

[72] Inventor **Joseph S. Schumacher**
7256 Concord Ridge Drive, Cincinnati,
Ohio 45244

[21] Appl. No. **839,339**

[22] Filed **July 7, 1969**

[45] Patented **Sept. 14, 1971**

Continuation-in-part of application Ser. No. 714,339, Mar. 19, 1968, now Patent No. 3,461,941.

[56] **References Cited**

UNITED STATES PATENTS

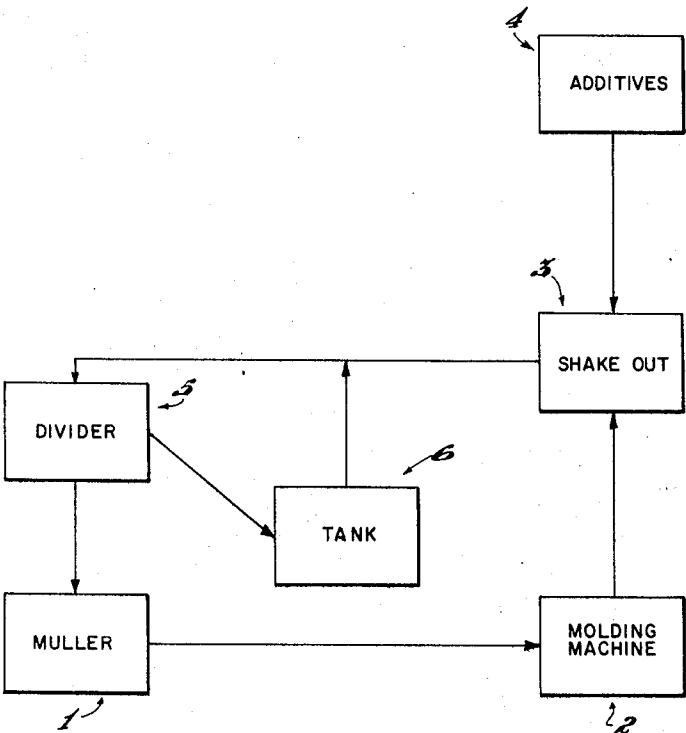
2,478,461	8/1949	Connolly.....	164/5 X
2,508,857	5/1950	Chamberlin.....	164/5
3,461,941	8/1969	Schumacher.....	164/5

