

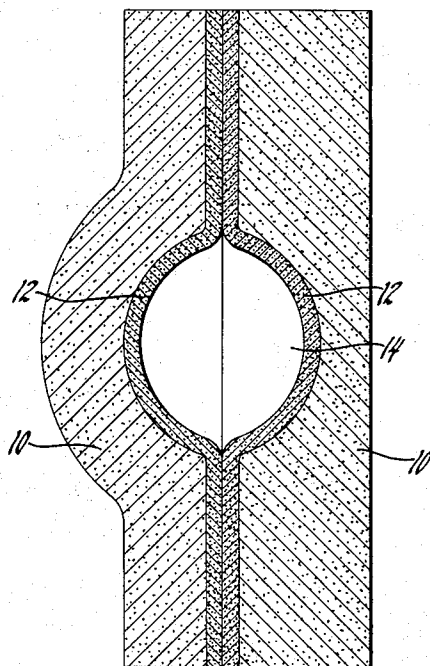
June 5, 1956

W. S. HACKETT

2,748,435

PROCESS FOR REINFORCING SHELL MOLDS

Filed Nov. 14, 1951



INVENTOR.
William S. Hackett
BY
Willie H. Hackett & Baillie
ATTORNEYS

1

2,748,435

PROCESS FOR REINFORCING SHELL MOLDS

William S. Hackett, Royal Oak, Mich., assignor to General Motors Corporation, Detroit, Mich., a corporation of Delaware

Application November 14, 1951, Serial No. 256,309

2 Claims. (Cl. 22—193)

This invention relates to reinforced sand-resin molds and cores for metal casting operations and particularly to a process for reinforcing shell-type sand-resin molds, mold sections and cores to prevent distortion of any portion of the mold or core assembly by metal pressure during casting. This invention contemplates the use of a novel and useful mix which may be placed on the back surfaces of thin-walled molds or cores and subsequently baked so as to constitute a reinforcing material.

Recently developed techniques in foundry practice incorporate the use of thin-walled dispensable molds and cores composed of sand and plastic binders. These procedures, generally referred to as "shell molding" processes, are particularly suited to the production of precision or semi-precision castings in a wide variety of metals.

Essentially the shell molding process consists of using a thermosetting plastic or resin as a binder for the sand grains to form thin-walled molds having high gas permeability, good surface smoothness and dimensional stability. The molding material, which is generally a dry mixture of a major proportion of silica sand and a minor proportion of a plastic binder, is used in powder form with no water being added. Phenol formaldehyde and melamine formaldehyde resins are typical examples of the type of thermosetting binders preferably used. The sand employed is preferably free of metallic oxides, clay, moisture and organic matter.

These sand-resin molds are prepared by allowing the dry mixture of sand and resin powder to come into contact with a hot metal pattern for a short period of time. A layer of the mix adheres to the metal surfaces due to the melting of the resin which entraps the sand with which it is intimately mixed, thereby reproducing pattern detail. Metal patterns must be employed because they are subjected to elevated temperatures. Pattern temperatures in the range of between 250° F. and 350° F. are typical, but temperatures up to 800° F. may be advantageously employed under particular conditions. Half patterns, gates and runners are usually all permanently fixed on the metal plates. The pattern temperature and the length of time the molding material is allowed to remain in contact with the hot pattern surfaces determine the resulting thickness of the mold. Mold build-up times ranging from a few seconds to approximately one minute are appropriate for various applications.

After this short time interval, the excess dry sand and resin are removed, and the closely adhering sand-resin layer is preferably cured by heating to a temperature within the range of approximately 300° F. to 600° F. for a short period of time, usually from a few seconds to five minutes, while in contact with the metal pattern. This baking operation results in the conversion of the resinous material to a hard, insoluble binder which securely bonds the sand grains together. After the removal of the pattern and mold from the curing oven, the mold is stripped from the pattern.

2

The formed molds are, in effect, thin shells which usually have sufficient strength and stiffness to make them suitable for many casting operations if these shells are properly backed up by steel shot or other suitable materials. However, I have found that thin shell molds lack the necessary rigidity, even when certain external backing means are employed, to provide precision castings under many operating conditions, the molds frequently tending to bulge, crack, or otherwise become distorted by the pressure of the molten metal during or immediately after pouring. Not only does such mold distortion prevent casting to very close dimensional tolerance, but it also results in excessive finning at the mold parting line. Moreover, backing up the molds with steel shot is a cumbersome and expensive process.

Accordingly, a principal object of my invention is to provide an inexpensive and easily applied mix which may be placed on the back surfaces of thin-walled molds and subsequently baked so as to reinforce these molds, thus permitting the elimination of the aforementioned type of backing means and the attendant casting difficulties. A further object of this invention is to provide a process for reinforcing shell-type sand-resin molds by the use of the aforementioned mix and to thereby permit greater flexibility and economy in the method of backing up this type of mold.

