

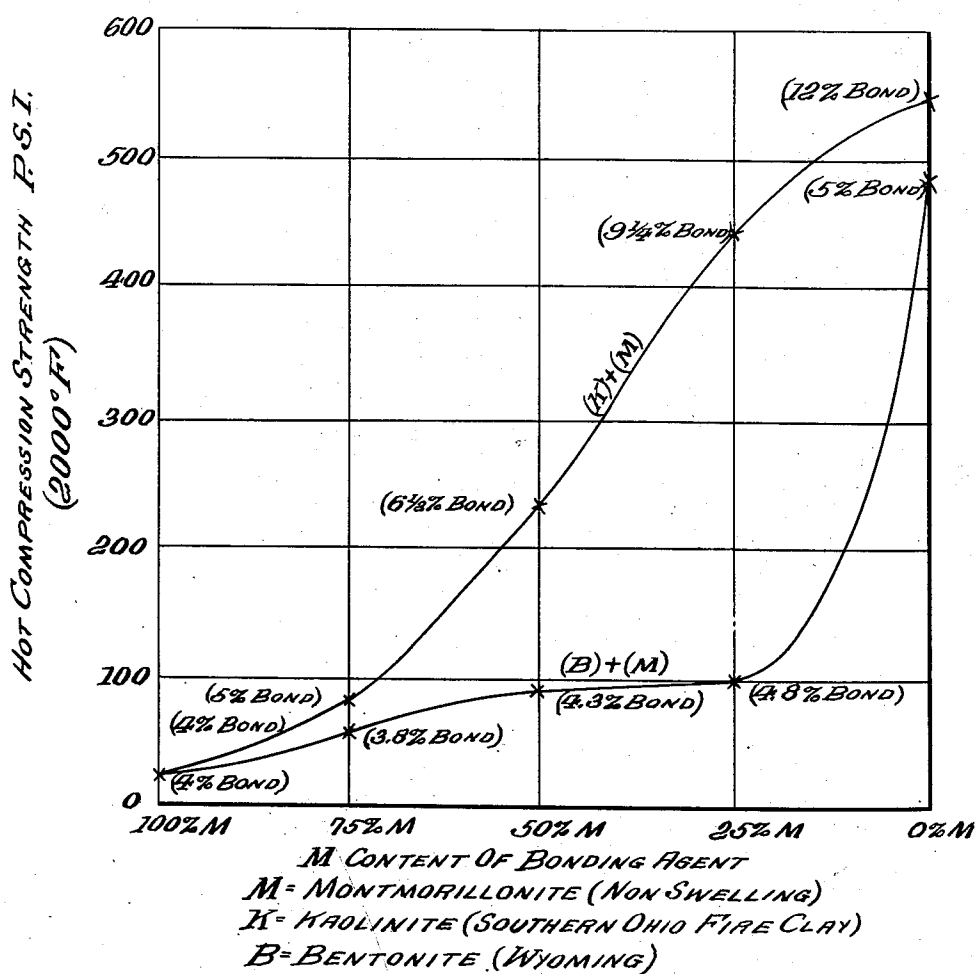
Sept. 23, 1941.

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2,256,943

FOUNDRY COMPOSITION

Filed March 10, 1941



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2,256,943

FOUNDRY COMPOSITION

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Application March 10, 1941, Serial No. 382,656

9 Claims. (Cl. 22-188)

My invention relates to compositions of matter, and more especially to such compositions as are used for foundry binders and to the foundry compositions employing such binders.

One of the objects of my invention is the provision of a bonding agent which is made from inexpensive and readily available materials and which can be so modified that numerous types of foundry work are performed with good results by its use.

Another object of my invention is the provision of a foundry composition which has adequate strength yet is of sufficient permeability under working conditions to allow the escape of gas and fumes, which at high temperatures is capable of withstanding the cutting and washing effects of the casting material, which at approximately 2000° F. has peak hot strength, which, at the same time, has an unusually high green strength together with a high sintering point and which resists caking and hardening in use, which is easily recovered after use and which may be repeatedly employed to give sound, high grade castings.

