

UNITED STATES PATENT OFFICE

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INVESTMENT MATERIAL

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The invention relates to bonded refractory material and more particularly to a material capable of being mixed with water to form an embedding mass.

An object of the invention is an improved bonded refractory material that more nearly meets the demands placed upon such a material by present practices in the investment casting field.

Another object of the invention is to provide an investment material that combines a high green strength on setting at room temperature with a low fired strength.

Another object of the invention is that the investment material must mix with water to form a satisfactory consistency for pouring.

Another object of the invention is that the investment material must be permeable enough at the casting temperature to allow rapid escape of the gases in the mold cavity as the metal is cast so that a sound casting free from entrapped gases is produced.

Another object of the invention is a critical combination of refractory materials of the proper grain size together with the right combination of bonding ingredients.

Another object of the invention is a refractory material comprising a blend of coarse, medium, and fine particles of silica.

Another object of the invention is a refractory material comprising both granular and powdered form of silica.

Another object of the invention is to provide an investment material which must be relatively soft, whereby the castings may be shaken out easily and economically.

Other objects and a fuller understanding of the invention may be had from the following description and claims.

In the manufacture of castings by the lost wax method, a refractory mold of investment material is first formed about one or more patterns which are connected to a central sprue. Next, the investment is allowed to set at room temperature for several hours. After the investment material is set, the mold is heated to relatively high temperatures such as 1600 degrees F. to eliminate the patterns, after which molten metal is then cast into the mold cavity.

Recent attempts by a number of precision casters to use plastic patterns in place of wax has emphasized the fact that an improved back-up investment material was required having a combination of properties that could not be found in the materials available at the present state of the art.

One of the difficulties encountered in using present day investments for back-up purposes with plastic patterns, was that the mold cracked on heating. When metal was cast into such a mold, it was lost through the crack and no cast was obtained. The failure of available materials is readily explained by the fact that the plastic

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used for patterns has a high thermal expansion between room temperature and 200 degrees F. The plastic thermal expansion is about double the expansion of the investment materials for the same temperature range and the forces developed are sufficient to rupture the mold. The investment material must develop sufficient green strength on setting at room temperature to prevent rupture of the mold by the expansion forces of the plastic pattern.

In addition to the above, the investment must mix with water to form a satisfactory consistency for pouring. It must have sufficient working time to allow for the mixing and investing operations and it should set and harden in a reasonable length of time. The investment material must be permeable enough at the casting temperature to allow rapid escape of the gases in the mold cavity as the metal is cast so that a sound casting free from entrapped gases is produced.

It can readily be seen that recovery of the metal pieces after casting must be easily accomplished else the process becomes uneconomical. For ease in shaking out the castings, the investment material must be relatively soft after the casting operation. Therefore, the investment material must combine a high green strength on setting at room temperature with a low fired strength.

Such a combination of properties is not provided by any material with which the inventor is aware.

The applicant has discovered that a rather critical combination of refractory materials of the proper grain size together with the right combination of bonding ingredients not heretofore disclosed, will give results that cannot be obtained with existing products. The refractory material consists of silica having a definite grain size distribution. The applicant has found that a refractory composition comprising a blend of coarse, medium, and fine particles of silica will be weaker and more permeable after firing than one comprising all fine particles for the same proportions of bonding ingredients. It has also been found that such a material will have a higher green strength than one comprising all fine particles because less water is required to make a pouring consistency. The reason for this is not fully understood, but is probably due in part to the fact that the finer particles present a much greater surface area and that the bonding ingredients react in some way with this increased surface area to produce greater strength and less permeability than a similar composition comprised of coarse particles.

As a back-up investment, the following composition has been found to give results that cannot be obtained with any known material.

The refractory material preferably comprises the following proportions:

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	Percent
8 mesh silica (granular) -----	5
30 mesh silica (granular) -----	33
50 mesh silica (granular) -----	18
200 mesh silica (powder) -----	29

Total refractory material ----- 85

The bonding ingredients preferably comprise the following proportions:

	Percent
Fused magnesium oxide powder -----	7.5
Mono ammonium phosphate powder -----	5.0
Mono magnesium phosphate powder -----	2.5

Total bonding ingredients ----- 15.0

The above composition when mixed with water in the proportions of one part water to five parts powder, will develop sufficient strength on setting at room temperature (70 degrees F. $\pm$ 5% F.) to withstand the expansion forces of plastic patterns. The room temperature compression strength developed on standing for 24 hours is between 500 and 600 pounds per square inch. The fired compression strength is between 100 and 200 pounds per square inch. With the above silica values, substantially 66% is in granular form and the remainder is in powdered form.

This material mixes to a good pouring consistency, develops great strength on setting in air at room temperature, yet softens on heating and makes recovery of the casting much easier. Also, the investment is very permeable at casting temperatures and makes possible sound castings, free from porosity due to entrapped gases.

The above set of values constitutes the preferable form of the invention. Below is set forth a range of values which produces satisfactory results.

The refractory materials comprise approximately the following ranges:

	Per cent
5 to 10 mesh silica (granular) -----	2 to 10
20 to 40 mesh silica (granular) -----	25 to 35
40 to 60 mesh silica (granular) -----	15 to 25
100 mesh or finer silica (powder) -----	10 to 35

The bonding ingredients comprise approximately the following ranges:

	Per cent
Fused magnesium oxide powder -----	5 to 9.5
Mono ammonium phosphate powder -----	4 to 6
Mono magnesium phosphate powder -----	1 1/2 to 4

With the above ranges, the selection of the total amount of silica is preferably limited to 80 to 90% and the selection of the total amount of the bonding ingredients is preferably limited to 10 to 20%. The granular silica ranges from approximately 50 to 80% and the remainder is in powdered form. With the above silica ranges, the granular form may vary from approximately 50 to 80% and the remainder is in powdered form.

Although the invention has been described in its preferred form with a certain degree of particularity, it is understood that the present disclosure of the preferred form has been made only by way of example and that numerous changes in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and scope of the invention as hereinafter claimed.

What is claimed is:

1. A material capable of being mixed with water to form an embedding mass, said material consisting of silica in a range of substantially

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80% to 90% of the total dry composition and the remainder of bonding ingredients, the total of said silica being approximately 50 to 80% in granular form larger than approximately 60 mesh and the remainder in powdered form smaller than 60 mesh, said bonding ingredients comprising approximately 5 to 9.5% fused magnesium oxide powder, approximately 4 to 6% mono ammonium phosphate powder, and approximately 1 1/2 to 4% mono magnesium phosphate powder, said mass having a compression strength after setting 24 hours at room temperature in the neighborhood of 70 degrees F. of not less than 500 pounds per square inch and having a fired compression strength of not more than 200 pounds per square inch.

2. A material capable of being mixed with water to form an embedding mass, said material consisting of silica and bonding ingredients, said silica being of approximately the following proportions of the total dry composition:

2 to 10% -----	5 to 10 mesh
25 to 35% -----	20 to 40 mesh
15 to 25% -----	40 to 60 mesh
10 to 35% -----	100 mesh or finer

and said bonding ingredients being of approximately the following proportions of the total dry composition:

5 to 9.5% -----	fused magnesium oxide powder
4 to 6% -----	mono ammonium phosphate powder
1 1/2 to 4% -----	mono magnesium phosphate powder

said mass having a compression strength after setting 24 hours at room temperature in the neighborhood of 70 degrees F. of not less than 500 pounds per square inch and having a fired compression strength of not more than 200 pounds per square inch.

3. A material capable of being mixed with water to form an embedding mass, said material consisting of silica and bonding ingredients, said silica being of approximately the following proportions of the total dry composition:

5% -----	8 mesh
33% -----	30 mesh
18% -----	50 mesh
29% -----	200 mesh or finer

and said bonding ingredients being of approximately the following proportions of the total dry composition:

7.5% -----	fused magnesium oxide powder
5.0% -----	mono ammonium phosphate powder
2.5% -----	mono magnesium phosphate powder

said mass having a compression strength after setting 24 hours at room temperature in the neighborhood of 70 degrees F. of not less than 500 pounds per square inch and having a fired compression strength of not more than 200 pounds per square inch.

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