Other objects and advantages of this invention will more fully appear from the following description of a preferred process for forming and applying the reinforcing mix for shell molds, reference being made to the accompanying drawing showing a sectional view of the resultant reinforced mold assembly.

It will be understood that the term "mold," as used herein, is generally applied in its generic sense to mean a casting form which includes both molds and cores, this invention in no manner being limited to the former.

Similarly, unless otherwise indicated, the word "pattern" is used herein as including both mold patterns and core boxes.

In accordance with my invention, a layer of a mixture of sand and a waterglass solution, which functions as a binder, is placed on the back of a sand-resin mold and suitably dried or baked. This mixture, which forms the reinforcing material, provides a very firm and close contact with the entire outside surface of the mold, thus assuring no change in the mold cavity dimensions. At the same time, this reinforcing layer provides adequate permeability for mold gases generated at the time of metal pouring. The advantages of this type of mold backing also include the fact that low-cost materials are used and that only a relatively short time is required to apply it to a mold section or core.

More specifically, a waterglass solution of the desired concentration is first mixed with the sand. This may be done either by hand or machine mulling, the former method generally requiring approximately two to three minutes and the latter not more than one minute. The sand is readily wet by the waterglass solution and is immediately ready for application on the mold section. On the other hand, if it is desired to do so, this mix may be kept for several hours prior to use by covering it with a damp cloth.

Referring now to the drawing, a layer of the moist reinforcing mix 10 having the desired thickness is then placed on the back of a shell mold section 12, a layer having a thickness of from 1/2" to 2" usually being satisfactory for most applications. The resultant reinforcing mold construction is next dried, preferably by baking in a circulating air oven at a temperature within the range of approximately 300° F. to 700° F. This assembly generally should be permitted to remain in the oven from two to five minutes, the waterglass-bonded

sand setting readily upon heating to give a snug, firm support for all details of the mold. Upon baking, the waterglass not only securely bonds together the sand particles of the baking material, but also causes the backing layer to adhere to the shell mold section.

In the drawing, two reinforced shell mold sections 12 are shown in assembled position preparatory to the pouring of the molten casting metal into the formed inter-jacent mold cavity 14. Of course, these reinforced mold halves are retained in abutting position during the pouring operation by clamping or other suitable means, not shown. One of the reinforcing layers 10 is shown as being of a type which follows the general contour of the supported mold section, while the other reinforcing layer is shown as having a flush exterior surface, the latter being easier to form and to support during pouring. The contoured type of reinforcing layer, however, possesses the advantage of requiring less material to perform the same function.

Hollow cores may be similarly reinforced by this sand-waterglass mixture. This is accomplished by filling the interior space of the core with this mix and then heating the core and reinforcing layer in the aforementioned manner. In this connection it will be appreciated that my baked reinforcing mix possesses not only the required permeability and strength, but also the proper collapsing characteristics upon shake-out to make it suitable for such applications.

In accordance with the invention, I have found it convenient to employ commercially available waterglass containing between 30% and 40% sodium silicate. The sand which is preferably used to produce best results is a silica sand having an American Foundrymen's Society fineness number between 30 and 150, sands having AFS fineness numbers between 40 and 60 being particularly satisfactory for most applications. However, any type of sand or comminuted refractory material may be used, such as zirconium silicate sands, metallic shot, grit, etc. Currently the relatively high cost of some of these materials is the principal objection to their use.

By the term "waterglass" I mean to include not only sodium silicate and its water solutions, but also potassium silicate and mixtures of these two silicates, the latter generally being referred to as "double waterglass." Moreover, the use of sodium tetrasilicate, if the silicate is to be introduced in that form, is also meant to be included within the scope of this invention.

With respect to the quantity of waterglass used, sodium or potassium silicates, or mixtures thereof, may be advantageously added in amounts ranging from 0.07% to 7% of the total weight of the resultant mix. Depending upon the fineness of the sand employed and the amount of sodium silicate used, the water content of the mix may vary from 0.9% to 13%. The remainder of the reinforcing mix, of course, is substantially all sand, this mix proving satisfactory for many applications.

More specifically, when the waterglass is used with silica sand having AFS fineness numbers ranging from 30 to 150, particularly useful quantities of sodium silicate, for example, have been found to range from 0.2% to 0.7%, with the water content varying from 1.3% to 4% and the balance of the mixture being substantially all sand. Finer refractory materials, of course, require a somewhat greater quantity of binder.

It will be understood that the water content in the above examples is the sum of the water of hydration and any additional water which may be present in commercial waterglass, together with any other water which it may be desirable to add to satisfactorily wet the sand-binder reinforcing mixture. Accordingly, either the pure or commercially pure solid silicates may be employed in conjunction with the amount of water necessary to bring the water content to the above percentages, or a commercial waterglass solution may be used with more water being added, if it is found advantageous to do so, in order

to provide sufficient wetting properties. It also will be appreciated, of course, that when a commercial waterglass solution containing between approximately 60% and 70% water is used, the greater the amount of this solution employed, the lesser the amount of additional water required. In fact, when one of these waterglass solutions is used in a quantity which provides a relatively high silicate content in the final mix, no additional water is usually required. On the other hand, it is frequently necessary to add water to this same waterglass solution to adequately wet the sand particles when this solution is used in an amount providing a relatively low silicate content in the final mix.

