March 7, 1950 P. J. SOFFEL 2,500,097

EXOTHERMIC COMPOSITION FOR CONTROLLING THE FLUIDITY OF CASTINGS

Filed Oct. 14, 1947 2 Sheets-Sheet 1

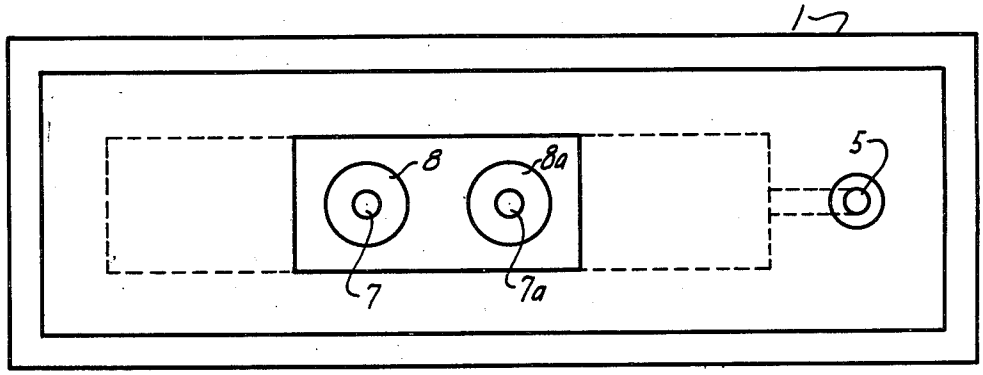


Fig. 1

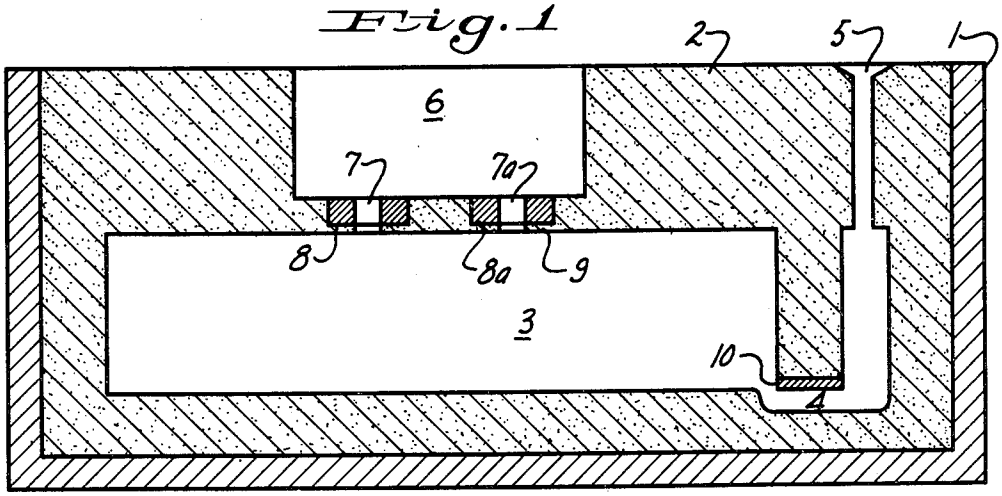


Fig. 2

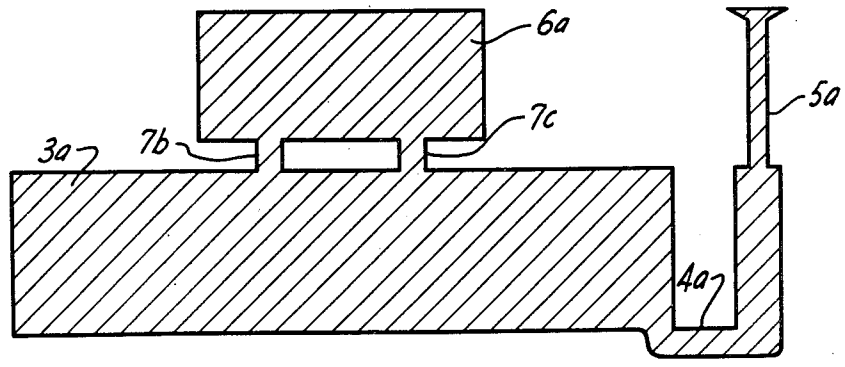


Fig. 3

INVENTOR.
Peter J. Soffel
BY William B. Jaspert
