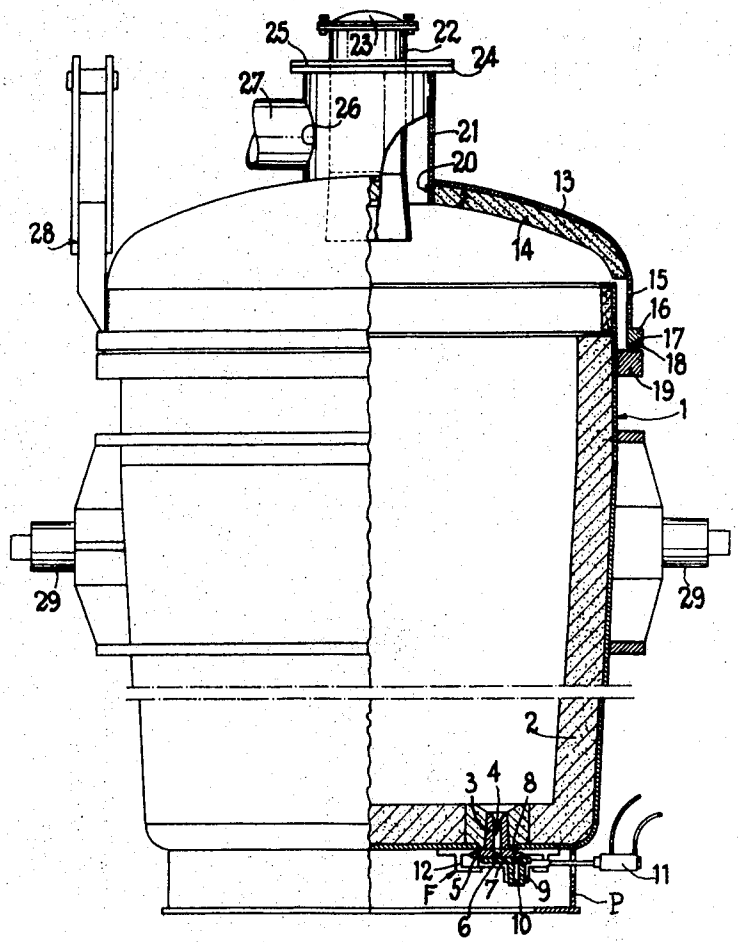
Attorney—Irving M. Weiner

[57] **ABSTRACT**

Combined pouring vessel and caisson for treating molten metal in a regulated atmosphere comprising a vessel having a bottom molten metal outlet controlled by sliding closing means and a cover adapted to be sealingly engaged on the upper end of the vessel. Means are associated with said cover for regulating the atmosphere inside the vessel.