A further object of my invention, along with those previously mentioned, is to provide a foundry composition the proportions of the ingredients of which are capable of being pre-selected to produce a desired hot strength of composition to meet instant working requirements and which has satisfactory hot strength without the sacrifice of other desirable qualities necessarily present in a molding composition.

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

The invention accordingly consists of 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 as described herein, the scope of the application of which is indicated in the following claims.

The accompanying drawing compares the change in hot strength of a mold composition made in accordance with my invention, with the change in hot strength of a conventional mold composition; based upon the change in the proportions of the ingredients contained in the bonding agent.

In forming foundry compositions it is common practice to thoroughly mix with clean silica sand a proportionately small amount of clay binder and this mixture when tempered with water forms a workable molding material. The practice of substituting burnt or reclaimed sand for

part of the clean silica sand is also well known in the art.

As a general rule, it is desirable to maintain the water content of a foundry composition reasonably in keeping with the characteristic permeability of the mixture. When this is done, less steam will be formed, and that which is formed, will have an opportunity to escape from the mold, with the result that the danger of having gas flaws appear in the casting is consequently reduced. Too little moisture, on the other hand, is likely to produce a composition of undesirable dryness, and in consequence, the mold will crumble or wash during foundry operations. Harder ramming could be used to overcome excess dryness except for the fact that such practice materially reduces the permeability of the composition. Thus it is to be observed that in taking steps to correct one existing fault in a mold composition, other new and undesirable factors are likely to arise unless particular care is exercised in originally selecting proper constituents for the foundry composition.

The amount of clay mixed with a molding sand should be low in proportion to the quantity of sand. The type of molding sand available has a governing effect upon the amount of bonding material needed. For example, an angular or sub-angular grained sand requires less clay than a sand having smooth rounded grains. Fine grained sands require less clay bonding agent than do coarse sands. Ordinarily the amount of bonding clay employed, ranges from 5% to 30% of the mass of the mold mixture.

Several types of bonding clays are now used in foundry practice. Probably the most prevalent among these clays are the fire clays which are largely comprised of kaolinite and naturally included montmorillonite and beidellite. Non-refractory clays are also employed and they are generally of glacial origin and are predominant in minerals of the sericite or illite type. Certain sedimentary clays of greater geological age are also found in the non-refractory group. A large proportion of the mineral beidellite or illite may also be found in these clays.

Both refractory and non-refractory clays can be obtained from various parts of the United States. Such clays have not proven to be highly satisfactory, however, since they fail to give necessary mold strength when used in small amounts. When the percentage of such clays is increased in foundry compositions, the mold permeability is then severely decreased and mold dry strength is unduly increased. It is highly

essential that a foundry composition be sufficiently permeable, otherwise the necessary escape of gas and fumes generated at working temperatures is impaired. If too much clay is used, the mold will bake hard at working temperatures. Castings will crack when a part of the mold which is partially surrounded by metal bakes so hard as not to allow the casting to shrink properly as it cools. It is accordingly, obvious that a high amount of clay present in a molding composition is undesirable.

Where a clay, such as fire clay, is employed as the bonding material, the amount required varies from approximately 10% to 30% of the mass of the molding sand, depending upon the quality of the sand and upon the quality of the clay. Clay of this sort lends good hot strength to a molding sand, but at the same time impairs the permeability of the sand and imparts an undesirably high dry strength to the sand. For reasons such as the latter, the use of fire clay for a foundry bonding agent is restricted.

Good green strength of mold together with good permeability and desirable dry strength can be obtained by using either a non-swelling, colloidal or non-colloidal clay binder. The properties of a Porter's Creek clay binder, a non-swelling, non-colloidal clay, are more fully described in my Patent No. 2,128,404, issued to me on August 30, 1938. The adaptability for foundry use of a non-swelling, colloidal clay of the Pontotoc, Mississippi type, is set out in my Patent No. 2,180,897, issued to me on November 21, 1939. These non-swelling clay binders have proven to be quite satisfactory in most respects except that they are not totally satisfactory for high temperature work since they tend to impart low hot strength to molds at high temperatures.