Attorney

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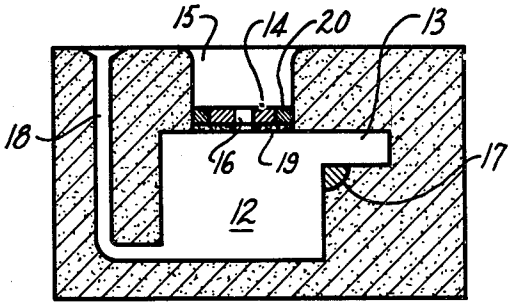


Fig. 4

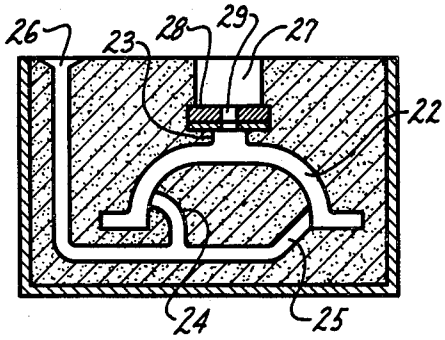


Fig. 5

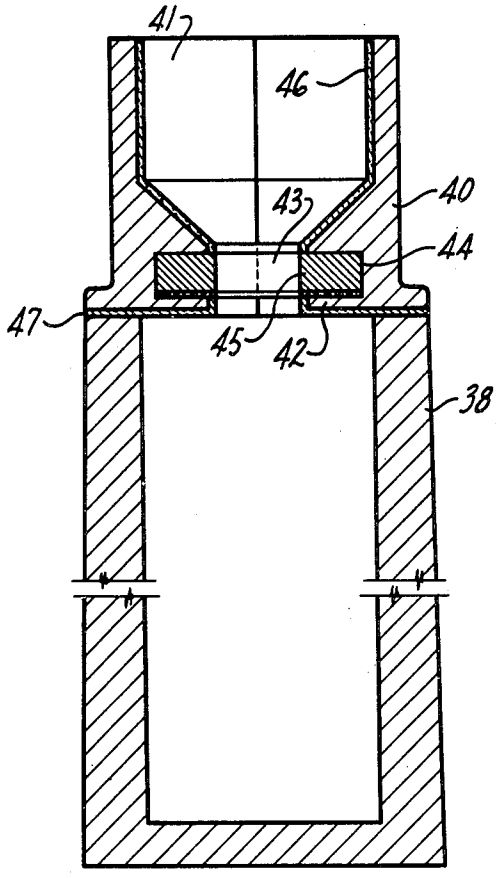


Fig. 7

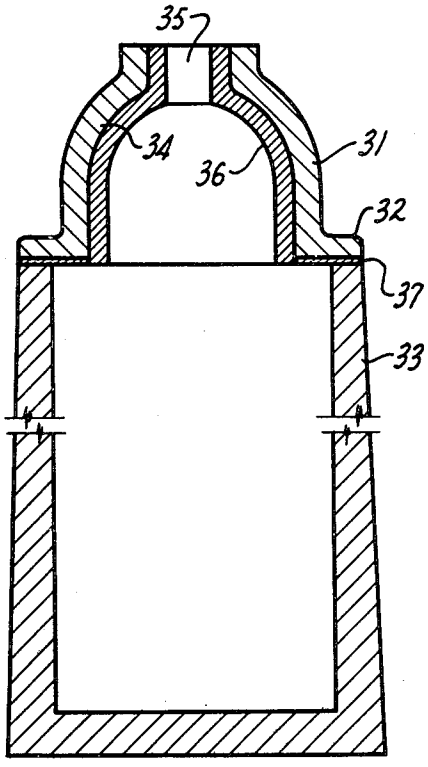


Fig. 6

INVENTOR.
Peter J. Soffel
BY William B. Jaspert
Attorney.