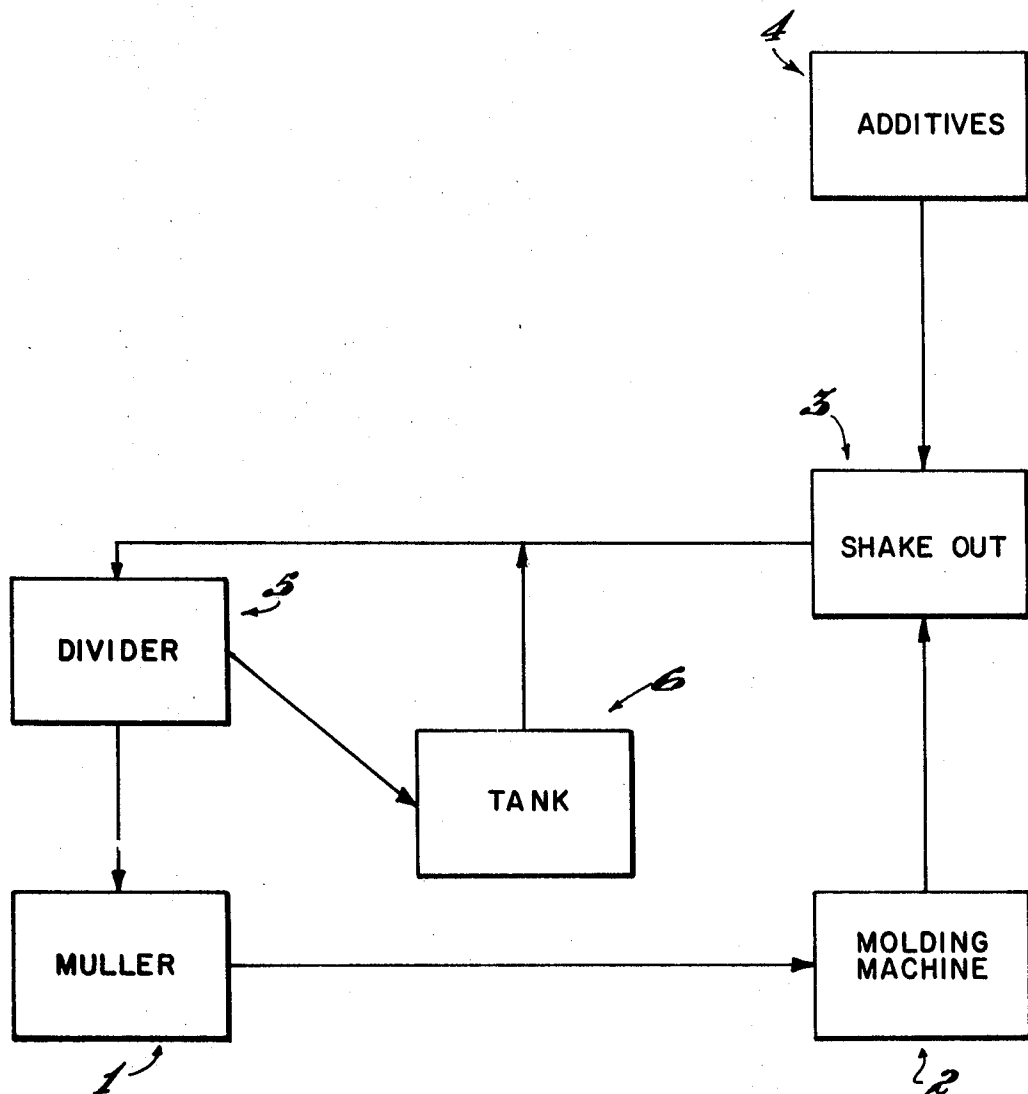
Primary Examiner—J. Spencer Overholser
Assistant Examiner—John E. Roethel
Attorney—Wood, Herron & Evans

[54] **METHOD FOR HANDLING AND COOLING
FOUNDRY SAND**
3 Claims, 1 Drawing Fig.

[52] U.S. Cl.....	164/5
[51] Int. Cl.....	B22c 5/16
[50] Field of Search.....	164/5

ABSTRACT: The invention disclosed herein relates to a novel method of handling and cooling foundry sand. The method includes the steps of preparing a quantity of the foundry sand, conveying a portion of the sand to a molding machine and forming molds therefrom, casting a metal into the molds, breaking up the molds, and mixing the unused sand with the used sand. Only a portion of the used-unused sand mixture is subsequently mulled, the remainder being retained in a storage tank for subsequent cooling. By using this method, the temperature of the foundry sand can be controlled and the use of costly cooling apparatus can be eliminated.





INVENTOR.

Joseph S. Schumacher

BY

Wood, Henson & Evans
ATTORNEYS

METHOD FOR HANDLING AND COOLING FOUNDRY SAND

This application is a continuation-in-part of application Ser. No. 714,339, filed Mar. 19, 1968 now U.S. Pat. No. 3,461,941.

This invention relates to a method for handling foundry sand. More particularly, it relates to a method for handling foundry sand wherein the temperature of the sand is cooled to a desired temperature after it has been used.

In a recent article entitled "Survey of Methods to Cool Hot Sand" written by A. J. Filipovitch, and appearing at page 92 in Volume 95, No. 10 of the Oct., 1967 issue of "Foundry" magazine, a survey of the methods used by 211 foundries to cool foundry sand is presented. The author reports that the most frequently used methods for cooling foundry sands include costly apparatus such as mullers, belt aerators, rotary screens, fluidizing units, perforated cooling conveyors, cooling elevators and cooling tables. He states that all of the methods rely upon the use of water to lower the temperature of the hot, used sand to about 170° F. and then on air cooling to further reduce the temperature. The optimum temperature to which the sand must be cooled to is about room temperature.

