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(71) Applicant: **FOSECO INTERNATIONAL LIMITED, 285 Long Acre, Nechells Birmingham B7 5JR (GB)**

(72) Inventor: **Barnes, Andrew, 6 Castle Hall Glascote, Tamworth Staffordshire (GB)**
Inventor: **Flood, James, 4 Lomax Close, Lichfield Staffordshire (GB)**

(74) Representative: **Warman, Charles Alfred, Group Patents Department Foseco Minsep International Limited 285 Long Acre, Nechells Birmingham B7 5JR (GB)**

(54) Containers for molten metal.

(57) Containers for molten metal having a permanent refractory lining and a molten metal contacting inner lining have in at least one place, separating the permanent and inner linings a layer substantially consisting of heat-carbonisable sheet material. The sheet material carbonises during use to yield a carbonaceous parting layer which facilitates removal of skull and the inner lining without damage to the permanent lining.

CONTAINERS FOR MOLTEN METAL

The invention concerns the lining of containers for molten metal.

Containers for molten metal commonly comprise a metal casing lined with refractory brickwork or a monolithic refractory lining and this lining is often termed the permanent lining. The permanent lining is subject to damage and is expensive and time-consuming to repair or replace. In particular, after use, a residue (skull) of solidified molten metal and slag may adhere to the lining, and require removal before re-use of the container, and may be difficult to remove and its removal may damage the lining.

In view of the above problems, it has been proposed to protect the permanent lining by an inner layer or layers, which may also serve other purposes. In particular U.K. patent specification 1477632 discloses application of two layers over the permanent lining. The first layer is a parting layer comprising particulate carbonaceous material e.g. coke dust and is free or substantially free of

permanent binding agent. The first layer may be applied as a liquid or paste composition by, for example, spraying or trowelling. The second, i.e. inner, layer is of bonded particulate refractory material and may be applied by, for example, trowelling on a coating composition. The combination of the two layers protects the permanent lining and in particular enables clean stripping of skull e.g. from a tundish without damage to the permanent lining. The layers are re-applied before each re-use of the container.

According to the present invention a container for molten metal has a permanent refractory lining, an inner, refractory lining and, in at least one place separating the permanent and inner linings, a layer substantially consisting of heat-carbonisable sheet material.

When the container contains molten metal, sufficient heat is conducted from the metal through the inner lining to the sheet material to carbonise the latter to yield a carbonaceous residue. Alternatively, the inner lining may be pre-heated before molten metal in introduced into the container and pre-heating may suffice to carbonise the sheet material to yield a carbonaceous residue. The carbonaceous residue provides a valuable

parting layer facilitating removal of skull and the inner lining and without damage to the permanent lining.

The heat-carbonisable sheet material may be, for example, newsprint, kraft paper, cardboard (e.g. laminated corrugated cardboard), wallpaper, hessian, straw matting or woven polyethylene or polypropylene.

The heat-carbonisable sheet material is flexible and this is of value in positioning it as desired, especially if the permanent lining has irregularities at its surface e.g. cavities or areas of adhering extraneous matter. Moreover suitable sheet materials are available as large pieces and can easily be cut to size. Accordingly the layer of heat-carbonisable sheet material can be provided quickly and easily. To hold the sheet material against the permanent lining before the inner lining is applied, clips or an adhesive can be used if desired, for example at places where the permanent lining is generally upright and if the sheet material is very flexible e.g. newsprint rather than less flexible e.g. cardboard. In the case of newsprint even water will provide sufficient adhesion and in general a variety of widely available inexpensive adhesives e.g. starch-based ones are suitable.

If the sheet material used is thin e.g. newsprint it may be desirable to use a number of pieces of it superimposed to form the layer whereas with thicker sheet materials e.g. cardboard a single thickness may suffice. Preferably the thickness of the layer is from 0.1 mm to 2 mm.

In containers for molten metal having an inner lining and a permanent lining, the tendency for the inner lining (with adhering skull) to become fused to the permanent lining may only be significant at certain parts of the container. For example, in the case of tundishes the above tendency for fusion to occur is most marked at the floor of the tundish and at the slag line i.e. the usual level of slag on the top surface of the molten metal in the tundish. Accordingly, in a container according to the invention the heat-carbonisable sheet material may be provided only at those places where there is a significant risk of the inner lining becoming fused to the permanent lining.

The inner lining keeps the carbonaceous residue in place to serve its eventual function as a parting layer. The inner lining and the carbonaceous residue also protect the permanent lining from attack by molten metal and slag in the container.