Swelling montmorillonite or Wyoming type bentonite binders have many advantages in foundry practice, but one disadvantage which has been recognized by foundrymen is the exceptionally high dry strength obtained by the use of such binders. This latter characteristic causes difficulty when the molding material is removed from the flask. The material bakes to great hardness. To shake the mold from the flask is expensive since the flasks must receive rough treatment. More expense is encountered in that much of the baked sand cannot be reclaimed for it is difficult to crush from hard lumpy condition. Further, Wyoming type bentonite is expensive to obtain in the eastern part of the country because of the great shipping costs involved.

Another problem which arises in foundry practice is that of obtaining a bonding agent for use in foundry sands which can be suited to different working conditions without changing more than the proportion of its basic ingredients. Castings of different sizes and proportions and of differing materials can be produced conveniently when a bonding agent of this nature is employed. The ingredients of the bonding agent can be so modified in proportion that the particular working requirements will be satisfied. A procedure such as this is by far more economical than that of using an entirely different bonding agent each time a different type of casting is to be produced.

Some compositions, such as those in which Wyoming type bentonite bonding agent is used, are very satisfactory when heavy castings are made, since in this instance, a higher dry strength of the composition is permissible. On

the other hand, compositions containing a Wyoming bentonite binder have a dry strength too great to be satisfactory for use in casting small thin objects. A non-swelling montmorillonite whether a non-colloidal clay such as Porter's Creek clay, as described in my Patent 2,128,404, above referred to, or a colloidal clay as set forth in my Patent No. 2,180,897, also referred to above, are suitable for use as bonding agents in the production of thin, light castings, for they impart a relatively low dry strength to compositions in which they are ingredients.

It was subsequently learned that the constituent parts of a mold bonding agent can be varied in proportions so as to impart to molding sands with which the agent is mixed, any desired, pre-determined dry strength. This development is set out in my Patent No. 2,230,939, issued to me on February 4, 1941, which discloses a foundry composition having a bonding agent basically comprised of Wyoming type bentonite and a non-swelling montmorillonite. A valuable advantage of a binder formed with these constituents lies in the fact that the dry strength of mold in which it is employed definitely can be pre-determined by proper proportionment of basic binder ingredients. Consequently, the foundryman is furnished with a new and valuable method of controlling mold dry strength. Once the particular working conditions are known, the dry strength of the mold composition can be designed to meet the instant needs. This is accomplished by mixing together the proper amounts of bonding ingredients and sand. Fortunately, many other advantages follow from the above improvement. The danger of having sand bake in the flasks because of the presence of an excess of clay has been overcome. It is a simple matter to break down the dry composition and thereafter recover the burnt sand without encountering hard lumps.

One puzzling factor which has become evident while controlling the dry strength of foundry compositions by the practice of properly proportioning the constituents of the binding agent, is that of the development of cuts and washes in the mold and in the casting at high temperatures. This occurs in spite of the fact that the dry strength of the foundry composition is carefully regulated. Precise control over dry strength of a foundry composition does not, in the same measure, give absolute assurance that the hot strength of the composition will be suitable. Therefore, even though the molding material does not bake to a hard degree, and even through it is easily removed from the flask, recovered and reconditioned, the casting itself may still have scabs, flaws or defects because of the cutting and washing away of portions of the mold composition at high temperatures. This condition is more or less prevalent depending, for example, upon the working temperatures; the nature of the casting, as for example, the character of the casting material; the composition of the foundry material with respect to proportion of elements, one to the other, of sand, moistening agent and bonding material or to the proportions, with respect to each other, of the elements of which the bonding agent is comprised.

It will be observed from Table I that a foundry sand containing bonding material of the combined Wyoming bentonite (B) and non-swelling montmorillonite type (M), as described in my previously mentioned Patent No. 2,230,939, does not possess extremely high hot strength in the

neighborhood of 2000° F., but has reached peak hot strength near 1500° F.

Table I

	Bond				
	M	75% M 25% B	50% M 50% B	25% M 75% B	B
Percent bond.....	4	3.8	4.3	4.8	5
Percent moisture.....	2.6	2.5	2.5	2.5	2.5
Green compression (p. s. i.).....	9.9	9.6	9.8	9.8	9.6
Dry compression (p. s. i.).....	47.0	42.0	59.0	59.0	83.0
Hot strength (p. s. i.):					
500°.....	21	31	38	43	75
1,000°.....	35	42	53	55	74
1,500°.....	30	70	160	175	195
2,000°.....	25	65	90	95	490
2,500°.....	3	4	5	4	8

M=Non-swelling colloidal montmorillonite (Pontotoc Mississippi clay).