Despite the necessity of sufficiently wetting the sand, reinforcing mixes containing very high water contents, or which use extremely dilute solutions of waterglass, should not be employed without adequate external support because such mixes reduce the green strength of the core. Accordingly, it is highly desirable that the resultant concentration of a sodium silicate solution, for example, be retained between the limits of approximately 2% and 35%, these percentages representing the ratio of the weight of the pure anhydrous silicate to the total weight of the waterglass solution. On the other hand, with larger amounts of water, a longer setting time is required in order to drive off the water. I have therefore found that a particularly useful mixture of the sand and waterglass reinforcing material is one which consists of approximately 98% sand, 1% commercial waterglass having a sodium silicate content of approximately 37%, and 1% additional water. This, of course, is equivalent to a mixture of approximately 0.4% anhydrous sodium silicate, 1.6% water and 98% sand. In this latter example, the water content is the sum of water in the free form and that which may be present in the silicate as water of hydration. As heretofore stated, sand having an AFS fineness number between 40 and 60 may be advantageously employed, the use of this particular sand being especially desirable in conjunction with the aforementioned specific waterglass composition.

Upon pouring the liquid metal into the mold cavity in the usual way, the hot metal, on coming into contact with the mold, burns the plastic binder to essentially carbon. As a result of this plastic breakdown, the shake-out is readily accomplished. The gases which are generated readily escape through the highly permeable sand-resin shell and reinforcing layer.

Inasmuch as the above-described reinforced mold assemblies faithfully reproduce pattern details and maintain good dimensional tolerance, this process can be used to provide cast metal parts of extremely thin section which can be cast to almost the precise dimensions ultimately desired. The resultant castings have unusually smooth and clean surfaces, true dimensions and a minimum of fin at the mold parting line because of the unusual surface smoothness, high gas permeability and rigidity of these mold assemblies. The surfaces of these castings are also free of residual mold material, thereby eliminating the necessity of shot blasting. Hence the use of the above reinforced molds permits the production of sound precision castings in a variety of metals over a wide range of casting temperatures. Moreover, these mold assemblies can be produced and processed without objectionable dust formation.

While my invention has been described by means of certain specific examples, it will be understood that the scope of my invention is not to be limited thereby except as defined in the appended claims.

I claim:

1. A process for forming a reinforced shell mold assembly for casting metal, said process comprising placing a mixture of a major proportion of sand and a minor proportion of thermosetting resin in contact with a hot metallic pattern for a period of time sufficient to melt the resin and to bond a substantial portion of the sand par-

5

ticles together, removing any excess sand and resin, subsequently curing the formed mold shell by baking for a short period of time while in contact with the pattern, stripping the mold shell from the pattern, applying to the back surface of said mold shell a moist layer of a mixture comprising 0.9% to 13% by weight of water, 0.07% to 7% by weight of sodium silicate and the balance substantially all sand, and thereafter baking the formed reinforced shell mold assembly for at least two minutes at a temperature between 300° F. and 700° F.

2. A process for forming a reinforced shell mold assembly for casting metal, said process comprising placing a mixture of a major proportion of sand and a minor proportion of thermosetting resin in contact with a hot metallic pattern for a period of time sufficient to melt the resin and to bond a substantial portion of the sand particles together, curing the formed mold shell by heating for a short period of time while in contact with the pattern, stripping the mold shell from the pattern, applying a moist mixture comprising approximately 0.2% to 0.7% by weight of sodium silicate, 1.3% to 4% by weight of water and the balance substantially all sand to the back surface of said shell mold so as to form a reinforcing layer having an average thickness between about one-half inch and two inches, and thereafter baking the formed reinforced shell mold assembly for approximately two to five minutes at a temperature between 300° F. and 700° F.

6

ing layer having an average thickness between about one-half inch and two inches, and thereafter baking the formed reinforced shell mold assembly for approximately two to five minutes at a temperature between 300° F. and 700° F.

References Cited in the file of this patent

UNITED STATES PATENTS

10	1,889,007	Wallace -----	Nov. 29, 1932
	1,914,037	Norton et al. -----	June 13, 1933
	1,959,179	Snell -----	May 15, 1934
	1,999,382	Weggandt -----	Apr. 30, 1935
	2,322,667	Seastone et al. -----	June 22, 1943
15	2,368,322	Passelecq -----	Jan. 30, 1945
	2,398,047	Schmidt -----	Apr. 9, 1946

FOREIGN PATENTS

585,665	Great Britain -----	Feb. 18, 1947
---------	---------------------	---------------

OTHER REFERENCES

FIAT Final Report No. 1168. The "C" Process of Making Molds and Cores for Foundry Use. Recd. in Library April 8, 1948.