1 Claim, 3 Drawing Figures



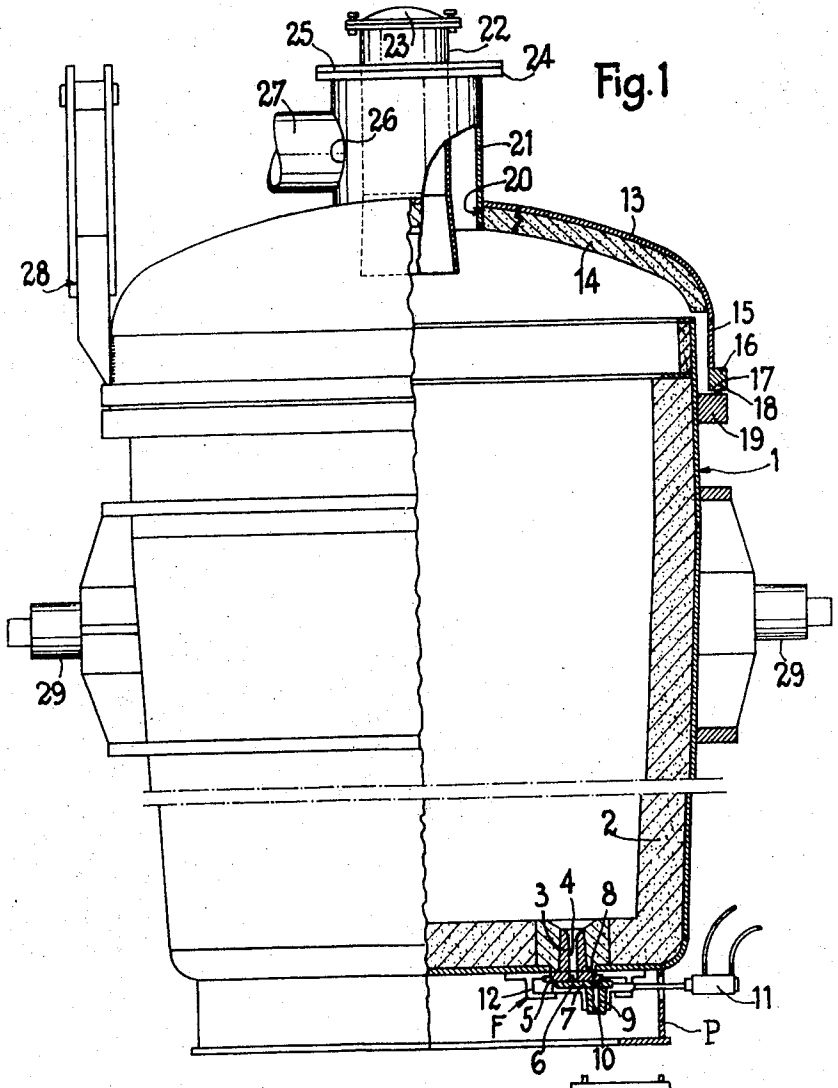

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Fig. 1

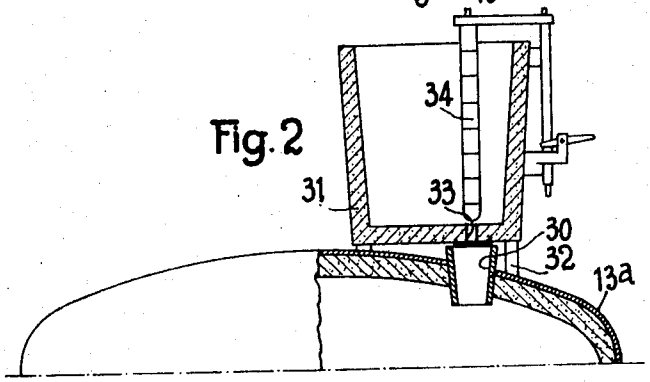
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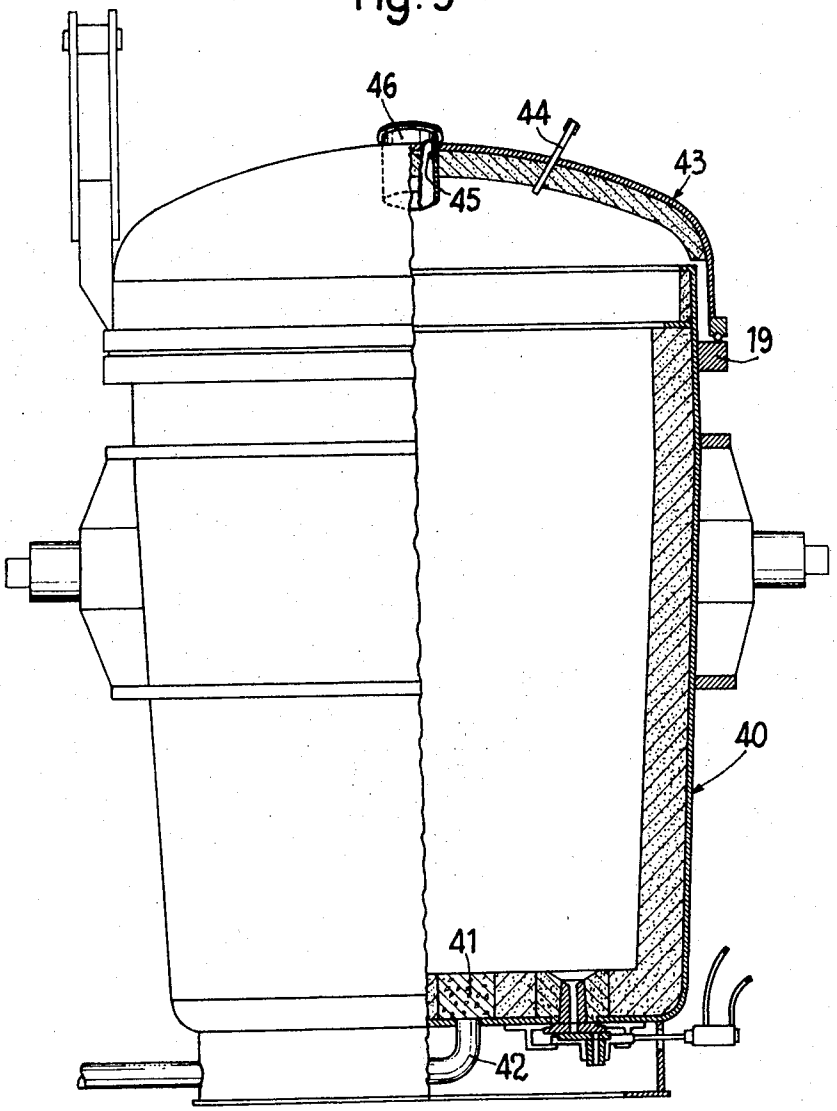
Fig. 2