B=Swelling montmorillonite (Wyoming type bentonite).

Accordingly the main object of my invention is to provide a bonding material which imparts good high temperature hot strength to molding sands, which contains cheap and readily available ingredients, which has peak hot bonding strength at temperatures around 2000° F., which has a hot bonding strength that is capable of being predetermined by proper proportionment of binder constituents, which imparts high green strength and an adequately high dry strength to molding sands regardless of the proportions of the bonding material constituents used and which has good permeability and good workability, together with a high sintering point.

Considering now the practice of my invention, I prepare my bonding composition by thoroughly mixing kaolinite (K) with another clay composed largely of non-swelling montmorillonite (M). My invention is not to be limited in any way to the combination of these particular ingredients, but such ingredients are to be treated as illustrative only. The non-swelling montmorillonite clay which I use can be, for example, either of a colloidal or non-colloidal nature. I control the high temperature bonding strength of my foundry binder by varying the relative amounts of kaolinite and montmorillonite placed in the mixture. By increasing the amount of kaolinite in my composition I find that the high temperature bonding strength of the binder will improve. Green bond strength is unusually high in such kaolinite and montmorillonite binder compositions, hot bond strength is ideal and dry bond strength is sufficiently low. Further, the materials which I use in my bonding agent are cheap and readily available in many parts of the country, such as in the eastern States.

In preparing a foundry mold composition in accordance with one embodiment of my invention, I form my foundry binder of kaolinite (Ohio fire clay) and non-swelling, colloidal montmorillonite (Pontotoc, Miss.). The two ingredients are mixed to produce a uniform mass. Thereafter, I add by weight to approximately 85% to 98% of clean silica sand or silica sand containing a certain proportion of burnt sand as desired, 15% to 2% of my binder comprising kaolinite and non-swelling colloidal montmorillonite. The whole is then mixed in the usual foundry mixers to obtain uniform consistency. Thereafter, water is added in desired amount, usually 2% to 5% by weight. The mixing is then continued, finally giving a homogeneous mixture of desired strength and workability.

The hot strength of such mixture is controlled

accurately by proper proportionment of the parts of kaolinite (K) and non-swelling montmorillonite (M). It is to be observed from Table II and in the drawing that for a given temperature the hot strength of a foundry sand containing my bonding agent increases fairly uniformly as the percentage of kaolinite in the bonding agent is increased.

It will also be observed that the experimental results given in Table II are based on tests made on foundry compositions containing varied proportions of kaolinite (Ohio fire clay) and montmorillonite of the Pontotoc, Miss. type.

Table II

	Bond				
	M	75% M 25% K	50% M 50% K	25% M 75% K	K
Percent bond.....	4	5	6.5	9.25	12
Percent moisture.....	2.6	2.6	3.2	3.7	4.0
Green compression (p. s. i.).....	9.9	12.9	10.4	11.0	8.5
Dry compression (p. s. i.).....	47.0	55.0	71.0	83.0	71.5
Hot strength (p. s. i.):					
500°.....	21	40	35	54	55
1,000°.....	35	48	50	59	100
1,500°.....	30	30	62	100	153
2,000°.....	25	85	238	450	550
2,500°.....	3	4	5	5	5

M=Non-swelling colloidal montmorillonite.
K=Kaolinite.

It is to be especially noted when comparing Table I and Table II that the hot strengths of mold compositions which contain bonding materials comprising proportionate parts of kaolinite and non-swelling montmorillonite clay are very high in the neighborhood of 2000° F. while the hot strengths of bonding materials comprising Wyoming bentonite and non-swelling montmorillonite clay have begun to decrease after temperatures higher than 1500° F., are reached. It is accordingly, evident that the present invention permits the foundryman to produce better castings at high temperatures.