If foundry sand which has been used is not cooled before it is reused, several problems arise. It is pointed out in the article referred to previously that hot sand is very unstable and its properties change as its moisture evaporates. This variable condition causes poor pattern draws resulting in inferior casting quality. It is also known that variations in moisture, even though they appear inconsequential, can cause radical changes in compressive strength, permeability and flowability. These changes can lead to poor finish, defective castings and increased scrap. If too much moisture is added, the sand tends to agglomerate. Another problem that is present is that when hot sand is conveyed, it does not flow very well and tends to pack and agglomerate in the equipment, tanks, conveyors and elevators. The constant and rapid loss of moisture by evaporation as the sand cools creates in a quantity of sand a condition of dryness on the surface to wet in the center. Uniformity of properties is a condition to quality. It does not exist in hot sand.

An important object of my invention is to provide a method for cooling foundry sand to approximately room temperature without the need for using expensive and complicated cooling equipment. Another important objective of my invention is to provide a method for cooling foundry sand which does not depend upon air or water as the cooling medium. A still further objective of this invention is to provide a foundry sand-handling system wherein the composition of the foundry sand can be easily controlled and the compositional variations are minimized.

In the casting of metals into sand molds, the amount of sand used to form a mold is usually expressed as a function of the amount of metal to be poured into it. This relationship is called the sand to metal ratio. For example, sufficient sand can be used for the mold to give a sand-to-metal ratio of from 3 to 1 to 20 to 1. While these ratios are frequently used, others are oftentimes used too. A common ratio used is a ratio of about 6 to 1. That is, a mold is formed which consists of 6 pounds of sand for each pound of metal to be cast.

Foundry sand is, of course, not sand alone but contains additional constituents such as clays and/or carbons and/or other additives and/or temper water. Carbons in common use are powdered coal, coal tar, pitch, asphalt, graphite and coke. Other additives can be added such as celluloses, cereal binders, etc. After one or more molding operations new sand and/or clays and/or carbons can be added to the used sand to replace the portion of the original sand which has been made unuseable. Temper water is also frequently added in minor amounts. The following is a typical table which shows the amount of additives which usually must be added after the

batch of sand has been used. This table is for ferrous metals other than steel. Other data for nonferrous metals, steel and ductile metals is known to those in the foundry industry.

TABLE I

Suggested Additive Requirements Per Muller

Load Of 2000 Pounds

Ratio Sand/Metal	Clay Bentonite	Carbons	New Sand
3/1	18.8 lbs.	16 lbs.	100 lbs.
4/1	14.4	11.9	75.
5/1	11.3	9.5	60.
6/1	9.41	8.0	50.
8/1	7.15	6.03	37.5
10/1	5.65	4.75	30.0
12/1	4.71	4.00	25.0
14/1	4.05	3.43	21.4
16/1	3.60	3.03	18.7
18/1	3.15	2.66	16.6
20/1	2.83	2.40	15.0

As it can be seen from this table, it requires about 34.8 pounds of new clay and additives plus 100 pounds of new sand to reconstitute the molding sand for reuse at a sand to metal ratio of 3 to 1. However, at a ratio of 20 to 1 it requires only 5.2 pounds of new clay and additives, plus 15 pounds of new sand to reconstitute it at this ration.