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EXOTHERMIC COMPOSITION FOR CONTROLLING THE FLUIDITY OF CASTINGS

Peter J. Soffel, Pittsburgh, Pa.

Application October 14, 1947, Serial No. 779,830

3 Claims. (Cl. 22—147)

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This invention relates to the method of casting metal bodies and more particularly to the use of exothermically reactive material in regions of the cast body or molten metal forming such bodies to retain a controlled fluidity during the setting or freezing of the metal whereby to eliminate fissures, piping and other defects ordinarily resulting from shrinkage during the solidification of cast metal bodies.

Another object of the invention is to minimize the amount of metal employed in sinkheads or feeders utilized in the casting of metal bodies and to facilitate the removal of such sinkheads from the finished castings.

It is still another object of the invention to produce more dense grain structures and higher tensile strength in castings through prolonging fluidity of the feeding heads of the castings.

The instant application is a continuation-in-part of certain applications heretofore filed by me, Serial No. 595,823, filed May 25, 1945, entitled Method of and apparatus for casting ingots; Serial No. 595,824, filed May 25, 1945, entitled Method of and apparatus for pouring castings; and Serial No. 595,825, filed May 25, 1945, entitled Prefabricated self-sustaining thermit-active bodies, the subjects matter of which are combined and embodied in the present application. All the above named applications are now abandoned.

It is well known in metal founding that shrinkage separates the metal of the casting from the riser or sinkhead unless the riser is maintained sufficiently fluid to feed metal to compensate for such shrinkage. On this account it has been conventional practice to employ an excessive volume of metal in the riser to maintain fluidity during feeding, which excess in some cases is equal to or even exceeds the mass of metal in the casting. By means of the present invention the volume of the feeding metal or riser is reduced to a minimum, is readily removed after the casting has solidified, and insures a sound, dense casting free of fissures, piping or other defects.

Briefly, the invention consists in the use of an exothermically reactive material which is inserted in selected regions of the mold or sand flask where a controlled heating of the metal is required to prolong its fluidity. The exothermically reactive materials are of a nature to be built into the sand flask or inserted in permanent molds, having the properties of keeping the metal free from contamination resulting from the use of common exothermic materials such as carbon or other burnable materials, and which has the property of leaving a self-sustaining refractory residue after it has performed its function which is not dispersed in the body of the metal during the casting operation.

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The exothermically reactive material preferably consists of a composition that generates heat through oxidation of a metal or metals by means of one or more oxides modified to control the rate of heat release. Such a composition may consist of metallic powders chosen from the second and third periodic groups such as magnesium metal and aluminum metal compounded with aluminum oxide, potassium nitrate, sodium nitrate, ammonium nitrate, ferric oxide, ferrous oxide, sodium oxide, potassium fluoride, aluminum fluoride, calcium fluoride, sodium fluoride, sodium bifluoride, titanium dioxide, silicon dioxide, aluminum metal, magnesium metal, and a suitable binder such as silicate of soda, or a cereal or other binder, such as dextrines, resins, plastics, molasses, etc., which lends to the composition the characteristic of being shaped in ring form or otherwise for use as an insert in a sand flask or mold.