Further, by the practice of my invention the likelihood of obtaining cracked castings because of excess hot strength of mold is eliminated. While sufficient hot strength of a mold composition is necessary to prevent the casting material from cutting and washing into the mold, it is also essential that this strength be not too great. The hot strength of a mold composition must not be too high, or metal sections which partially enclose mold material may crack because the sand does not have sufficient collapsibility to permit normal metal shrinkage. I have overcome this difficulty by providing bonding elements which can be combined in such proportions that a predetermined hot bond strength at a given working temperature can be obtained. Therefore, in a foundry composition containing my bonding agent, the hot strength of the composition for a given working temperature can be modified by changing the proportions of the ingredients in my bonding agent. Thus, once the working temperature is known, I prepare a mold composition comprising sand, kaolinite and non-swelling montmorillonite in such proportions, one to the other, that the hot strength of the composition will not be too high, nor too low. By the use of a molding composition prepared in this manner, there is little danger that its hot strength will be so great that the casting will crack. Further, the hot strength of this mold composition will not be so low that molten casting material will wash, or cut into it. Con-

sequently, clean, sound castings can be produced at high temperatures, free from cracks, cuts, and scabs. No sand will cut or wash from the mold composition, to be replaced by metal washes and mix with the casting material to cause an imperfect casting to be produced. My binder, therefore, is economical in use, for it enables consistently good castings to be produced at high temperatures with a minimum waste of labor, time, and materials.

The ingredients going to make up my mold composition may be mixed together in any desired sequence. While the amount of mixed kaolinite and non-swelling montmorillonite bonding material is illustratively given as about 2% to 15% of the weight of the sand with which it is incorporated, it will be noted that these amounts may vary beyond the given limits, depending upon the nature of the sand which the foundryman may desire to use. In fact, these amounts will change considerably if burnt or reclaimed sand is chosen, since much bonding material may be present in the reclaimed sand, requiring an addition of only a few tenths of a percent of mixed kaolinite and non-swelling montmorillonite to restore original strength. In foundries which have only a slight daily loss of sand on the castings, it is frequently desirable to make a highly concentrated mixture of sand and blended bond clays, the clays in such cases sometimes comprising 50% of the mixture. Only a very small amount of such concentrated strength sand will be added to the mold material which it is desired to strengthen.

Although, as illustrative of my invention, a green mold composition comprising silica sand and a combination of kaolinite and a non-swelling montmorillonite has been stressed, my invention is applicable to like combinations of sand and clay for other foundry uses. These include the preparation of cores and both green and dry and facing sands. Any of these may consist of new silica sand, burnt silica sand, new molding sand, burnt molding sand, lake sand or bank sand, together with the bonding material to which may be added auxiliary binders in small quantities, such as cereal binders, goulac, cement, pitch or rosin, or a casting cleaning element such as sea coal, wood flour or oils. In the practice

of my invention, the composition is directly added to foundry sands of any type which require strengthening by placing the necessary quantity of my bonding agent on each mold, by feeding it directly into sand handling systems, by spreading it over sand heaps or by any other of the methods in common use.

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

I claim:

1. In a composition of matter, a foundry composition comprising in combination, sand, kaolinite and a clay of which montmorillonite is a large constituent.

2. In a composition of matter a foundry composition comprising in combination silica sand, kaolinite and a non-swelling, non-colloidal clay largely comprising montmorillonite.

3. In a composition of matter, a foundry composition comprising in combination silica sand, kaolinite, and a non-swelling, colloidal clay largely comprising montmorillonite.

4. In a composition of matter, a foundry composition comprising in combination silica sand and 2 to 15 percent of a mixture of kaolinite and montmorillonite.

5. In a composition of matter, a foundry mold composition comprising in combination silica sand and a mixture of kaolinite and non-swelling montmorillonite in such proportions as to give a desired hot strength of mold.

6. In preparing a mold for foundry purposes, the art which includes mixing with silica sand a binding material comprising kaolinite and non-swelling montmorillonite in such relative proportions as to produce a desired hot strength of the mold.

7. A foundry binder comprising kaolinite and a non-swelling montmorillonite clay.

8. A foundry binder comprising kaolinite and a non-swelling colloidal montmorillonite clay.

9. A foundry binder comprising kaolinite and a non-swelling, non-colloidal montmorillonite clay.

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