I have discovered that if one desires to operate a sand system at a normal sand to metal ratio of about 4 to 1 to 6 to 1 that conventional cooling methods can be eliminated if a batch of foundry sand is mixed so as to provide a 20 to 1 ratio, the molds are made, for example, on a 4 to 1 to 6 to 1 ratio, and if immediately after the molds are used and broken up, the remaining unused cool portion of the mixed sand is mixed with the hot used sand. By mixing the unused sand with the used sand, the temperature of the combination of sand is lowered so that a portion of the batch can be reused without further cooling, after temper water and/or additives have been added and it has been remulled. No other cooling step is needed. Moreover, sand used in this manner is easy to reconstitute because the amount of additives lost per molding cycle expressed as a percent of the total batch is very small. It can be seen, therefore, that my invention provides a novel method of cooling foundry and while at the same time it provides a method for controlling the composition of the foundry sand and for minimizing variations in composition.

I have found that it is generally desirable to cool the used sand as close to ambient temperature as possible after the molds are shaken out and prior to the mulling and reconstituting of the sand. While ambient temperature is preferred, sand at a temperature of 120° F. can be used. However, it is desirable to cool the sand to below 120° F. to obtain the best mixing results. Most clays are difficult to wet and plasticize when the temperature is over 120° F. If sands are prepared at 120° F. then drying out will rapidly occur due to evaporation till ambient temperature is reached. Moisture losses change the properties of the molding sand. A consistent molding media is desired for best results. Therefore, I have found that the most efficient mixing is achieved when the sand is at ambient temperature. The amount of sand which must be added after shakeout in order to obtain a mixture of used and unused sand at a particular temperature is, of course, dependent upon the temperature of and the amounts of the used and unused sands. I have found that the approximate amount of unused sand which must be added can be calculated in the following way.

An estimation of the temperature of the sand at shakeout can be made if it is assumed that all the heat evolved from the hot metal is transferred to the sand. The temperature of the metal in an average pouring for iron is about 2,600° F. The heat evolved can be calculated from the following formula H

$=cp(t-60)$ where cp =cpmean specific heat of pure iron at 2,600° F., t = shakeout temperature, and 60= standard ambient temperature. No heat of solidification has been included because of the different metals which might be used. The following table shows the heat evolved at the indicated shakeout temperature when the pouring temperature is 2,600° F.

TABLE II

Shakeout Temp. of The Metal Casting	Heat Evolved-Btu 1 lb. of Metal
2,000	219
1,800	253
1,500	299
1,000	395.2
800	412.5
600	445
400	480
200	510
100	525
60	532

These results can be plotted on a graph so that the intermediate values can be easily obtained.

Knowing the heat evolved from the metal and assuming that all of this heat is transferred to the sand then the temperature of the sand at various shakeout temperatures can be calculated. The formula that should be used is $H=cp \times \text{sand weight per pound of iron} \times (t-60)$ where H is the heat evolved from the iron, cp is the heat for SiO_2 for $t-60$, and t = sand temperature at shakeout. The following tables show the temperature of the sand at various metal shakeout temperatures.

TABLE III

20 to 1 Sand to Metal Ratio Casting Shakeout Temp.	Sand Temperature
2,000° F.	120° F.
1,600° F.	140° F.
1,200° F.	160° F.
800° F.	180° F.
400° F.	200° F.

TABLE IV

10 to 1 Sand to Metal Ratio Casting Shakeout Temp.	Sand Temperature
2,000° F.	180° F.
1,600° F.	220° F.
1,200° F.	260° F.
800° F.	300° F.
400° F.	340° F.

TABLE V

4 to 1 Sand to Metal Ratio Casting Shakeout Temp.	Sand Temperature
2,000° F.	360° F.
1,600° F.	450° F.
1,200° F.	540° F.
800° F.	630° F.
400° F.	

Again it was assumed that the pouring temperature of the metal was 2,600° F. The above temperatures can be plotted so that intermediate temperatures can be determined quickly. The above calculated sand temperatures assume that there is no moisture in the sand. However, in practice there is usually

between 3 to 5 percent of water in the sand. The evaporation of this moisture will cool the sand still further. For example, at a 10 to 1 sand to metal ratio the sand, at shakeout temperatures, will be cooled about 53° F. for each 1 percent of moisture evaporated. In most foundries the shakeout temperature is between 1,000° F. and 1,300° F. Therefore, in order to have sand at not more than 120° F. as it goes into the muller, the sand to metal ratio at this point must be between 10 to 1 and 20 to 1. A 10 to 1 mixture will provide this temperature because about 3 percent of moisture has been evaporated.