The various forms in which the exothermically reactive material may be employed in practicing the invention is shown in the accompanying drawings, constituting a part hereof, in which like reference characters designate like parts, and in which:

Fig. 1 is a top plan view diagrammatically illustrating a sand flask for pouring castings embodying the principles of this invention;

Fig. 2 a vertical cross-sectional view of the flask shown in Fig. 1 ready for pouring;

Fig. 3 a vertical cross-sectional view of a finished casting poured in the flask of Figs. 1 and 2;

Fig. 4 a vertical cross-sectional view of a modified form of flask and casting adapting the invention to metal founding;

Fig. 5 a vertical section of still another modified form of flask and casting;

Fig. 6 a vertical cross-sectional view of an ingot pouring mold and sinkhead or hot top; and

Fig. 7 a similar view of a modified form of ingot casting mold and hot top.

With reference to Figs. 1 to 3 inclusive of the drawings, the numeral 1 designates a frame or flask for retaining sand 2 in which a matrix 3 of the shape of a casting is formed in the conventional manner, the matrix portion being connected by a gate 4 to a sprue 5 through which the metal is poured. As is conventional practice a riser portion 6 is provided for feeding metal to the matrix 3 which, after the casting has solidified, is removed as croppage. In accordance with the present invention the riser is connected by passages 7 and 7a with the matrix portion 3, the passages 7, 7a being formed as perforations in discs 8, 8a, that are constituted of an exothermically reactive composition which functions to keep the metal in the passages 7, 7a fluid so that the sinkhead metal is fed to the casting in the matrix 3 during the solidification of the latter. The exothermic material 8, 8a is, on its upper face, exposed to the metal of the sinkhead 6 and may similarly be exposed to the metal in the matrix 3, but as shown in Fig. 2 it may be insulated from the metal in the matrix by a thin layer 9 of sand or other refractory material. The exothermically reactive rings 8, 8a permit of the employment of a very small flow passage 7, 7a so that after the casting has solidified the riser may be removed by simply knocking it off the casting, the break-off occurring at the thin portions of the metal in passages 7, 7a.

The same exothermically reactive material as is employed in the rings 8, 8a may be utilized as a thin layer or preformed section 10 at the gate 4 to maintain the metal at the gate in a highly fluid state while flowing from the sprue 5 into the matrix cavity 3. The finished casting, consisting of the cast body 3a, the small sprues 7b and 7c, and the riser 6a, the gate metal 4a and the sprue 5a is shown in Fig. 3. Because of the use of the exothermically reactive material the volume of the sinkhead metal 6a is reduced to a minimum since it is not required to be of a mass to itself retain a high degree of fluidity during the feeding of the metal to the casting, this being the function of the exothermically reactive materials 8, 8a which retain a controlled fluidity for a sufficient period of time to allow full feeding of the metal. After the reaction of the exothermically reactive material takes place the rings 8, 8a retain their shape in the form of self-sustaining burnt out refractory bodies which act as molds in retaining the shape of the flow passages 7, 7a during the feeding of the riser metal to the casting.

In Fig. 4 the casting 12 is poured, having an offset 13 of substantially lesser cross-sectional area than the remainder of the casting. A preformed perforated disc 14 of exothermically reactive material is again employed between the riser 15 and the casing 12 for the same purpose of maintaining a fluid feed passage 16 through which the riser metal feeds to the casting 12. A small triangular piece of exothermically reactive material 17 is employed as a fillet in the corners between the main body of the casting and the reduced portion 13 to control solidification of the metal between the large and small masses to prevent fissures or cracking due to uneven cooling. The usual sprue 18 is employed for pouring the casting which, when the metal in the matrix 12 rises to the exothermically reactive insert 16, is discontinued and the remainder of the metal is poured into the riser chamber 15. An insulating refractory material 19 may be employed beneath the ring 14, and instead of employing exothermically reactive material for the entire partition wall between the riser and the casting, a portion 20 thereof may be sand or other refractory substance.

