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METHOD OF CASTING METAL AROUND SHEET METAL INSERTS

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Fig. 1.

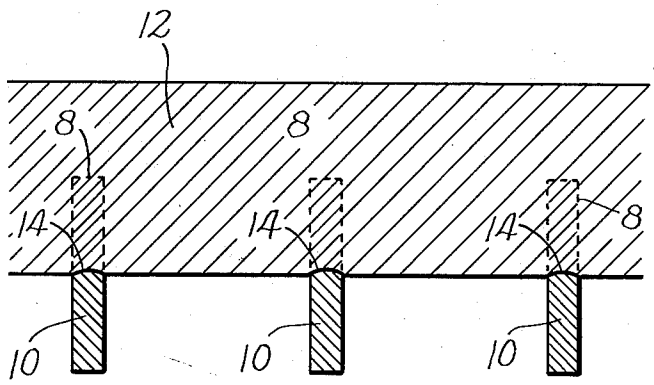
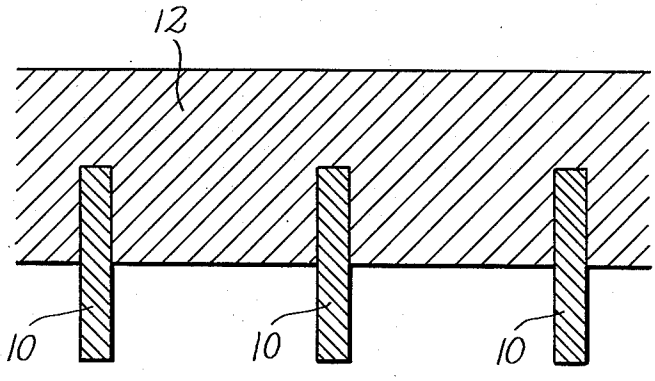


Fig. 2.



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METHOD OF CASTING METAL AROUND SHEET METAL INSERTS

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This invention relates to a method of casting and to casting molds for iron and like metals, with thin metal inserts for such castings. More particularly, the invention relates to molds, inserts and methods adapted for the making of tire molds and the like from ductile cast iron (nodular iron).

For many years, the advantage of tires having closely spaced very thin transverse cuts or slots in the treads has been recognized and utilized. Such tires have good traction even on wet slippery streets because of their squeegee action with is made possible by the transverse cuts in the treads. Cutting rubber treads (the method used by the inventor Mr. Sipe) is a tedious expensive operation. The Bean and Gunsaulus Patent No. 2,263,001 provided a simple, economical method for manufacture of siped tread tires at negligible increase of cost over tires having plain treads.

When iron molds are used instead of aluminum the high temperature of the molten metal may burn, fuse, embrittle or otherwise weaken the thin sheet metal inserts, where they are surrounded by the cast metal. Advantageously the inserts are of Austenitic sheet steel. Even the use of such metals as stainless steel, Inconel or heavily nickel plated iron had not fully eliminated such failures; and experiments with other temperature-resistant alloys has not given promise of a solution. In general, the sheet metals having requisite mechanical properties for the Sipes, and which are commonly available at economical cost, melt or recrystallize to a weak condition at temperatures substantially below the temperature range needed for casting the iron in the main body of the tire mould.

Accordingly it is an object of the present invention to provide a way of preventing the melting or appreciable deterioration of relatively thin metal inserts when these inserts are cast in a metal having a pouring temperature substantially above the melting temperature of the inserts.

In accordance with the present invention, in one specific embodiment thereof, very thin sheet 18–8 grade stainless steel Sipes are treated prior to the casting process by coating each with a thin layer of magnesium oxide (M_gO), e. g., by spraying with a water suspension of the magnesium oxide or hydroxide. After the layer has dried sufficiently, molten iron can be cast around the Sipes at a pouring temperature of 2650° F. to 2750° F. without noticeably weakening them or melting their roots.

The general nature of the invention together with its more specific details will best be understood from the following description and by reference to the accompanying drawings based on actual photographs of test specimens.

Figure 1 is a cross-section on an enlarged scale of a portion of a tire tread mold showing how the roots of untreated Sipes are almost completely melted off in the process of casting;

Figure 2 is a similar cross-section of a mold having Sipes treated in accordance with the present invention, showing how their roots are left almost completely unaffected by the same casting process and conditions as that used for the mold shown in Figure 1.