The amount of sand actually used to form the mold can be any ratio but common values are a sand to metal ratio of 4 to 1 to about 6 to 1.

Conventional foundries usually have a muller, a sand storage bin, a molding machine and some means for breaking up the used sand molds and separating the castings. Such a conventional sand system with the conveyors, muller, etc. is shown at pages 9 and 10 of the aforementioned foundry magazine. In my system any number of the various kinds of batch or continuous mullers, molding machines and shakeout mechanisms can be used. Such devices are well known to those in the art and the use of any particular one forms no basis of invention of this application and is not required in my process.

The following is an example of how my process has been successfully practiced at a foundry where expensive equipment had previously been used to cool its foundry sand.

The muller used at the foundry was a continuous muller, that is, a continuous flow of sand was introduced into the muller and a continuous flow of mulled sand was discharged from the muller. The approximate composition of sand used was 86 percent silica, 6 percent clay, 4 percent carbons and 4 percent water. Periodic additions of clays, carbons and new sand, calculated according to the figures shown in table I were made to the sand at the muller during the casting cycle. A large amount of sand was prepared. However, the molds were made on a 4 to 1 sand to metal ratio. The metal cast was a malleable iron having an approximate composition of 3.5 percent total carbon and 0.6 percent Si. The sand which was not used to form the molds was conveyed to a storage tank. After the metal was cast, the castings and molds were conveyed to a shakeout station and the molds broken. Immediately after the castings were separated from the broken molds at the shakeout station, about 16 parts of cool sand at ambient temperature from the storage tank were added to the hot used sand. The temperature of the used sand prior to the addition of the unused sand was over 350° F. By the time the mixture of hot used sand and cool unused sand has been transported by a conventional conveyor to a second storage bin, a distance of approximately 200 feet, the temperature of the batch was approximately 100° F. After this, the sand was conveyed to the muller. After the mulling process, the temperature of the sand was approximately 90° F. No additional cooling of the sand was provided. It was then conveyed to the first storage tank. After using this process for several weeks, it was apparent that the quality of the molds and of the finished castings was greatly improved over the process previously practiced which included conventional sand-cooling apparatus. Moreover, it was found that it was much easier to control the composition of the sand and there was much less variation in the composition. Additionally, it was found that the sand was much easier to handle because its flowability was improved. Another unexpected result was that air pollution was drastically reduced. It is believed that expensive air-cleaning equipment will also be eliminated by using my process.

I have found that further advantageous results can be obtained if the additives necessary to replace those that have been destroyed during the molding process are added at the shakeout point. At this point it is easier to determine the amount of new sand, clays and carbons which are needed because the amount of sand actually used during the molding process is known. In most foundries the sand to metal ratio remains constant over a period of several hours. Therefore,

the additions would be constant over the same period of time and could be gauged for example by color coding the molds to indicate that a particular sand to metal ratio is being used. Once the sand to metal ratio and the weight of the sand used or metal poured is known, then the amount of clays, new sand and carbons can be ascertained for ferrous metals by referring to table I hereof.

In some existing foundries where my process could advantageously be practiced it has been observed that the muller capacity of the existing mullers has been insufficient to mull the quantity of sand required for both molding and cooling. I have found that in these foundries my process can be employed if the portion of sand which could not be mulled because of the insufficient mulling capacity is bypassed around the muller. Of course, as desired, the quantity of sand bypassed around the muller can be varied as desired.

Referring now to the drawing, there is shown there my cooling process wherein a portion of the sand can be bypassed around the muller if desired.