In the form of casting to be poured in the structure shown in Fig. 5, the body of the casting is in the shape of a relatively thin wall member or spider 22 having a boss or neck 23. The matrix is provided with pouring gates 24 and 25 connected with a sprue 26 and a riser chamber 27 is provided which is separated from the matrix by an exothermic disc 28 having a flow passage 29 therein. The casting is poured in the usual manner through the sprue 26 and then into the riser 27. The feeding metal is retained in a controlled fluid state by the exothermically reactive material 28 while feeding through the relatively narrow passage 29.

In Fig. 6 of the drawings the exothermically reactive material is employed in a hot top 31 having a flange 32 that rests on an ingot mold 33, the hot top having a curved inner wall 34 and a narrow opening 35. The entire hot top is lined with exothermic material 36 to retain the sinkhead metal in the hot top chamber in a controlled fluid state for feeding to the body of the ingot to eliminate piping therein. A refractory liner 37 may be employed between the hot top and ingot mold if desired.

Another form of adaptation of the exothermically reactive material in the pouring of ingots is shown in Fig. 7 wherein the numeral 38 designates the ingot mold, 40 the hot top which has a wide open mouth 41 into which the metal is poured. The hot top is provided with a throat 42 to provide a constricted opening 43 through which the metal feeds to the ingot. The hot top is further provided with a recess 44 for receiving an insert 45 of exothermically reactive material which is preformed and inserted therein.

The inner wall of the hot top 40 may be provided with a refractory lining 46 and a similar refractory material 47 may be disposed between the flanged bottom of the hot top and the upper face of the ingot mold as shown.

In the pouring of the ingots the metal in the hot top is retained in a controlled fluid state to permit the escape of gases from the ingot body and produce a sound casting free of piping at the center top of the ingot. In the form shown in Fig. 7 the metal in the constricted flow passage is retained in a controlled fluid state to permit feeding to the ingot. In both forms of hot tops of Figs. 6 and 7, a minimum amount of sinkhead metal is needed resulting in a minimum amount of croppage which is a substantial saving in the total tonnage of steel poured for ingot yield.

The general typical reaction of the exothermically reactive material is as follows:

$$FeO_3—2Al$$
$$Al_2O_3—2Fe—heat$$

also modified by

$$Fe_2O_3—3Mg$$
$$3MgO—2Fe—heat$$

I have found the following proportions of the composition to produce exothermic reactions suitable for maintaining controlled fluidity to retard solidification during the feeding or shrinkage of the metal when employed in the various

forms of inserts and liners shown in the drawings:

	Percent
Aluminum oxide	40–90
Potassium nitrate	1– 4
Sodium nitrate	1½– 5
Ferric oxide	2– 6
Ferrous oxide	2– 6
Sodium oxide	0.10–10
Calcium fluoride	0.10–10
Potassium fluoride	2–12
Aluminum fluoride	0.10–12
Titanium dioxide	0.10–10
Silicon dioxide	0.10–10
Ammonium nitrate	0.10–10
Sodium fluoride	0.10–12
Sodium bifluoride	0.10–12
Aluminum metal	.5–50
Magnesium metal	0.10–10
Suitable refractory or cereal binder	4–10

The preferred composition is in the following proportions:

	Percent
Aluminum oxide	76.43
Potassium nitrate	2.09
Sodium nitrate	3.95
Ferric oxide	4.43
Sodium oxide	0.32
Calcium fluoride	0.68
Titanium dioxide	0.36
Silicon dioxide	0.48
Aluminum metal	2.34
Magnesium metal	0.64
Refractory or cereal binder	8.23

The aluminum oxide forms a refractory matrix and is an insulator retaining the heat generated. The fluoride promotes fluxing and thinning of the slag present in the molten metal, also increasing fluidity of the metal and causing the slag and oxides to separate and rise to the top of the metal. The fluorides form oxyfluorides which deoxidize the metal coming in contact with the exothermically reactive material. The nitrate combines with the aluminum metal in the beginning and acts as a fuse to start the reaction of aluminum and ferric oxide and combine with aluminum oxide generating heat of substantially 3500° F., leaving a refractory shape to substantially the size of the original inserts, such as **8**, **14**, **20** and **45**, after the reaction. The product of the reaction does not disintegrate to an ash but remains as an insulator or partition and does not burn into the metal or contribute any impurities or contamination, such as carbon or aluminum, to the metal.

