Patented Nov. 20, 1945 2,389,538

UNITED STATES PATENT OFFICE

2,389,538

FOUNDRY COMPOSITION

Arnold Edward Pavlish and Chester Ronald Austin, Columbus, Ohio, assignors, by mesne assignments, to Peerpatco, Incorporated, Indiana, Pa., a corporation of Delaware

No Drawing. Application July 23, 1943, Serial No. 495,898

5 Claims. (Cl. 22—188)

Our invention relates to foundry compositions, more particularly foundry binding and mold compositions employing these binders, and to the art of producing the same.

The objects of our invention include the provision of a high-quality foundry composition having a high sintering point and low contraction at high temperatures; and which has controlled high green strength and controlled dry strength and high permeance to vapors and gases encountered in actual use; and, moreover, the ingredients of which are readily avaliable and easily handled, which composition is readily introduced and rammed about a pattern, does not cake and harden in use, is easily recovered after use, and may be repeatedly employed in the production of sound, high-grade castings.

Other objects in part will be obvious and in part pointed out hereinafter.

The invention accordingly consists in the combination of elements, mixture of materials and composition of ingredients, and in the several steps and the relation of each of the same to one or more of the others, all as described herein, the scope of the application of which is indicated in the accompanying claims.

To facilitate complete understanding of the essential features and novelty of our invention, it is to be noted at this point that in foundry practices heretofore employed it is customary to add a certain rather considerable amount of bonding clay to silica sand in forming a mold, for example. This bonding clay is mixed with the clean silica sand preparatory to its use. The mixture is tempered with water to provide a moist, easily workable mix. It is conventional where desired, and in order to reduce operating costs, to mix with and as a substitute for part of the clean sand, a certain quantity of burnt sand.

While as may be seen from the foregoing, the clay present in the conventional composition is valuable to the extent that it imparts the necessary strength and cohesiveness to the composition, the attendant disadvantage is present that to accomplish this end the clay must be present in rather high percentage. A large quantity of clay, however, correspondingly decreases the porosity of the mold. Decrease in permeance constitutes a serious problem, since it is well known that such porosity or permeance is essential in venting through the mold the vapors and gases evolved upon contact of the cast material with the mold walls.

The exact quantity of bonding clay employed, ranging from 10% to 30% in ordinary instances, depends upon a number of factors. For example, sharp-edged, irregular-grained sands require comparatively little bonding material. Smooth, rounded grains, of which the standard Ottawa sands are typical, require more. Coarse sands require more binder than do fine-grained sands. The type of work to be cast likewise exercises a controlling influence on the required amount of binder. For example, where the work to be cast is comparatively light, then a comparatively weak mold may be employed. Conversely, where large castings are being poured, having substantial weight in the mold, then a strong mold is required to support the same, and more binder is required. This added binder decreases the permeance in just the case where the large quantity of molten metal employed requires high mold permeance to vent the vapors and gases incident upon pouring. Again, where part of the clean sand of the composition is replaced by a certain amount of burnt or used sand, then since some clay is already mixed with this substituted sand the quantity of clay to be added to the composition is correspondingly decreased.

Typical among the large number of bonding clays heretofore in use may be listed fire clays which are clays largely comprising kaolinite, but also including montmorillonite and beidellite, and in certain classes of work, the non-refractory grades of clays as well. These clays, both the refractory and non-refractory types, are available in numerous localities throughout the United States. They have the disadvantage, however, that only a limited increase in the strength of the mold is brought about by their use. Additionally, as stated hereinbefore, these clays when present to an extent providing required mold strength considerably diminish the permeance of the mold. Compromise or balance thus has been required between the factors of strength on the one hand and permeance on the other hand, the final result not being completely satisfactory from either standpoint.

It has been suggested, as an improvement upon the known clays just discussed, to employ the bentonite clays, either of the colloidal swelling type such as the western bentonite or the non-swelling colloidal southern bentonite. These clays consist largely of the mineral montmorillonite. The western bentonites, however, while having desirable high permeance, are characterized in that they swell as much as ten times or more their original volume upon admixture of water thereto, forming a stiff, strong gel. Mold compositions formed with western bentonite are

somewhat gummy, do not flow readily, and ram only with difficulty. This difficulty in ramming frequently results in failure to follow closely the details of the pattern. Shrinkage in drying tends to the formation of fins and scabs on castings made in molds employing this binder. The hardening of the mold and its high dry strength constitute important disadvantages except in the casting of large heavy articles.

