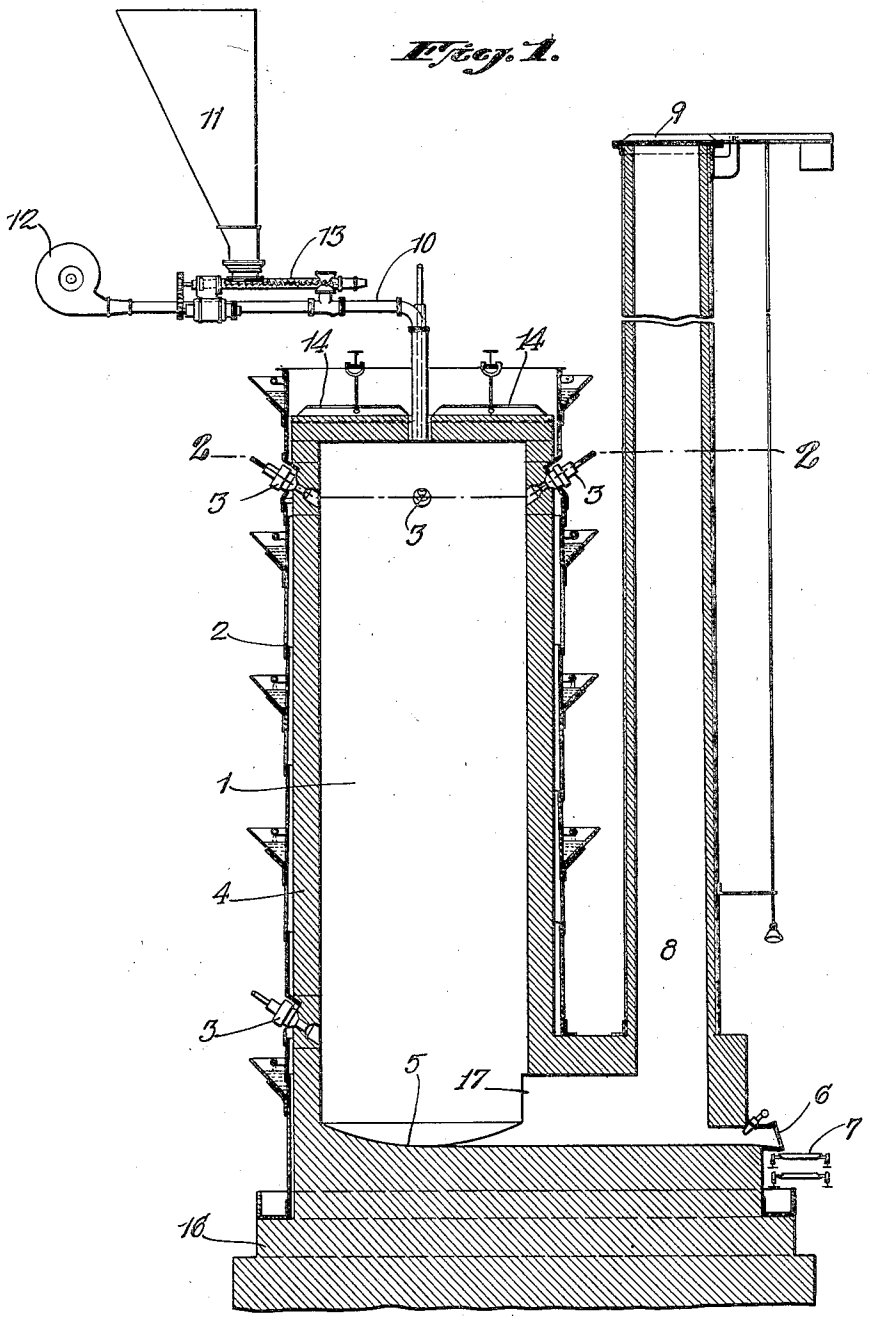
July 3, 1934. A. B. HASWELL ET AL 1,964,915

APPARATUS FOR SINTERING AND FUSING FINELY DIVIDED MATERIAL

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Fig. 1.



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Fig. 2.

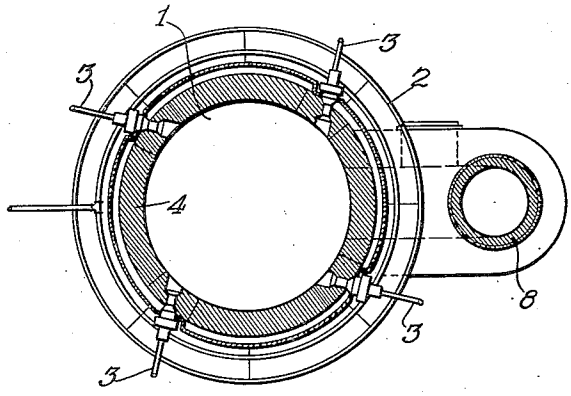
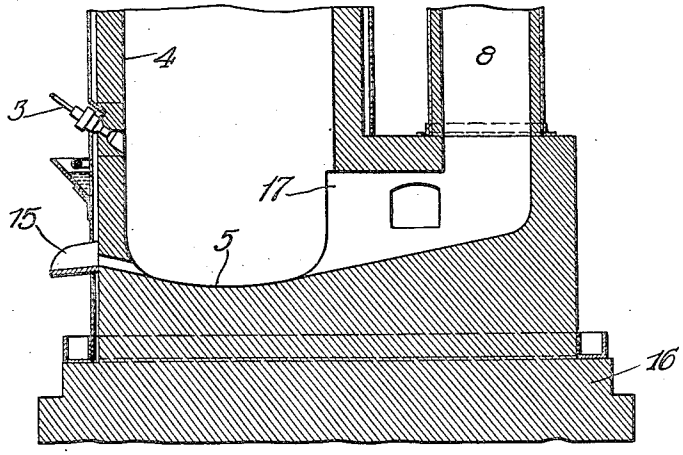


Fig. 3.



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Fig. 5.

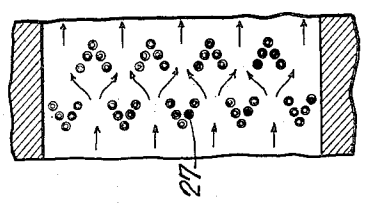


Fig. 4.

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APPARATUS FOR SINTERING AND FUSING FINELY DIVIDED MATERIAL

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10 Claims. (Cl. 263—21)

This invention relates to furnace apparatus and more particularly to furnace apparatus for sintering and fusing finely divided metalliferous materials such as blast furnace flue dust, and to heat exchange apparatus in combination therewith.

One of the objects of the present invention is to provide an improved apparatus for agglomerating finely divided, metalliferous materials such as blast furnace flue dust.

Another object of the present invention is to provide a suitable furnace apparatus for accomplishing the sintering and fusing of the finely divided metalliferous materials.

Another object is to provide means to agglomerate finely divided materials, such as blast furnace flue dust into a sintered and fused product.

Another object is to provide means to facilitate and to improve the recovery of the metal content of blast furnace flue dust.

Other objects and advantages may become apparent as the invention is more fully disclosed.

In accordance with the objects of the present invention, we have found that finely divided metalliferous materials may be sintered and fused in the following novel manner. The finely divided materials may be admixed in any convenient manner with finely divided materials capable of reacting therewith to form a fusible slag and the admixture fed preferably by air blast, through a high temperature heat zone maintained at a temperature sufficient to effect a substantial incandescence of the individual particles of the admixture to approximately a plastic state, to and upon a hearth which is maintained at a temperature at or above the melting point of the fusible slag admixture, from which hearth the fused slag is recoverd in any convenient manner.

In order to effectuate this invention, we have devised a novel type of furnace comprising substantially a refractory lined stack closed at its upper end and having at the bottom a hearth, and having an opening adjacent the hearth leading into a chimney. Means are provided in the stack to introduce burning fuel, such as gas, oil, powdered coal and the like; and means are provided to introduce in the stack, preferably at the top, and preferably by air blast, the finely divided metalliferous materials in such manner that they pass through the hot temperature zone in the stack before falling upon the hearth. The temperature in the stack is maintained sufficient to incandesce the metalliferous particles at or to approximately the plastic stage and the temperature of the hearth is maintained at a temperature at or above the melting point of the slag admixture. This furnace has also been designed to operate in conjunction with apparatus designed to utilize the excess heat energy of hot combustion gases, such as a boiler, or air preheater, or the like apparatus.

Before further disclosing the nature of the present invention, reference should be made to the accompanying drawings, wherein—

Fig. 1 is a sectional side elevation view of a type of furnace designed to accomplish the main object of the present invention;

Fig. 2 is a cross-sectional plan view of the same along plane 2—2 of Fig. 1;

Fig. 3 is a enlarged sectional side elevation view of the bottom part of the furnace showing a modified structure thereof;

Fig. 4 is a sectional side elevation view of a contemplated modification of the furnace illustrated in Fig. 1 when utilized in combination with a boiler furnace; and

Fig. 5 is an enlarged sectional view of a type of slag screen utilized in the furnace of Fig. 4 taken along plane 5—5 of Fig. 4.

As a specific embodiment of the practice of the present invention we will describe the same as it has been adapted to the sintering and fusing of blast furnace flue dust. This dust is collected in any convenient manner heretofore practiced in the art. Such finely divided metalliferous material comprises approximately 26% iron, 11% silica, 12% calcium oxide, and approximately 25% carbon, with the remainder comprised in part, of aluminum oxide, manganese and phosphorus compounds. The particle size varies materially, usually the coarser particles being comprised in the main of carbon, and the finer particles being comprised of the bulk of the iron. We have found that where the lime content of the material is relatively high, it may be readily fluxed at a temperature approximately 2500° F. without the addition thereto of additional amounts of fluxing material. In order to properly flux the material, however, the bulk of the carbon content thereof should be eliminated. We have designed a furnace to accomplish this.

Referring to the drawings, Fig. 1, the furnace of the present invention, comprises substantially a refractory lined stack 1 supported on refractory base 16, having a water cooled shell 2, the refractory lining 4 terminating at the bottom into a slightly sloping hearth 5 leading towards a tap opening 6, from which the molten material on

the hearth may be tapped into a conveyor 7. The precise method of water cooling the shell 2 is immaterial for the purposes of the present invention and it may be accomplished in the manner shown in the drawings Fig. 1 or otherwise as may be deemed expedient. The products of combustion of the furnace pass out through conduit 17 disposed in the bottom of the furnace adjacent the hearth into stack 8 provided with a damper 9 to regulate the draft. A number of burners 3 disposed about the circumference of the stack 1 in the manner indicated are provided. Preferably the burners are gas or liquid fuel burners and are disposed so as to introduce the burning fuel tangentially to the inner circumference of the stack and also preferably in a downward direction towards the hearth 5.

In the sealed top of the furnace, through pipe 10, the fine flue dust particles are fed from bin 11 by means of a blast of air blown from fan 12 and under control of feeding mechanism 13. Bin 11 is supplied with the fine flue dust particles by a conveyer (not shown). Means, such as removable covers 14, are provided in the top of the sealed furnace to give access to the interior of the furnace 1.

The operation of the furnace illustrated in Figs. 1, 2 and 3, in the sintering and fusing of finely divided metalliferous material, such as blast furnace flue dust, may be briefly described as follows: By means of burners 3, which may be fed either with liquid, gases or powdered fuel, such as for example, natural, by-product, or blast furnace gases, or with oil, tar or powdered coal, the interior of the furnace is raised to a temperature approximately 2500° F. Into this furnace the finely disseminated flue dust is fed by the air blast coming through pipe 10, in the manner indicated. This flue dust may be of the same substantial composition as is obtained from the blast furnace, or it may be admixed with proportions of additional carbonaceous material, or with proportions of additional fluxing materials, or both, as may seem suitable. By being introduced within the heated furnace in the manner indicated, the carbonaceous content thereof is ignited and burned to oxides of carbon and the inert iron, silica, lime, and other materials are incandesced to a temperature at which they become molten. The relatively fine particle size of the flue dust facilitates the rapid and complete incandescence of the flue dust particles to the fusion temperature. The fused material collects in the bottom of the furnace upon the hearth 5, from which it is periodically withdrawn through tap opening 6 into conveyer molds 7. By positioning the gas burners so as to play upon the hearth the temperature thereof may be readily maintained above the temperature at which the fluxed material fuses.

The bulk of the iron and the inert ingredients of the flue dust, is recovered in the fused slag product. The bulk of the carbonaceous material contained in the flue dust is oxidized to carbon oxides and passes out the chimney with the rest of the combustion gases. By water cooling the exterior of the furnace in the manner illustrated in Fig. 1 or otherwise as may be deemed expedient, a relatively long life in the refractory lining 4 is assured.

An alternative hearth structure is illustrated in Fig. 3, which may be briefly described as a continuous tap hearth, wherein the molten slag, as formed on the hearth 5, overflows through lip opening 15 into the suitable molds or conveyers, where it is solidified.