While certain specific metals chosen from the second and third periodic groups, such as magnesium and aluminum metals, have been designated as suitable for the reaction, it is evident that other metals and fluorides of the designated groups may be employed.

The foregoing composition is not to be confused with Thermit, which does not burn out to a self-sustaining refractory residue. Thermit furthermore contaminates sand which cannot be reused, whereas the residue of the composition of the exothermically reactive material herein disclosed is more refractory than sand and does not contaminate it. Also, the exothermically reactive composition herein disclosed differs from common exothermic materials, such as coke, coal, carbon or wood which require oxygen from the atmosphere or other outside source because the compound contains its own oxygen as hereinbefore described.

Although several embodiments of the invention have been herein illustrated and described, it will be evident to those skilled in the art that various modifications may be made in the shapes and applications of the exothermically reactive material in metal founding without departing from the principles hereof. It is also apparent that the ingredients of the composition may be varied in proportions, some of the elements may be omitted, or others substituted therefor.

1. An exothermically reactive material for use as an insert in a casting mold for prolonging the fluidity of sections of the cast metal comprising a preformed body of exothermically reactive material containing aluminum oxide, potassium nitrate, sodium nitrate, ferric oxide, ferrous oxide, sodium oxide, calcium fluoride, potassium fluoride, aluminum fluoride, titanium dioxide, silicon dioxide, ammonium nitrate, sodium fluoride, sodium bifluoride, aluminum metal, magnesium metal, compounded with a suitable binder, in the following proportions:

	Percent
Aluminum oxide	40–90
Potassium nitrate	1– 4
Sodium nitrate	1½– 5
Ferric oxide	2– 6
Ferrous oxide	2– 6
Sodium oxide	0.10–10
Calcium fluoride	0.10–10
Potassium fluoride	2–12
Aluminum fluoride	0.10–12
Titanium dioxide	0.10–10
Silicon dioxide	0.10–10
Ammonium nitrate	0.10-10
Sodium fluoride	0.10–12
Sodium bifluoride	0.10–12
Aluminum metal	.5–50
Magnesium metal	0.10–10
Suitable cereal binder	4–10

2. An exothermically reactive material for use as an insert in a casting mold for prolonging the fluidity of sections of the cast metal comprising a preformed body of exothermically reactive material containing aluminum oxide, potassium nitrate, sodium nitrate, ferric oxide, sodium oxide, calcium fluoride, titanium dioxide, silicon dioxide, aluminum metal, magnesium metal, compounded with a suitable binder, in the following proportions:

	Percent
Aluminum oxide	76.43
Potassium nitrate	2.09
Sodium nitrate	3.95
Ferric oxide	4.43
Sodium oxide	0.32
Calcium fluoride	0.68
Titanium dioxide	0.36
Silicon dioxide	0.48
Aluminum metal	2.34
Magnesium metal	0.64
Cereal binder	8.23

3. A fluidizer for maintaining localized fluidity of molten metal comprising an exothermically reactive composition of metallic powders including aluminum and magnesium compounded with

other compounds in the following proportions by weight:

	Percent
Aluminum oxide	40–90
Potassium nitrate	1–4
Sodium nitrate	1½–5
Ferric oxide	2–6
Ferrous oxide	2–6
Sodium oxide	0.10–10
Calcium fluoride	0.10–10
Potassium fluoride	2–12
Aluminum fluoride	0.10–12
Titanium dioxide	0.10–10
Silicon dioxide	0.10–10
Ammonium nitrate	0.10–10
Sodium fluoride	0.10–12
Sodium bifluoride	0.10–12
Aluminum metal	.5–50
Magnesium metal	0.10–10

PETER J. SOFFEL.

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