On the other hand, a foundry composition containing the so-called southern bentonite, a non-swelling colloidal montmorillonite found for example at Pontotoc, Mississippi, displays rather desirable flow qualities, and can be rammed with comparative ease about a pattern, ensuring that the result-casting will possess the required degree of detail. The composition is soft and free from stickiness. The southern bentonite imparts high green strength but only a low dry strength as compared to western bentonite. The composition has a high sintering point, with low contraction at high temperatures. It may be explained at this point that where the term colloidal is employed herein with respect to southern bentonite it is used in the sense accepted in the foundry practice. That is, it is descriptive of the size of particle of the clay. The colloidal clay is usually considered as consisting of fine particles of one micron or less in diameter.

It may be noted that the rather high green strength and comparatively low dry strength imparted by the southern bentonite particularly adapts mold compositions embodying the same for the accurate and successful casting of small articles of intricate design which must be faithfully reproduced. Nevertheless many instances arise where it is desirable to cast articles of substantial dimensions and considerable weight. The low dry strength of compositions employing southern bentonite as a binder do not adapt them for such purposes. On the other hand, it is known that the western bentonites give rise to mold compositions which have substantially lower green strength but high dry strength. Mold compositions employing western bentonites as a binder, therefore, are satisfactory for the production of large size castings possessing considerable weight, but which have no great intricacy of design.

There exist, however, a number of foundry problems involving the casting of forms of weight and degree of detail ranging the full gamut between the extreme conditions just described. Moreover, there are occasionally encountered instances in foundry practice where abnormally large castings must be produced, in which it is desirable to increase the dry strength of the mold even above that imparted by the use of western bentonite alone as a binder.

One of the objects of our invention, accordingly, is the provision of a bonding composition which is readily available, and which gives a foundry mold composition which while retaining and in some instances increasing the high flowability thereof, permitting easy ramming about a pattern and giving rise to high permeance and high sintering point of the composition, permits within wide limits the regulation or control of both the green and dry strength thereof and moreover permits high recovery of that mold composition after use.

Turning now to a more detailed discussion of the practice of our invention, we find that boric acid, when added in small quantities to the bentonite binder, imparts in some unexplained manner a marked degree of regulation to both the green and dry strength of the foundry composition in which the binder is employed. In U. S. Patent No. 2,180,897, issued to Norman J. Dunbeck on November 21, 1939, and entitled Composition, southern bentonite as a binder in a foundry composition has been fully discussed. Referring first to a binder comprised largely of this material, we find that by treating the southern bentonite with some 5% to 30% by weight of boric acid and then using this treated clay or mixed binder gives a foundry composition of correspondingly increased green strength together with corresponding increase of its dry strength. Since the dry strength of compositions employing southern bentonite as a binder is already low, however, the controlled increase in dry strength attendant upon admixture of the larger proportions of boric acid is not undesirable. On the contrary, this increased dry strength is desirable in the production of those castings of intermediate size and weight which require high detail of design.

The fact that the admixture of boric acid does not increase the total quantity of binder employed, but, in fact, somewhat decreases the amount of clay employed, ensures that the required high degree of permeance of the foundry composition is retained. The percentage of southern bentonite in the binder dominating, there are retained in the mold composition embodying the same, the high flow qualities characteristic of this binder, together with ease of ramming about the pattern and close adherence to the detail of the pattern, and its ready collapse in intricate sections and high degree of recovery after use.

In making a foundry composition in accordance with our invention, there is added to clean silica sand, or to silica sand containing such proportion of burnt sand as is desired, about 5% of a binder which in itself consists of from 95–70% southern bentonite and 5–30% boric acid. This composition is mixed in the usual foundry mixer to obtain a uniform consistency. Thereupon water is added in desired amount, ordinarily about 2–5% by weight, and illustratively 2½% by weight. Continued mixing produces a uniform mix of desired strength, whereupon this composition is employed in preparing a sand mold following known technique. This new mold composition is easily handled. Being neither gummy nor sticky, it flows readily.