The inner lining may be provided by a set of slabs of refractory heat-insulating material as described in relation to tundishes in U.K. patent specification 1364665. In accordance with the invention it is however sometimes preferred that the inner lining should be of a unitary construction, preferably formed in situ. The inner lining may be formed by applying a refractory, coating composition and this may be done, for example, by trowelling but it is preferred to apply the composition by spraying.

Coating compositions for forming the inner lining are preferably based on one or more particulate refractory materials and an inorganic binding agent. Examples of suitable particulate refractory materials include silica, chamotte, olivine, sillimanite, zircon, magnesia, alumina and zirconia. Examples of suitable inorganic binding agents include silicates, phosphates and aluminates of alkali or alkaline earth metals, colloidal oxide hydrosols and clays. In order to enhance the initial strength or cohesion of the applied coating composition a proportion preferably 0.5 to 5% by weight, of fibre may be included in the composition. The fibres may also serve to enhance the heat-insulation provided by the composition. It is usually preferred that the inner lining should be heat-insulating. The fibre content may be organic

and/or inorganic and an example of organic fibre is chopped straw whilst an example of an inorganic fibre is glass fibre. Organic binder may also be present in the composition.

The thickness of the inner lining is preferably from 10 to 50 mm.

If the inner lining is provided by use of a coating composition containing a significant proportion of moisture or a binder that requires heating to harden, the composition after application can be heated to drive off moisture or harden the binder.

If the inner lining is provided by pre-formed articles e.g. slabs, when the container is in use or during any pre-heating, certain consitituents of the lining e.g. soda may tend to migrate to the back of the lining under the influence of the heat and, in the absence of the parting layer cause the inner lining to adhere to the permanent lining. Likewise, in the case of an inner lining provided by a coating composition any water-soluble binder e.g. sodium silicate in the composition may tend to migrate to the back of the lining during use or any pre-heating. In such cases the parting

layer present in accordance with the invention is particularly valuable.

The invention is of particular value where the container is a tundish but it is also of use in the case of other containers for molten metal e.g. ladles. The invention is particularly useful in the case of containers for molten ferrous metals e.g. steel.

The method of lining the container forms a part of the invention.

An example of a container according to the invention is a tundish (for use in the continuous casting of steel) having an outer, metal shell, a monolithic permanent lining of cast refractory material adjacent the shell, a parting layer overlying the permanent lining and provided by laminated corrugated cardboard (thickness about 1.5 mm) on the floor of the tundish and a number of layers (total thickness about 0.2 mm) of newsprint on the walls of the tundish, and, overlying the parting layer, a layer applied by spraying a composition of particulate refractory material and inorganic binder.

CLAIMS

1. A container for molten metal having a permanent refractory lining and an inner, refractory lining characterised in that, in at least one place, there is separating the permanent and inner linings, a layer substantially consisting of heat-carbonisable sheet material.

2. A container according to Claim 1 characterised in that the heat-carbonisable sheet material is at least one of newsprint, kraft paper, cardboard, wallpaper, hessian, straw matting, woven polyethylene or polypropylene.

3. A container according to Claim 1 or Claim 2 characterised in that the layer of heat-carbonisable sheet material is formed of a plurality of thin sheets.

4. A container according to any one of the preceding claims characterised in that the layer of heat-carbonisable sheet material has a thickness of from 0.1 to 2 mm.

5. A container according to any one of the

preceding claims characterised in that the inner, refractory lining is formed from a set of slabs.

6. A container according to any one of Claims 1 to 4 characterised in that the inner lining is of a unitary construction.

7. A container according to Claim 6 characterised in that the unitary lining has been formed in situ.

8. A container according to Claim 7 characterised in that the unitary lining has been formed by means of trowelling or spraying.

9. A container according to any one of Claims 6 to 8 characterised in that the inner lining is formed from one or more particulate refractory materials and an inorganic binding agent.

10. A container according to Claim 9 characterised in that the particulate refractory material is one or more of silica, chamotte, olivine, sillimanite, zircon, magnesia, alumina or zirconia.

11. A container according to Claim 9 characterised

in that the inorganic binding agent is one or more of alkali or alkaline earth metal silicates, phosphates or aluminates, colloidal oxide hydrosols and clays.

12. A container according to any one of Claims 9 to 11 characterised in that the inner lining includes a proportion of fibre.

13. A container according to Claim 12 characterised in that the fibre is organic fibre or inorganic fibre or an admixture of fibres.

14. A container according to Claim 12 or Claim 13 characterised in that the proportion of fibre is from 0.5 to 5% by weight.

15. A container according to any preceding Claim characterised in that the container is a ladle or a tundish.