Fig. 3



POURING VESSEL-CAISSON FOR TREATING MOLTEN METAL IN A REGULATED ATMOSPHERE

The present invention relates to pouring vessels and caissons for treating metals in a regulated atmosphere.

The conventional method for treating in a vacuum in a pouring vessel or ladle a molten metal and more particularly molten steel, comprises placing in a caisson a pouring vessel or ladle usually equipped with a conventional stopper-rod closing system. The caisson is then closed in a fluidtight manner and a vacuum is created in the caisson by means of a suitable pumping system.

Owing to the presence of this caisson the volume of air to be evacuated so as to create the vacuum is very large and requires powerful pumping means. Moreover, during the treatment in the caisson, the stopper-rod of the pouring vessel is subjected to very severe mechanical and chemical stresses so that safety of operation is not fully satisfactory.

Further, the mixing or stirring of steel in the ladle or vessel affords a number of advantages the most important of which is homogeneization of the temperature, homogeneization of the chemical composition, reduction in the content of non-metallic inclusions and the possibility of effecting large additions of ferro-alloys in the vessel.

The efficiency of the mixing, which can be effected pneumatically (injection of an inert gas) or electrically (by induction), depends on its intensity. In the treatment in a vacuum in a pouring vessel, bearing in mind that the work is carried out remote from air, it is possible to effect the mixing at very high intensity since the risk of contamination of the metal by the oxygen of the air no longer exists, but at atmospheric pressure, in the absence of suitable protection against the action of the air, it is very difficult, if not impossible, to bring into action an intense mixing of the metal owing to the danger of the repeated contact of the metal with the surrounding air. It is then necessary to adopt a compromise, that is, to operate with a relatively low intensity of mixing whose efficiency can be no more than poor.

An object of the invention is to provide a pouring vessel whereby it is possible to proceed directly to the treatment in a vacuum in the vessel without placing the vessel in a caisson but with complete operational safety.

Another object of the invention is to provide a pouring vessel whereby it is possible to mix the metal intensely at atmospheric pressure while affording an almost total protection of the metal against the oxygen of the air by providing a regulated atmosphere above the metal.

The invention provides a pouring vessel-caisson for treating molten metal in a regulated atmosphere, comprising a pouring vessel for receiving the molten metal and comprising in the bottom thereof an orifice for the outlet of the metal which is provided with a slidable orifice-closing device, means on the outer wall of the vessel for receiving a cover which surrounds the upper edge of the vessel in the closing position, means for affording a seal between the vessel and the cover when the latter is placed on the receiving means, and means associated with the cover for regulating the atmosphere inside the vessel.

In one embodiment of the invention, the means for regulating the atmosphere in the vessel comprise an orifice formed in the cover and a system of conduits for connecting said orifice to a source of vacuum.

In another embodiment of the invention, the means for regulating the atmosphere in the vessel comprise a first orifice in the cover, a system of conduits for connecting said orifice to a source of inert gas, and at least one second orifice in the cover for discharging the gas from the vessel.

Further features and advantages of the invention will be apparent from the ensuing description with reference to the accompanying drawings.

In the drawings:

FIG. 1 is an elevational view, with a part in section, of one embodiment of the pouring vessel-caisson according to the invention more particularly adapted for the treatment of metal in a vacuum;

FIG. 2 is a sectional view of a part of the cover of the vessel shown in FIG. 1 with means for introducing molten metal and removing gas from the jet or stream in a vacuum, and

FIG. 3 is a view similar to FIG. 1 of another embodiment of the pouring vessel more particularly adapted for mixing molten metals in an inert atmosphere.

With reference more particularly to the embodiment shown in FIGS. 1 and 2, which is more particularly intended for treating molten metals in a vacuum, in particular for removing gas therefrom, the illustrated pouring vessel-caisson comprises a circular pouring vessel or ladle 1 receiving the molten metal and comprising an inner lining 2, of refractory material (refractory bricks, refractory clay or pise).