Upon its introduction into a conventional jolt or other type molding machine, the composition is rammed readily about a pattern, and the sand packs tightly about the latter. A smooth surface is produced which accurately follows the pattern details. The high strength of the mold ensures that it is well retained in the cope of the flask when the pattern is withdrawn. A mold is left which is clear-cut and free from edge breaks and cracks, thereby requiring only a minimum of repair before casting.

An important advantage of our invention is that the mold composition is strong and well adapted to practical use. A summary of actual tests upon samples of mold compositions following our present invention discloses an accurately controlled and predictable increase in green compression strength, and a similar desired, controllable and predictable increase in dry strength. These tests strikingly disclose the improved nature of the foundry composition, according to our invention. In carrying out these tests, sample mixes are prepared comprising 95% clean, un-

bonded silica sand, Michigan City sand being employed, with 5% by weight of binder. These are mulled in a laboratory muller along with 2½% by weight of water, and then tested. The recommended procedure published by the American Foundrymen's Association was followed in carrying out the tests. The test data are conveniently shown in the following table.

Composition 95% sand and 5% mixed binder (southern bentonite with boric acid noted)	Green compression strength	Dry compression strength	Green permeability
	Lbs. per sq. in.	*Lbs. per sq. in.*	*A. F. A. units*
0% boric acid	12.94	24.0	275
5% boric acid	15.94	35.1	300
15% boric acid	18.14	43.9	313
30% boric acid	21.54	52.5	350

It is readily apparent from a consideration of the foregoing table that increase in the proportion of boric acid in the binder results in corresponding substantial yet controlled and predictable increase in the green strength of the composition, together with moderate controlled and predictable increase in the dry strength of the latter. Permeance is improved somewhat.

According to the teaching of our invention, we produce a mold composition which is readily suited for the exacting requirements of a wide variety of foundry problems. Thus it responds to a wide-felt need in the art. The application of our invention to southern bentonite as a binder is particularly advantageous where it is necessary to produce castings having intricate detail in moderate size and weight.

Similarly, good results as to dry strength are obtained by the admixture of boric acid to western bentonite, where it is desired to increase the already high dry strength of the latter to a still higher value to accommodate for castings of outstanding dimensions and weight. Employing 95% by weight Michigan City sand, together with 5% by weight of binder and water to the extent of 2½% by weight of the dry ingredients, and following the same preparation as set forth hereinbefore in connection with the testing of southern bentonite, the results obtained are presented in tabular form.

Composition 95% sand and 5% mixed binder (western bentonite with boric acid noted)	Green compression strength	Dry compression strength
	Pounds per square inch	*Pounds per square inch*
0% boric acid	11.92	52.3
5% boric acid	12.98	53.6
15% boric acid	9.68	112.0
30% boric acid	9.24	139.0

Examination of the data set forth in this table demonstrates that there is a predictable increase of dry strength of the western bentonite binder upon admixture of determined percentages of boric acid. Moreover, while the green strength of the 5% boric acid binder is higher than that of the straight 5% bentonite, this figure apparently is critical, and added percentages of boric acid result in a decrease in the green strength. This is by no means detrimental, since ordinarily the large castings do not have the considerable amount of detail which frequently characterizes the smaller castings. This means that high green strength is not so essential.

We find that a mold produced in accordance with the teachings of our invention has a high sintering temperature, on the order of 2500° to 2600° F., as compared with 2300° to 2400° F. for molds using western bentonite alone as a binder. A mold or foundry composition, according to our invention, therefore, displays high resistance to heat and "burning on" of sand particles to the casting. Moreover, the mold is resistant to contraction at high temperatures, displaying only about .05% contraction at 2500° F. It is for this reason that the formed castings display freedom from fins, scabs and like imperfections heretofore of common occurrence in the foundry art.

Particularly where southern bentonite is employed as the principal ingredient of the binder, the composition, according to our present invention, not only retains the desirable features of the composition covered by the prior Patent No. 2,128,404 issued to Norman J. Dunbeck on August 30, 1938, and entitled "Composition," of moderate dry strength, good flowability and ramming properties, high sintering point, low contraction at high temperatures, but as well, is capable of working at lower moisture content and with faster mixing. This low moisture content is highly desirable since it is recognized that it is this element which contributes most of the vapors and gas driven off when the hot metal strikes the mold. Large capacity foundries are particularly benefited by faster mixing, since frequently in such instances only limited mixing time is available.