Referring particularly to Figure 1, the dotted lines S therein indicate the depth of penetration of the Sipes **10** into the cavity of a suitable mold, such as a bonded sand mold adapted for casting a tire mould, before the main body **12** of the casting was poured. After casting and cooling, the body and Sipes were cut along the cross-section shown from which it is evident that only a small nub **14** barely depressing the body **12** is all that remains of each root. The Sipes used in this test were 18–8 grade stainless steel each approximately 0.015 inch thick with an original depth of penetration into the mould cavity of approximately 0.100 inch and an overall length of roughly twice this. The width of each was much greater than its thickness. The melting temperature of this grade of stainless steel is roughly 2550° F. The body of the mould was ductile iron (i. e., nodular cast iron), poured at approximately 2700° F.

Figure 2 shows a casting similar to that shown in Figure 1 and made under the same conditions and with the same materials but with the roots of the Sipes **10** treated in accordance with the present invention. As can be seen these roots have been effectively protected from melting during the casting operation.

This treatment is given to the part of each Sipe which projects into the mould cavity. Only the part of the Sipe exposed to contact with the molten iron need be protected. According to this treatment, an inert refractory material which does not fuse or decompose or dissolve at the temperature encountered in the molten metal during the casting process is made into a finely divided liquid suspension, such as a water or alcohol slurry, and sprayed, or otherwise applied, in a thin layer, for example to give, when dried, a thickness of the order of 1 mil (0.001") over the otherwise exposed surface of the Sipe.

The effectiveness of this treatment is quite surprising; even a very thin layer of refractory material coated on the Sipes keeps them from melting. It is particularly surprising that layers of the refractory sufficiently thin to allow secure bonding of the Sipes in the casting can be effective to preserve the Sipes. Also, because the refractory coating on the Sipes is so thin there is no objectionable gap, i. e. there is a flush seal, at the junction of the cast metal and the inserts as seen in Figure 2.

Experimental tests have demonstrated that the invention may be practiced with a considerable range of metals in the Sipes and of refractory materials for the coating. In one test, 18–8 grade stainless steel inserts approximately 0.015 inch thick were sprayed with water slurries of the following materials, respectively, to give a coat approximately 0.001 inch thick:

(*a*) Magnesium oxide (M_gO)
(*b*) Aluminum oxide (Al_2O_3)
(*c*) Nickel oxide (NiO)
(*d*) Calcium oxide (CaO)

The coating "*a*" was effective to prevent melting of the inserts by the molten iron poured at temperatures up to 200° F. above the melting temperature of the inserts. The coatings "*b*" and "*d*" appeared to be about, but possibly not quite, as effective as the coating "*a*." The coating "*c*" was effective but allowed a slight amount of melting. Similar tests using Inconel alloy inserts gave substantially the same results. Alcohol slurries used instead of water slurries showed no noticeable difference in results. Layers substantially thicker than 1 mil also proved effective.

In general, it appears most desirable to have the coating of a thickness which assures barely, or even not

quite complete, coverage of the surface of the metal by the finely divided oxide. When properly applied, the film may have a somewhat transparent look, that is, the gray-blue color of the blades can definitely be perceived through the film. The film appears continuous because of the extreme fineness of the particles, but it is made up of discrete particles so distributed that the color of the surface on which they lie is quite evident. The layer may be heavier also, up to the point where it is opaque. If the coating is too thin, the metal of the insert will be deteriorated. If the coating is too thick, the metal of the insert will not be bonded strongly to the casting. A coating which is almost, but not quite opaque has proven most satisfactory. However, advantage can be taken of the invention even with thicker coatings, if the insert is formed so as to provide a mechanical anchorage and not depend upon adhesion. In some cases it is desirable to use stainless steel or like inserts into the pattern as miniature cores to produce holes, slots or other depressions in the casting. In such case a thicker coating of the oxide is used to prevent bonding of the insert into the casting to permit its removal. The presence of the oxide layer during the casting protects the metal of the insert so that it has sufficient mechanical strength to be removable, and can be re-used.

Inserts of 0.020 inch and more thickness tested in the same way gave substantially the same results.