Placed in the bottom of the vessel is a metal-discharging device of the type having a slidable closing means generally designated by the reference character F. Any type of known sliding closing means can be employed in the embodiment according to the invention. The device shown in FIG. 1 comprises a nozzle 3 placed in the bottom of the vessel with an outlet orifice 4. This nozzle terminates outside the vessel in a slab 5 of refractory material provided with an aperture 6 corresponding to the orifice 4 of the nozzle. Another slab 7 of refractory material provided with an aperture 8 and on which is secured a second nozzle 9 having a discharge orifice 10 which corresponds to the aperture 8 is applied against the slab 5. The assembly comprising the slab 7 and the nozzle 9 constitutes a closure member and can be shifted by sliding the assembly on the slab 5 by means of a fluid motor 11. The assembly is guided by a case or housing 12 in this movement.

When the apertures 6 and 8 of the two slabs are in alignment with each other, the liquid flows out of the pouring vessel by way of the nozzles 3 and 9. When they are not in alignment, the metal can no longer leave the vessel 1.

The pouring vessel 1 is supported by an annular stand P.

The pouring vessel-caisson further comprises a cover 13 provided internally with a layer or lining 14 of refractory clay or pise, the circular peripheral marginal portion 15 of which is formed over in such manner as to surround the upper part of the vessel when the cover is in position.

A flange 16 is mounted on the end of the marginal portion 15 of the cover and includes a circular groove 17 in which is placed a rubber sealing ring 18 which resists the thermal and mechanical conditions of operation of the pouring vessel.

A complementary flange **19**, having a preferably plane upper face, is secured to the outside of the wall of the vessel and the cover **13** bears on the flange **19** through the ring **18** when it is in its closing position. The assembly comprising the pouring vessel and the cover is in this way rendered fluidtight.

An aperture **20** is provided in the cover into which extends an end of a tubular element **21** in which is mounted in coaxial relation a tube **22** which is hermetically closed in its upper part by a removable cap **23**. The other end of the tubular element **21** has a flange **24** to which is secured a plate **25** provided with a centre aperture for the passage of the tube **22** which is secured thereto in a fluidtight manner. The function of the tube **22** is to enable the introduction, if desired, of alloying elements in the molten metal without need to remove the cover.

The tubular element **21** has a lateral aperture **26** in which is welded the end of another tube **27** connected to a source of vacuum (not shown).

A holding device **28** is welded to the edge **15** of the cover whereby it is possible to remove the cover by means of an overhead crane or other suitable hoisting device.

The pouring vessel is also provided with two diametrally opposed trunnions **29** of conventional type whereby it is possible to raise the pouring vessel by means of a hoisting device.

The pouring vessel-caisson shown in FIG. **1** operates in the following manner:

When the molten metal is placed in the vessel, the device F being in the closing position, the cover **13**^{a} is placed on the flange **19**. The vacuum creating apparatus is then connected and the metal is treated in the usual manner.

At the end of this treatment the vacuum is removed, the sealing cover is withdrawn, and the pouring vessel is placed over ingot casting devices or on a continuous casting machine and the device F is put in the opening position so as to allow the metal to pour out of the vessel.

FIG. **2** shows a modification of the cover which is designed for removing gas from the jet or stream of molten metal. For this manner of proceeding the cover **13**^{a} is provided with a conduit **30** extending therethrough above which is disposed in a fluidtight manner a small container **31** carried by feet **32** which are welded or otherwise secured to the cover **13**^{a}. The bottom of the container **31** has an outlet orifice **33** which may be closed by a conventional stopper-rod device **34**. The function of the container **31** is to provide a seal between the vacuum in the vessel **1** and the stream of metal issuing from the metal melting apparatus (not shown).

The operation is carried out in the following manner:

When the container **31** is empty, the seal between the jet concentrator **30** and the orifice **33** is afforded by a disc of aluminium. With the stopper-rod **34** lowered, the molten metal is poured into the container **31**. Thereafter, the stopper-rod is raised, the metal melts the aluminium disc and enters the pouring vessel **1** by way of the conduit **30**. The stream of metal has gas removed therefrom during its descent under the effect of the vacuum prevailing in the pouring vessel-caisson in the known manner.

Owing to the absence of a stopper-rod for the outlet orifice of the pouring vessel **1** and of the corresponding control device, the sealing cover can be very easily placed on the pouring vessel filled with metal, whereas in the case of a pouring vessel having a stopper-rod the cover is placed in position with much difficulty and at the expense of serious technical complications.