In the drawing, muller 1 can be any type of conventional sand muller such as the continuous one described in U.S. Pat. No. 3,408,052. Other mullers, continuous or batch, could also be used. Likewise, the molding machine 2, shakeout 3, additive adding machine 4 and tank 6 may be of conventional design and are all very well known in the foundry art. The divider may be one of those shown in my copending application, Ser. No. 839,259, or others which are adapted for the specific purpose. Connecting these various machines in operable relationship are suitable conveyors, not shown, but which are illustrated by arrows. These arrows show the direction of sand travel during the molding operation.

During a typical cycle of operation sand exists in the muller 1 and is conveyed to the molding machine 2, where sand molds are then formed. A sufficient quantity of sand is conveyed so that molds are formed having a sand-to-metal ratio of at least 3. At this point, there resides in tank 6, a quantity of sand equal or greater than 10 times the weight of metal to be cast. After the castings and molds leave the machine 2, they are separated at the shakeout 3. At this point additives are added from the additive machine 4. The amount of additives added is based upon the weight of sand used and the sand-to-metal ratio. For instance, if the amount of sand was 2,000 pounds and the sand to metal ratio was 3 to 1 then referring to table I it can be seen that 18.8 pounds of clays, 16 pounds of carbons, and 100 pounds of new sand must be added.

It is important that the required additives be added before the hot sand—cool sand mixture is split and a portion sent to the muller and the other portion sent to bypass the muller. Preferably the additions should be made at the shakeout, for the reasons previously discussed. If instead, the additions are made at the muller, there will be no easy way for deterring the quantity of additives necessary for it will not be known whether or not the sand being mulled was the sand used for

molding and, hence, it would not be known what amounts of the various additives must be used.

As the hot sand leaves the shakeout 3 with the required additives, a sufficient quantity of cool sand from the tank 6 is discharged onto the hot sand. At this point mixing equipment such as that shown in my copending application may be used to mix the hot and cool sand.

The hot and cool sand mixture reaches the divider 5 where a portion of the sand is divided and deposited in the tank 6. The remaining portion, sufficient to form the number of desired molds, is mulled, with or without adding temper water, and the cycle starts again.

Having thus described my invention I claim:

1. A process for reducing foundry pollution and for cooling foundry sand comprising
 - mulling a quantity of sand greater than 3 times the weight of the metal to be cast,
 - forming molds from said sand,
 - casting metal in said molds,
 - separating the metal from said molds,
 - adding at least one additive selected from the group consisting of sand, clay and carbon to said sand,
 - cooling the used sand obtained from said molds by adding to it sand at a cooler temperature, whereby the resulting mixture has a temperature of 120° F. or below,
 - separating said mixture of sand into two portions, one portion sufficient to form molds for a succeeding molding operation, and
 - conveying the other portion to a storage tank for use in cooling hot used sand.
2. In a foundry process wherein molds are formed on the basis of a sand-to-metal ratio of at least 3 to 1 and wherein a larger quantity of relatively cooler sand is added to the hot sand to cool the hot sand and to reduce foundry pollution, the improvement which comprises,
 - dividing the hot sand and cool sand into two parts after the cool sand has been added to the hot sand, one part being a molding part and the other part to be retained for use in a later cooling step, the amount of said molding part being enough to form a desired number of molds therefrom, each of said molds having a sand-to-metal ratio of at least 3 to 1,
 - mulling only the molding part,
 - retaining the other part for the later cooling of said molding part,
 - forming molds from said molding part,
 - casting metal in said molds,
 - separating the metal from said molds,
 - adding the retained part to said molding part, and
 - returning the mixture of the molding part and the retained part to the aforesaid dividing step.
3. The foundry process of claim 2 wherein the amount of retained sand is at least 10 times the weight of the metal cast.

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,604,493

Dated September 14, 1971

Inventor(s) Joseph S. Schumacher

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 31, "ration" should be --ratio--

Column 2, line 48, "and" should be --sand--

Column 3, line 1, after "cp =" and before "mean" delete --cp--

Column 5, line 28, "the" should be --that--

Signed and sealed this 27th day of June 1972.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents