Oct. 16, 1956 C. BRADWELL 2,767,074

METHOD OF INCREASING SINTER RATE

Filed June 22, 1951 2 Sheets-Sheet 1

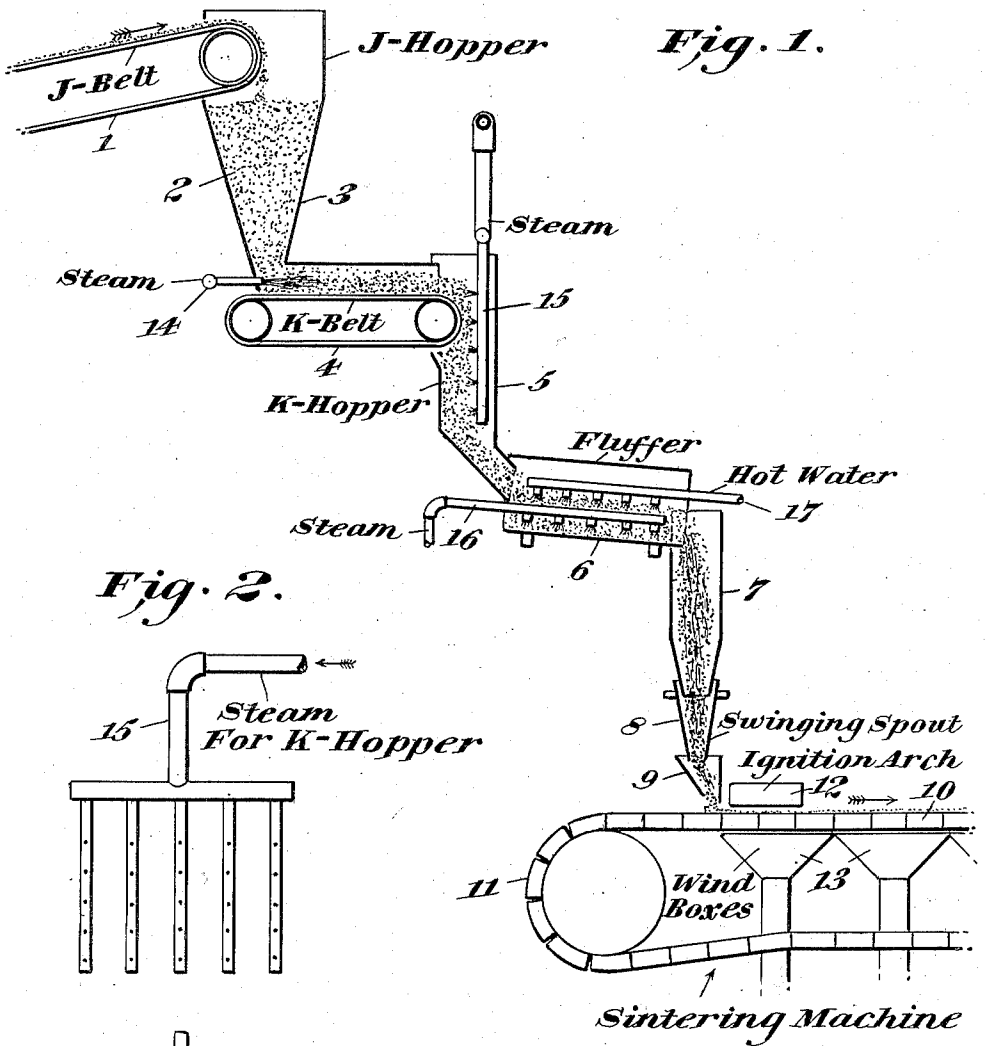



Fig. 1.

Fig. 2.



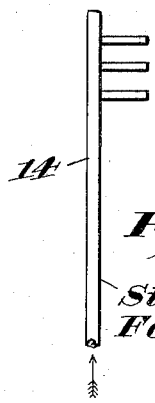



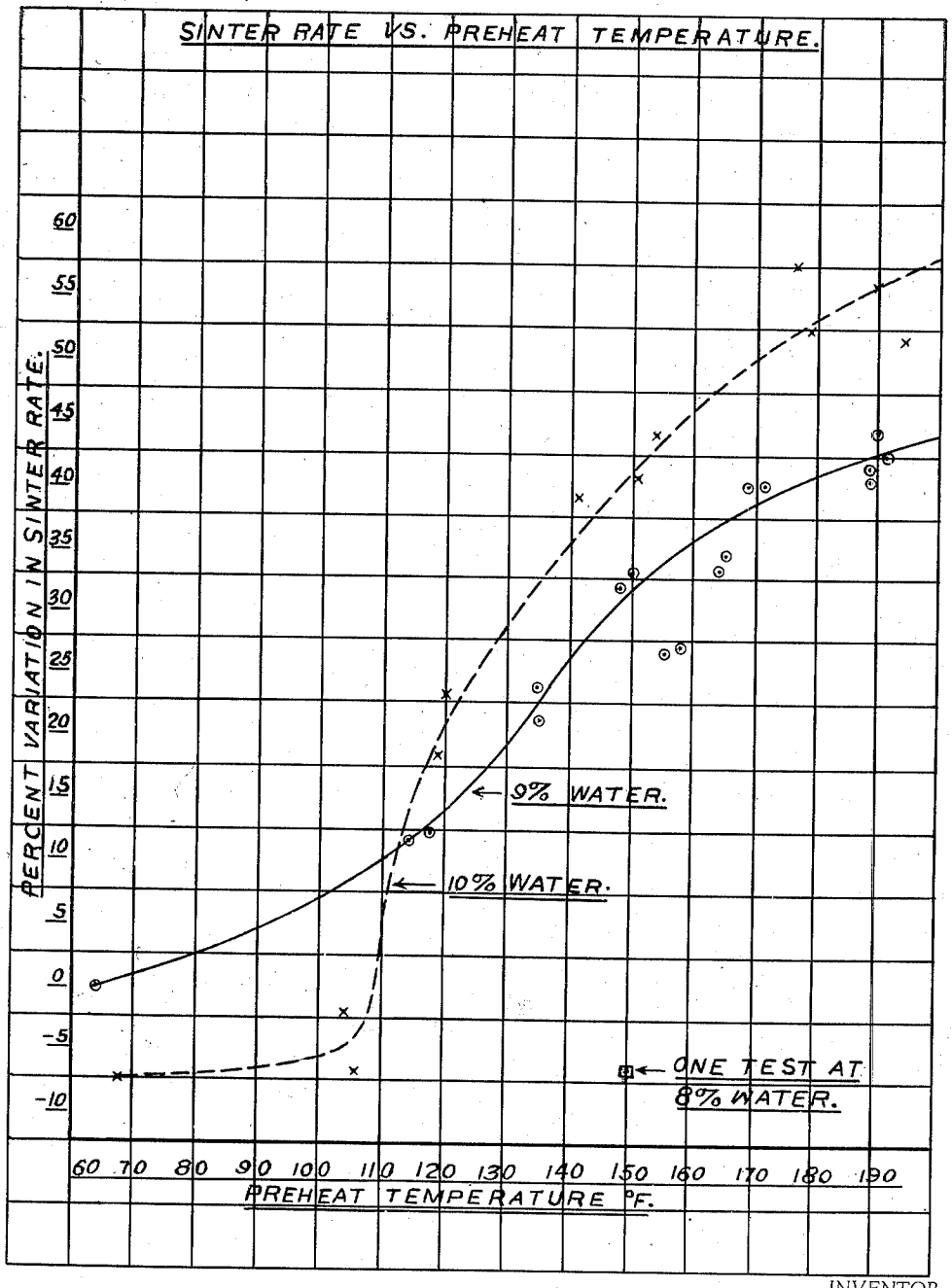

Fig. 3.

INVENTOR
Cyril Bradwell.
BY R.S.A. Dougherty.
ATTORNEY

Oct. 16, 1956 C. BRADWELL 2,767,074

METHOD OF INCREASING SINTER RATE

Filed June 22, 1951 2 Sheets-Sheet 2




INVENTOR

Fig. 4. Cyril Bradwell.

BY R. S. A. Dougherty.

ATTORNEY

United States Patent Office 2,767,074 Patented Oct. 16, 1956



2,767,074

# METHOD OF INCREASING SINTER RATE

Cyril Bradwell, Bethlehem, Pa., assignor to Bethlehem Steel Company, a corporation of Pennsylvania

Application June 22, 1951, Serial No. 232,997

5 Claims. (Cl. 75—5)

My invention relates to a method of increasing the speed of a sintering operation by means of preheating the mix.

In conventional sintering operations with iron ores, flue dust, concentrates and other materials, preparatory to charging into the blast furnace, the ore or the like is mixed with a finely divided fuel such as coal, coke, flue dust, sawdust, etc., and with some return sinter fines, to which a rather critical amount of cold water for tempering is added, and the moistened mix is then sintered on a conventional sintering machine. The operation of the sintering machine is such that the mix is deposited on a grate above wind boxes connected to a powerful suction fan or fans and its upper surface is traversed by a flame from a suitable ignition burner. Since sintering rate for a given mix increases with increase in air flow through the bed, for maximum speed of sintering, it is obvious that the bed must remain as permeable as possible after ignition has taken place.

As delivered to the sintering machine, a great deal of attention is directed to maintaining the mix at the optimum water content value, roughly about 6% to 14%, depending on the mix, which has been found to produce optimum permeability. Mixes which are too wet will not sinter effectively, and a mix which is excessively dry will have greatly reduced permeability and also too many of its particles will be pulled through the grate bars by the fan suction. The distribution of this water content, moreover, is intentionally made very uniform throughout the mix prior to depositing it on the machine.

This carefully predetermined moisture distribution often is upset, however, under the combined action of the burner and the downdraft, as soon as ignition and sintering begin. Water from the top portions of the bed is vaporized and carried downward by the combustion gases and free air to the cold lower portions of the bed where, frequently, some of its condenses. This action destroys much of the original permeability of the mix which was carefully developed by proper mixing and by close control of the amount of water added. With the flow of air through the bed thus reduced, the speed at which sintering can proceed is also reduced.

The object of this invention, therefore, is to prevent condensation of moisture in the bed and thereby to assist in maintaining the permeability of the bed to the flow of air during sintering.

I have discovered that by preheating the wet mix prior to sintering I can eliminate this condensing effect, and thereby increase the sinter rate at a rate increasing with increasing temperature of the raw mix.

The unsintered mix, of course, may more or less accidentally contain a certain amount of residual heat, since the solids in a typical batch may include about 10% to 40% return sinter fines together with the ores, concentrates and/or flue dust. The ores, concentrates and flue dust are always used cold, at approximately room temperature. If return sinter fines are used, these may be hot if returned immediately, but occasionally they are



stored in bins so that the percentage added can be controlled and when this is done the returns will lose much or all of their heat. Practically speaking, therefore, the amount of heat obtained from the fines is unpredictable, because the temperature and quantity of the returns are constantly changing and the differences in specific heats of the various materials introduce other variant factors. In any event, the amount of heat obtainable from return sinter fines is insufficient for the purposes of this invention.

Even after adding hot return fines, much of the heat from the return fines will be dissipated before the mix reaches the sintering machine, while it travels exposed to the air on conveyor belts and falling freely through open hoppers. Moreover, the addition of cold water for tempering will further reduce the temperature of the mix.

Since preheating is desired, it might seem convenient to raise the temperature of the mix simply by increasing the percentage of returned hot sinter, but as an economic matter this would merely increase the recirculating load with a concomitant waste of good blast furnace feed, and most of the heat would still be lost as before.

Because heat is lost by the mix in its travel through the plant, it is desirable to add heat to the mix as near as possible to the machine.

One means of increasing the mix temperature is to use hot water to bring the mix to its optimum moisture content rather than cold water as is the present custom. Because the amount of water which can be added is restricted by the considerations mentioned heretofore, hot water yields only a partial solution to the problem.

I therefore prefer to obtain the desired additional heat by the use of steam in the hoppers, bins, conveyor belts and, if applicable, in the fluffer mixer, pugmill or other mixing apparatus just before the machine. One method of preheating the mix by means of steam is shown in the drawings.

In the attached two sheets of drawings:

Fig. 1 is a diagram illustrating a method of preheating the mix by means of steam, as applied to conventional sintering plant apparatus;

Fig. 2 is a detail view of a jet arrangement for admitting steam to hopper;

Fig. 3 is a detail view of a steam jet arrangement for conveyor belt; and

Fig. 4 is a graph with curves indicating the general effect of increasing preheating temperatures upon sinter mixes of different original temperatures and water contents.

With reference to the drawings, and more particularly to Fig. 1, the numeral 1 designates a conveyor belt or so-called J-belt, from which the mix 2 falls through J-hopper 3 onto covered K-belt 4, upon which the mix is advanced and drops through K-hopper 5 into a rotating drum type fluffer mixer 6 or the like. From the fluffer mixer 6 the mix drops through hopper 7, swinging spout 8 and hopper 9 onto the moving grate 10 of a sintering machine, on which the mix travels under ignition arch 12 and over wind boxes 13 and is ignited and sintered. By means of multi-jet perforated pipes 14 (Fig. 3), 15 (Fig. 2) and 16, steam is injected into the mix on the K-belt 4, in the K-hopper 5, and fluffer mixer 6, respectively. In similar manner, hot water in suitable quantity for tempering is added by means of perforated pipe 17 in fluffer mixer 6.

There are obviously too many variables, such as differences in moisture, carbon, mix composition, machine speed, and charging conditions, all of which may affect sinter rate, for it to be possible to state with exactness the percentage of gain which may be expected at any particular preheat temperature. Merely as an illustration, however, a typical sinter mix with 9% water content preheated to 170° F. was found to produce 38% more

sinter by weight in a given time than the same mix sintered under the same conditions but preheated only to 120° F. Other results are shown on the attached curves (Fig. 4).

The curves in Fig. 4 illustrate the effect of preheating one typical mix whose optimum moisture content is 9% when it is prepared and sintered in the normal manner. The solid line shows how the weight of sinter produced in a given time increases with increase in preheat temperature of the mix.

When this same mix was prepared with 10% moisture and sintered without preheating, its rate of sintering decreased as shown by the dashed curve below 115° F. However, by preheating the mix to temperatures above 115° F., its sintering rate was greatly increased. The increases, due to preheating, shown on both curves occur not only because condensation is prevented but also because the gases moving through the preheated bed actually partially dry the lower layers and thus aid combustion of the fuel.

In this particular mix, it should be noted, 8% water was not sufficient to develop maximum original permeability.

In the sintering operation a certain strength of product is desired and this strength is largely controlled in a given mix by the amount of carbon or fuel introduced. Within limits, the sinter strength increases with increase in carbon content of the mix. During sintering most of the heat developed by the burning fuel wholly or partially fuses the materials and develops strength in the product but some of the heat released by the burning fuel is consumed in evaporating moisture. By preheating, condensation of moisture in the bed is prevented and therefore more of the heat developed by the burning fuel is available to fuse the mass. It therefore follows that if the mix is preheated, less carbon will be needed to develop a given strength of product. Since the sintering rate of a mix decreases as fuel content increases (within limits), a further gain in sintering rate is obtained by preheating because the fuel content of the mix can be decreased and still produce a sinter of equal strength to that obtained from the same mix sintered without preheating.

I have further found that many extremely fine grained materials such as for instance taconite concentrates, usually regarded as very slow or almost impossible to sinter without special treatment such as nodulizing and/or mixing with other ores or return fines, may be sintered at very rapid rates provided only that they are mixed correctly with fuel and water and preheated before they are fed to the sintering machine.

The preheating of the mix to prevent condensation of moisture from the air and combustion gases will also be beneficial in connection with the sintering of any of the non-ferrous sinterable materials well-known in the art where such condensation decreases the flow of air through the bed.

Although I have thus described my invention in considerable detail, I do not wish to be limited narrowly to the exact and specific preheating means and temperatures mentioned hereinabove, but I may also use such substitutes, modifications, or equivalents thereof as are embraced within the scope and spirit of the invention and of the appended claims. Nor do I wish to be limited to the type of sintering machine described herein, since the advantages of the process will apply to any sintering apparatus.

I claim:

1. The method of sintering which comprises delivering to the grate of a sintering machine a permeable mixture of finely divided sinterable material, fuel and water at a temperature in the range between 120° F. and 195° F. and rapidly sintering the mixture without substantial condensation of vapor in said mixture.

2. The method of sintering which comprises delivering to the grate of a sintering machine a permeable mixture of finely divided iron ore and fuel having a moisture content in the range between 6% and 14% and having a temperature in the range between 120° F. and 195° F. and sintering the said mixture very rapidly and without substantial condensation of vapor.

3. The method of sintering a mixture of small particles of iron ore, fuel and water which comprises agitating the mixture while injecting steam therein to produce a mixture having a water content in the range between 6% and 14% and having a temperature in the range between 120° F. and 195° F., delivering the heated mixture to the grate of a sintering machine, and sintering the said mixture very rapidly and substantially without condensation of vapor in the lower layers of the mixture.

4. The method of sintering a mixture of finely divided sinterable material, fuel and water which comprises heating the mixture to a temperature in the range between 120° F. and 195° F., delivering the heated mixture of sinterable material, fuel and water to the grate of a sintering machine, and sintering the said mixture in the absence of moisture of condensation from hot gases.

5. The method of sintering a mixture of sinterable fine material, fuel and water which comprises heating the mixture by means of steam to a temperature in the range between 120° F. and 195° F., delivering the heated mixture of sinterable material, fuel and water to the grate of a sintering machine, and igniting and sintering the said mixture without substantial condensation of vapors from hot gases in their passage therethough.

**References Cited** in the file of this patent

UNITED STATES PATENTS

| | | |
|---|---|---|
| 852,611 | Perkins et al. | May 7, 1907 |
| 1,632,829 | Fleissner | June 21, 1927 |
| 2,052,329 | Wendeborn | Aug. 25, 1936 |
| 2,119,615 | Wendeborn | June 7, 1938 |
| 2,532,335 | Royster | Dec. 5, 1950 |
| 2,544,742 | Gelbman | Mar. 13, 1951 |
| 2,608,481 | Royster | Aug. 26, 1952 |

FOREIGN PATENTS

| | | |
|---|---|---|
| 229,608 | Great Britain | Feb. 26, 1925 |
| 573,539 | Great Britain | Nov. 26, 1945 |

OTHER REFERENCES

Metallurgy of Copper, by Newton and Wilson. Pub. 1942 by John Wiley and Sons, Inc., New York. Pages 59 and 60.

Webster's New International Dictionary of the English Language, 2nd ed., unabridged, pub. 1940 by G. and C. Merriam Co., Publishers, Springfield, Mass. Page 2346.