The slag product of this type of furnace may be broken out of the molds into any desired particle size and charged back into the blast furnace without the detrimental results attending heretofore agglomerated or sintered blast furnace flue dust particles. Being fused, it is not subsequently broken down into relatively fine products, as heretofore sintered products have been found to do.

While we have disclosed the sintering and fusing of blast furnace flue dust, it is apparent that we are not limited thereby as the method disclosed is adapted to the sintering and fusing of a wide variety of finely divided metalliferous materials.

In the furnace structure of Figs. 1, 2 and 3, the hot combustion gases are permitted to pass out of the smoke-stack 8, without attempting to utilize their heat content. In Figs. 4 and 5, we have devised and designed an apparatus wherein the furnace principle of Fig. 1 is utilized in combination with a boiler and an air preheater. Referring to the drawings (Fig. 4), the blast furnace flue dust sintering furnace 21, is connected with a boiler furnace 22, and an air preheater 23, in such manner that the heated gases from the sintering furnace, circulate first through the boiler furnace, and then through the air preheater furnace before passing out of the stack 24, thus absorbing in the water and air substantially all of the heat energy in the combustion gases otherwise wasted in Fig. 1. The sintering furnace 21 is also shown as being lined with boiler tubes 25, protected with refractory brick 26, from direct contact with the furnace flames. A slag screen 27, is also provided in conduit 17', between the sintering furnace and the boiler furnace to intercept the slag that is carried along with the combustion gases passing from the sintering furnace into the boiler furnace. The fused slag collects upon the hearth 28, and may be tapped therefrom in a manner substantially as shown in Figs. 1, 2 and 3. For this purpose a tapping hole and access door 29 may be provided.

A gas burner 30 having a fuel intake 30' supplied with hot combustion air from header 31 supplied from air preheater 23 in any convenient manner, extends within the furnace 21. Into the current of gas and hot air, which has a relatively high velocity, so that an intimate admixture thereof is obtained, we feed the relatively finely pulverized blast furnace flue dust from bin 33, which is supplied thereto by a conveyer (not shown), by means of a blast of air from header 31, the feeding mechanism 32 being substantially identical with that heretofore described in Fig. 1.

An external fan (not shown) blows air at atmospheric temperature through the air heater 23 to the header 31, thereby supplying the gas burner with preheated combustion air. A damper 34 in the header 31, in the connection between the air header and the gas burner 30, regulates the air needed for combustion, and can be under the control of an automatic regulator (not shown), so that only the right amount of air required for combustion, will be admitted. In this manner, a relatively uniform high temperature sufficient to melt the finely divided flue dust feeding into the burner through pipe 35, may be maintained.

In the operation of the furnace, the particles of flue dust are incandesced to a temperature, at

which they are molten, and fall down and collect upon the hearth 28, from which they may be tapped out through tap holes 29, either continuously or intermittently in any convenient manner. The gaseous products of combustion play upon the hearth 28 and pass on through the slag screen 27, which is water cooled, and into the boiler furnace 22, where the bulk of the heat energy content in the gases is given up to the water in tubes 36, thereby generating steam, and from the boiler furnace passes into the air heater 23, where the residual heat is utilized in preheating the combustion air. From thence, the combustion gases pass into the smoke-stack 24 and out of the top thereof.

The design of the slag screen is illustrated in greater detail in Fig. 5, which is a cross-sectional plan view taken along line 5—5 of Fig. 4, wherein it may be noted that the screen substantially comprises a plurality of groups of tubes arranged as a baffle to extend substantially across the flue opening. Water is circulating through the tubes, and, the fine particles of the flue dust being carried along by the combustion gases, tend to condense thereon. As the temperature of the gases is relatively high, approximating at the melting point of the flue dust particles, the depth of the deposit of these flue dust particles that may collect thereon, is relatively low, the excess tending to melt and drain off from the tubes and collect upon the hearth 28.

Drums 40 and headers 43 are provided to connect the tubes 25, 27 and 36 in the stack furnace, slag screen and boiler furnace respectively into one system. Nozzles 41 and 42 provide means whereby steam is released from the system.

While we have shown and illustrated in Fig. 4 a specific type of boiler furnace, it is believed obvious that other types of boiler furnaces utilizing surplus heat in hot combustion gases as a source of heating energy, may be equally as well employed. It is also believed apparent that while we have illustrated an interiorly water cooled sintering furnace, a sintering furnace of an exteriorly water cooled type illustrated in Fig. 1 may equally as well be employed. It is also believed apparent that other types of sintering furnace may be designed to accomplish the objects of the present invention.

There may also be many modifications and departures of the specific embodiment disclosed herein without essentially departing from the nature and scope of the invention as set forth in the following claims.

What we claim is:

1. A furnace for sintering and fusing finely divided materials comprising a tubular stack closed at the top, an interior refractory lining for said stack, means to water cool the said stack and lining, a hearth disposed in the bottom of said stack, a smoke flue positioned adjacent the stack, a conduit connecting said stack and flue and opening into the bottom of the stack at a point adjacent to and above the said hearth, means adjacent the top of said stack to project finely divided materials into said stack, and means to heat the interior of said stack and the hearth to temperatures above the sintering and fusing temperatures of said projected material.

2. In a furnace of the type described and claimed in claim 1, means to water cool the said stack and lining comprising a plurality of vertically disposed conduits embedded in the said refractory lining and covered thereby, said conduits opening into headers, reservoirs and the like of a steam generating system associated therewith.

3. In a furnace of the type described and claimed in claim 1, means to project finely divided materials into said stack comprising a conduit extending from the exterior of the stack to the interior thereof, means to supply a blast of air through said conduit to the interior of said stack, a bin for the material, and a screw conveyor means to admix the finely divided materials with said air blast before entering into said stack.

4. In a furnace of the type described and claimed in claim 1, means to heat the interior of said stack and the hearth comprising at least one fuel burner disposed tangentially and downwardly in the wall of said stack at a point adjacent the upper end thereof, and means to supply fuel and an air blast to said burner.

5. In a furnace of the type described and claimed in claim 1, means to heat the interior of said stack and the hearth comprising a plurality of fuel burners disposed tangentially and downwardly in the wall of said stack at a point adjacent the upper end thereof, and a separate burner similarly disposed in the wall of said stack at a point adjacent the bottom thereof but above in a position to play upon the hearth thereof, and means to supply fuel and an air blast to said burners.

6. In a furnace of the type described and claimed in claim 1, means to project finely divided materials into the stack and means to heat the interior of the stack and the hearth to elevated temperatures comprising in combination a fuel burner disposed tangentially and downwardly in the wall of said stack adjacent the top thereof, means to supply fuel and air separately to said burner, and means to admix the finely divided material with the said fuel as it is supplied to the said burner.

7. In combination with the furnace of the type described and claimed in claim 1, a water cooled slag screen disposed in the conduit connecting the said stack with the said flue, said slag screen comprising a plurality of vertically disposed tubes communicating top and bottom with headers of a steam generating system associated therewith, said tubes being spaced apart relative to each other to provide for maximum contact of gaseous products of combustion therewith in passing through the said conduit.

8. In combination with a furnace of the type described and claimed in claim 1, a steam generator furnace and an air preheater furnace interposed between and in series with the said stack and the said flue, the said conduit communicating with the said steam generator instead of said flue and the gases after passing through said steam generator being conducted into said air preheater and thence into said flue.

9. In the combination described and claimed in claim 1, a steam generator furnace and an air preheater furnace interposed between and in series with the said stack and the said flue, the said conduit communicating with the said steam generator instead of said flue and the gases after passing through said steam generator being conducted into said air preheater and thence into said flue, and a slag screen disposed in the conduit between the stack and said steam generator, said slag screen comprising a plurality of vertically disposed tubes across the cross-section of said conduit, said tubes opening top and bottom into headers filled with water

supplied thereto as part of said steam generator system, and said tubes being spaced apart relative to each other to provide for maximum contact of gaseous products of combustion therewith in passing through the said conduit.

10. In the combination described and claimed in claim 1, a steam generator furnace and an air preheater furnace interposed between and in series with the said stack and the said flue, the said conduit communicating with the said steam generator instead of said flue and the gases after passing through said steam generator being conducted into said air preheater and thence into said flue, and a slag screen disposed in the conduit between the stack and said steam generator, said slag screen comprising a plurality of vertically disposed tubes across the cross-section of said conduit, said tubes opening top and bottom into headers filled with water supplied thereto as part of said steam generator system, and said tubes being spaced apart relative to each other to provide for maximum contact of gaseous products of combustion therewith in passing through the said conduit and a conduit to conduct heated air from said air preheater to the air blast means for said burners.

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