Particularly adapted for use in my invention are the refractory oxides of metals from the group of alkaline earth metals and aluminum, nickel and titanium. Materials which decompose to give off gases or soluble or fusible products at the pouring temperature of the casting metal are not effective. However, materials, such as magnesium hydroxide, which can be decomposed at relatively low temperatures into water or like volatile product and a refractory residue can be used satisfactorily if thoroughly baked prior to casting. Materials which, like graphite or sodium silicate are dissolved or fused by the molten metal are not suitable.

The layers should be thoroughly dried prior to the casting operation.

Instead of 18–8 stainless, other alloys may be used such as 300 or 400 grade (e. g. 302 or 410) stainless steel, Inconel, (e. g. Inconel "X").

From the description given above it is evident that this invention is not limited solely to the use of those materials, metals and temperatures specifically listed, even though these have been found superior, as a specific aspect of the invention, but resides more broadly in the use of refractory materials of the type described applied in a layer, which can be relatively thin. Various equivalent to the process steps or in the materials specifically described, as well as changes in the conditions listed will be suggested to those skilled in the art by the peculiar requirements of various uses, and these equivalents or changes may be substituted or adopted without departing from the spirit or scope of the invention as set forth.

What is claimed is:

1. The method of incorporating pre-formed sheet metal inserts of relatively thin flat section into a casting of a metal which to flow properly to all parts of the casting must be poured at a temperature substantially above the melting point of said inserts, which method comprises coating the root portion of said insert with a very thin layer of refractory material which does not dissolve and does not fuse in the metal as cast, and flowing molten casting metal around said coated root portion only at a temperature above the temperature at which the thin metal of the insert would be substantially damaged in the absence of said coating, and cooling the cast metal to solidify it around the insert, said refractory coating being so thin that the roots of said inserts remain firmly anchored in the solidified cast metal and there being a flush seal at the junctions of the inserts and the cast metal.

2. The method as defined in claim 1 in which sheet metal inserts are embedded in a mold body with a root portion projecting therefrom into a mold cavity and the metal is poured at a temperature about 50°–100° F. above the melting point of the metal in the root portion of the inserts.

3. The method as defined in claim 1 in which the inserts are an alloy selected from the group consisting of an iron alloy, a chromium alloy and a nickel alloy and having a melting point about 2600° F. and the casting is of iron poured at a temperature between 2620° F. and 2750° F.

4. The method as defined in claim 1 in which the inserts are selected from the group consisting of an iron alloy, a chromium alloy and a nickel alloy of melting point about 2600° F., and in which the step of coating includes dispersing the refractory material in a liquid, spraying the resulting suspension onto said root portions, and evaporating the suspending liquid from the sprayed material.

5. The method of casting molten metal around the roots of thin metal inserts which melt at a temperature lower than the pouring temperature of the molten metal comprising the step of applying by spraying on the surface of a root portion of each insert a layer of the order of 1 mil thickness of a finely divided suspension of a refractory material having a thermal conductivity much lower than that of said insert and which does not fuse, does not decompose and does not dissolve in the molten metal, the step of removing substantially all of the volatile products from said layer prior to contacting it with the molten metal, and the step of pouring molten metal around said inserts at a temperature high enough for proper casting and cooling it to solidify there being a flush seal at the junctions of the inserts and the cast metal and the inserts remaining firmly anchored therein.

6. The method as in claim 5 in which said refractory material is selected from the group consisting of Al_2O_3, MgO, NiO, and CaO, said inserts are a stainless alloy of iron having a thickness of roughly 0.02 inch and a melting point of roughly 2500 to 2600° F., and said molten metal is ductile iron poured at about 2700° F.

7. The method in making a tire mold of protecting a thin sheet metal Sipe insert from melting when it is covered with molten metal poured at a temperature above the melting temperature of said insert comprising the step of coating the part of said insert to be covered with molten metal with a layer not greater than about 0.001 inch thick when dry of a finely divided liquid suspension of a refractory material having a thermal conductivity much lower than that of said insert and which does not fuse, does not decompose and does not dissolve in the molten metal, the step of drying said layer prior to covering it with the molten metal, and the step of pouring molten metal around said insert at a temperature above its melting point the insert remaining firmly anchored in the solidified cast metal and there being a flush seal at the junction of the insert and the cast metal.

8. The method as in claim 7 wherein said insert is thin stainless steel, said refractory material is magnesium oxide (MgO), and said molten metal is iron poured at a temperature in the range from 2600 to 2750° F.

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