It is significant, as briefly noted hereinbefore, that the permeance of the mold remains substantially constant with various proportions of boric acid. This is contrary to the usual rule that increase in the green strength of a composition is accompanied by decrease in the permeance. It is highly desirable that a foundry composition have the greatest possible permeance. This most surprising result probably follows upon the important discovery that the increase in green strength in the case of the Southern bentonite is accomplished without increasing the amount of binder present in the foundry composition. High green strength is had with a minimum quantity of clay, thereby achieving high permeability, less dead clay and fines in the sand, and other advantages which are readily apparent to those skilled in the art.

While, illustratively, the amount of bonding material has been recited as preferably being about 5% by weight of the dry ingredients, good results are obtained when the quantity of bonding agent ranges from about 2% to about 8% of the weight of the dry ingredients. Where a part of the sand consists of burnt sand, these proportions can be extended to about ½% to about 8%. This is because the bonding agent is reversible in character. Thus it can be used over again.

The bonding clay is desirably first mixed with boric acid and the resulting bonding agent then mixed with sand. Then the mixed sand can be added to sand systems or heaps, to maintain a satisfactory volume of sand on hand. Where desired, however, the clay is mixed with sand and the boric acid subsequently added. Also, where desired, the mixed binder first is prepared and this is added to the sand of the mold being prepared, or is added to the sand in handling systems, or is added to sand heaps by spreading over the heaps, or is added by any of the methods in common use.

Also, while our new foundry composition has been illustratively described with reference to a mold comprising silica sand and our new binder, this invention is applicable to like compositions

for other foundry uses. Facing sands for green sand or dry sand, work or core sands and the like advantageously are prepared, consisting of various combinations of new and burnt silica sand, new and burnt molding sand, naturally bonded sand or bank sand, together with the bonding clay. Auxiliary binders in small quantities, such as pitch or rosin, goulac, cereal binders, and cement, and casting cleaning elements such as wood flour, oils or sea coal likewise may be added where required.

While we have particularly described a binder of bentonite and boric acid, and a foundry composition employing this binder, we have achieved good results in a binder of fire clay and boric acid in the same percentages as the mixed binder including bentonite. In general, then, it may be concluded that a mixed binder of boric acid and refractory clay gives rise to advantageous, controlled green and dry compression strengths in foundry compositions employing these binders.

Thus it will be seen that we have provided, according to our invention, a new foundry composition, a new binder and an art of employing the same in which the various objects hereinbefore noted are successfully accomplished, together with many other advantages important from the practical standpoint. Our new bonding composition is admirably suited to the many varying conditions encountered in actual operational practice, in many varied applications.

As many possible embodiments may be made of our invention, and as many changes may be made in the embodiments hereinbefore set forth, it should be understood that all matter described herein is to be interpreted illustratively, and not in a limiting sense.

We claim:

1. In a composition of matter, a foundry binder comprising a non-swelling montmorillonite clay with dry boric acid present in the approximate range of 5% to 30% by weight.

2. In compositions of matter of the class described, a foundry composition comprising in combination, silica sand and about ½% to 8% by weight of binder comprised of non-swelling montmorillonite clay and a small addition of dry boric acid.

3. In compositions of matter of the class described, a foundry composition comprising in combination, silica sand, about ½% to 8% by weight of binder comprised of non-swelling montmorillonite clay with dry boric acid present in the approximate range of 5% to 30% of the total weight of the binder, and water in the amount of 2% to 5% by weight.

4. In compositions of matter of the class described, a mold composition of controlled and predictable green and dry compression strengths, comprising in combination, sand and from ½% to 8% by weight of binder comprised of southern bentonite and dry boric acid present therein in the approximate range of 5% to 30% of the total weight of the binder.

5. In preparing a mold composition for foundry purposes, the art which includes intimately intermingling sand with approximately ½% to 8% by weight of a binder comprised of approximately 95% to 70% by weight of non-swelling montmorillonite clay and approximately 5% to 30% by weight of dry boric acid.

ARNOLD EDWARD PAVLISH.
CHESTER RONALD AUSTIN.