The pouring vessel-caisson according to the invention affords the following advantages over the conventional means and method:

1. The construction of the treating system is much cheaper owing in particular to the absence of the caisson and to a considerable reduction in the required power of the pumping means (a smaller volume is put under vacuum).

2. Lower running costs owing to a considerable reduction in the consumption of fluids employed for creating the vacuum (water, steam).

3. Much safer operation.

The pouring vessel can have any suitable general shape and any capacity.

FIG. **3** shows a pouring vessel-caisson particularly intended for mixing metal at atmospheric pressure by the bubbling of inert gas therethrough. The pouring vessel **40** is similar to the vessel **1** shown in FIG. **1**. It comprises in its bottom a pourous element **41** (for example porous brick) for introducing into the pouring vessel an inert gas (for example argon or nitrogen) which passes through the molten metal and causes a mixing thereof. This porous element is supplied with inert gas from a source (not shown) by way of a conduit **42**. This device is conventional.

The cover **43** has extending therethrough a tube **44** for supplying inert gas from a source (not shown) instead of being provided with orifices and conduits **20–27** in the embodiment shown in FIG. **1**. Preferably, the same gas as that for mixing is employed. The cover also comprises an outlet orifice **45** (preferably of large diameter) in which is secured a short tubular element **46** for discharging the gases contained in the pouring vessel. If it is desired, several vent holes **45** may also be provided. The cover may also include if desired a device for supplying alloying elements, as shown in FIG. **1**.

A seal is provided between the cover and the pouring vessel in the manner described with respect to the embodiment shown in FIG. **1**.

The mixing operation with the pouring vessel-caisson shown in FIG. **3** is carried out in the following manner:

1. When the pouring vessel is full of molten metal, the cover **43** is placed on the flange **19** of the vessel **40**.

2. The gas supply pipe **44** is connected to the source of argon or nitrogen and either of these gases is supplied under the cover. The reduction of the oxygen content of the atmosphere in contact with the metal occurs by dilution, the oxygen of the air initially contained under the cover being little by little evacuated by way of the pipe **46**. After having injected within a few minutes a volume of inert gas equal to about 4 times the volume of air under the cover, the atmosphere is rarified to about 4 percent of oxygen and, as no more oxygen is supplied, the very small amount of oxygen present above the bath of molten metal will be of no harm to the metal in the course of mixing.

3. As soon as this reduction in the oxygen content has been achieved, the supply of inert gas by way of the pipe **44** is stopped and the intense mixing of the metal by injection of argon (or nitrogen) into the metal mass through the porous element **41** is started. It must be

stressed that the gas which is employed for the mixing and escapes from the metal, maintains a slight overpressure above the metal and consequently there is no possibility of entrance of parasitic air through the pipe **46.** Consequently, assuming a rarified atmosphere having 4 percent of oxygen, as previously obtained, a simple calculation shows that the possible addition of oxygen to the metal is less than 0.0008 percent so that risk of contamination by oxygen can be considered as negligible. If the metal is mixed by electrical means, the device supplying inert gas **41, 42** is dispensed with and replaced by known agitating means acting by induction. It is necessary to maintain during the mixing a slight supply of inert gas by way of the pipe **44** so as to maintain a slight overpressure under the cover.

As the closure of the pouring vessel **40** is not controlled by a stopper device it is possible when the pouring vessel is full of molten metal to cover it and ensure an excellent seal between the latter and the pouring vessel.

Having now described my invention what I claim and desire to secure by Letters Patent is:

1. A pouring vessel-caisson for treating molten metal in a regulated atmosphere, comprising a pouring vessel for receiving the molten metal, said vessel having an outer wall including an upper edge portion, means defining an orifice in the bottom of said vessel for the outlet of said metal, a slidable closing device for closing said orifice, a cover which surrounds said upper edge portion in a closing position of said cover, receiving means on said outer wall for receiving said cover in said closing position, means for affording a seal between the vessel and the cover when said cover is placed on said receiving means, and means associated with said cover for regulating the atmosphere inside said vessel, said means for regulating the atmosphere comprising means defining an orifice in said cover and conduit means for connecting said orifice to a source of vacuum, said conduit means including a tubular element connected directly to said orifice, said pouring vessel-caisson further comprising a device for introducing alloying elements in said metal comprising a tube located within said tubular element and having an outlet end communicating with said orifice and an inlet end for receiving said alloying elements and removable means for closing said inlet end of said tube.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,764,124 Dated October 9, 1973

Inventor(x) Andre LeMoyne

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the title page at [73] change "Siderwigique" to --Siderurgique--.

Signed and sealed this 1st day of October 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents