Nov. 26, 1940. C. F. RAMSEYER 2,223,047

METHOD OF MAKING MINERAL WOOL

Filed March 9, 1936 4 Sheets-Sheet 1

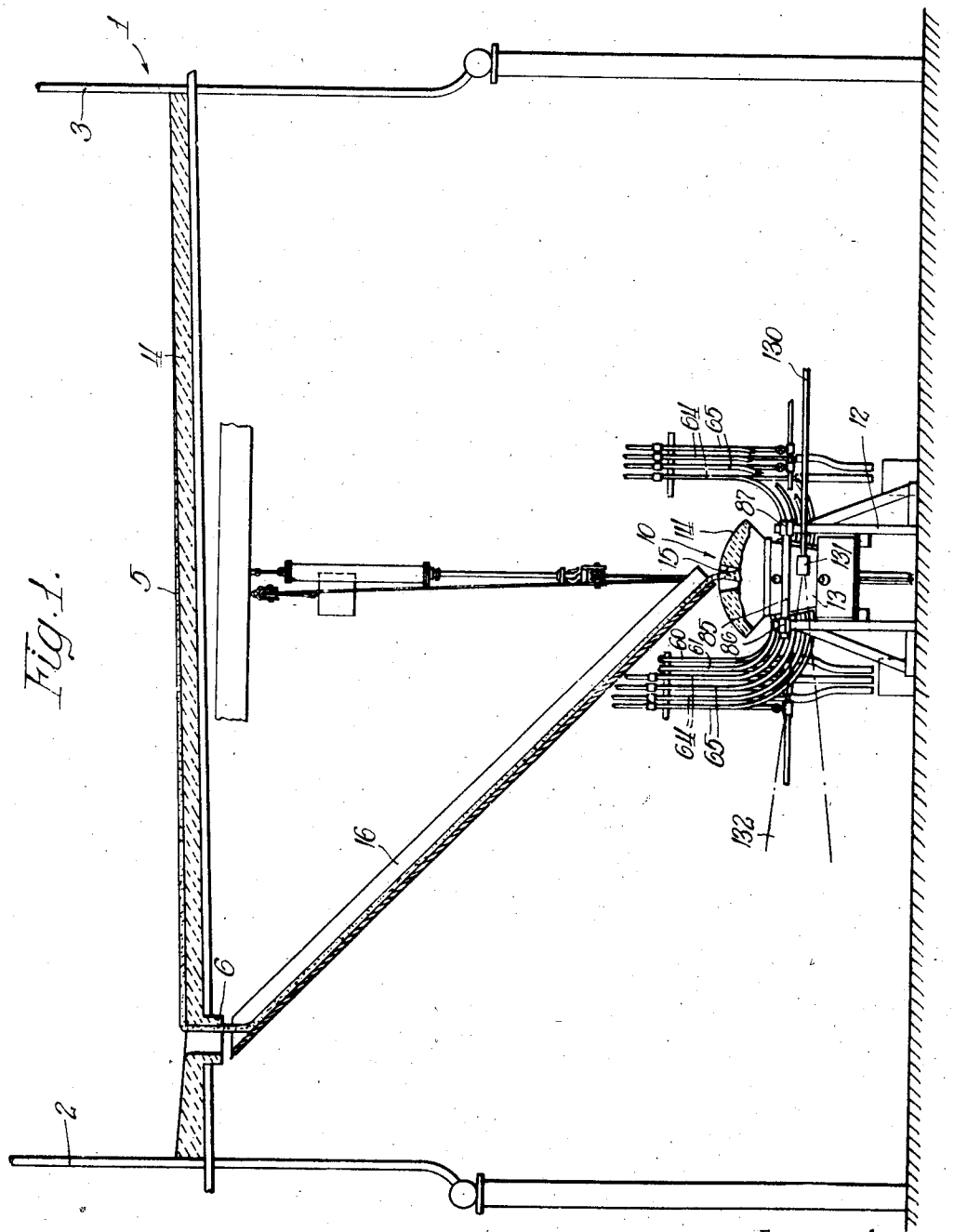


Fig. 1.

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Fig. 2.

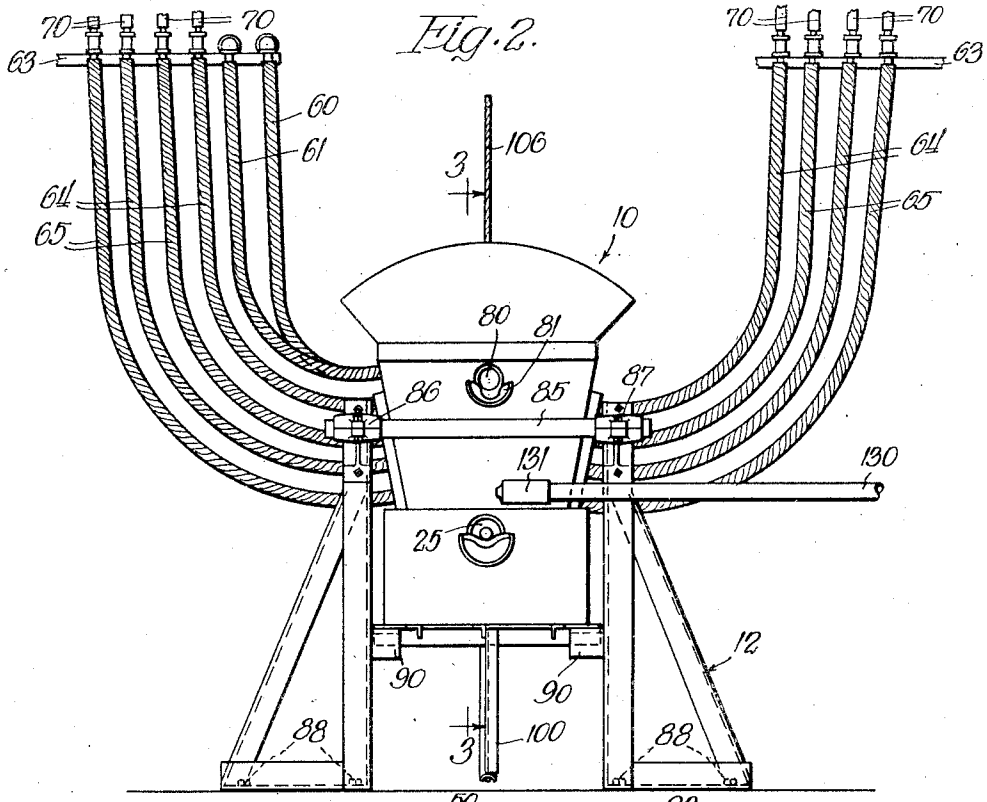
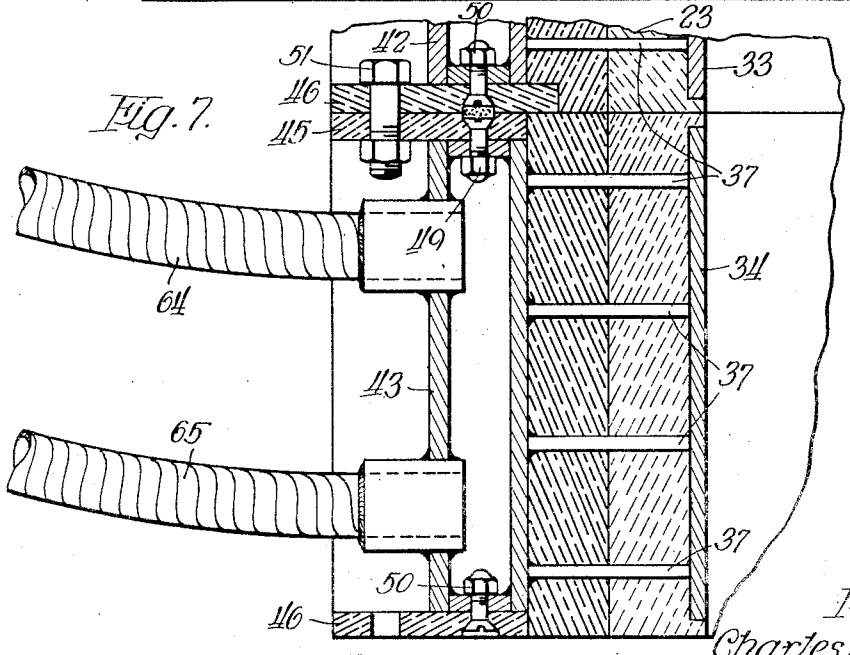


Fig. 7.



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METHOD OF MAKING MINERAL WOOL

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Fig. 6.

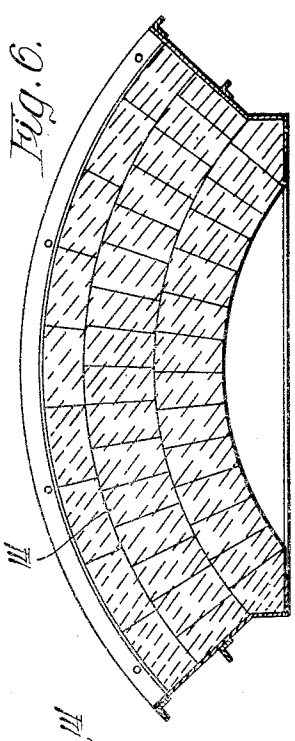


Fig. 4.

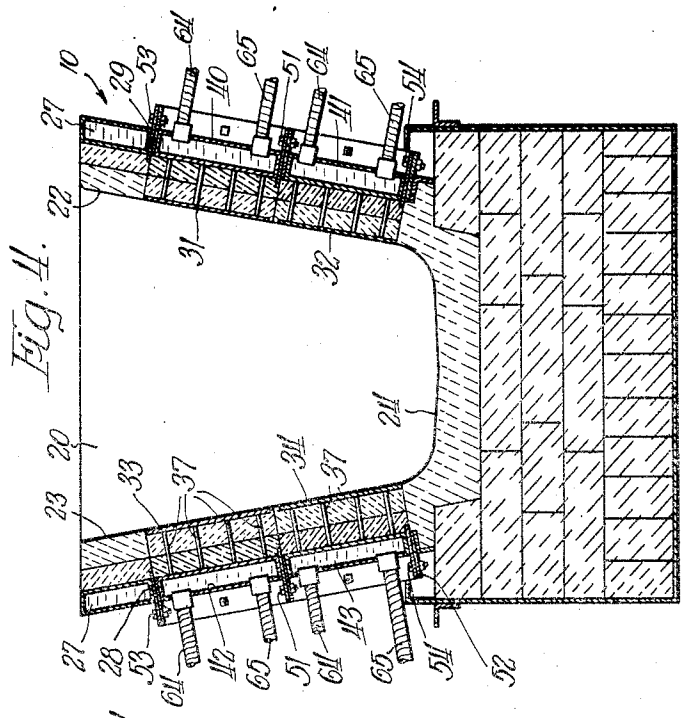


Fig. 5.

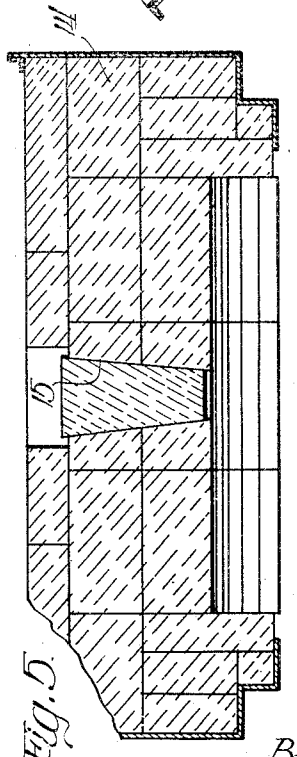
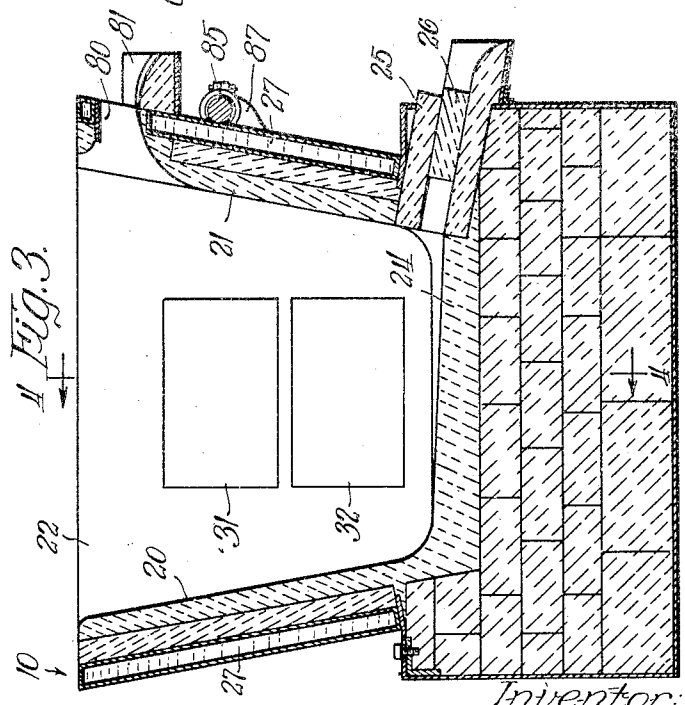


Fig. 3.



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Nov. 26, 1940. C. F. RAMSEYER 2,223,047

METHOD OF MAKING MINERAL WOOL

Filed March 9, 1936 4 Sheets-Sheet 4

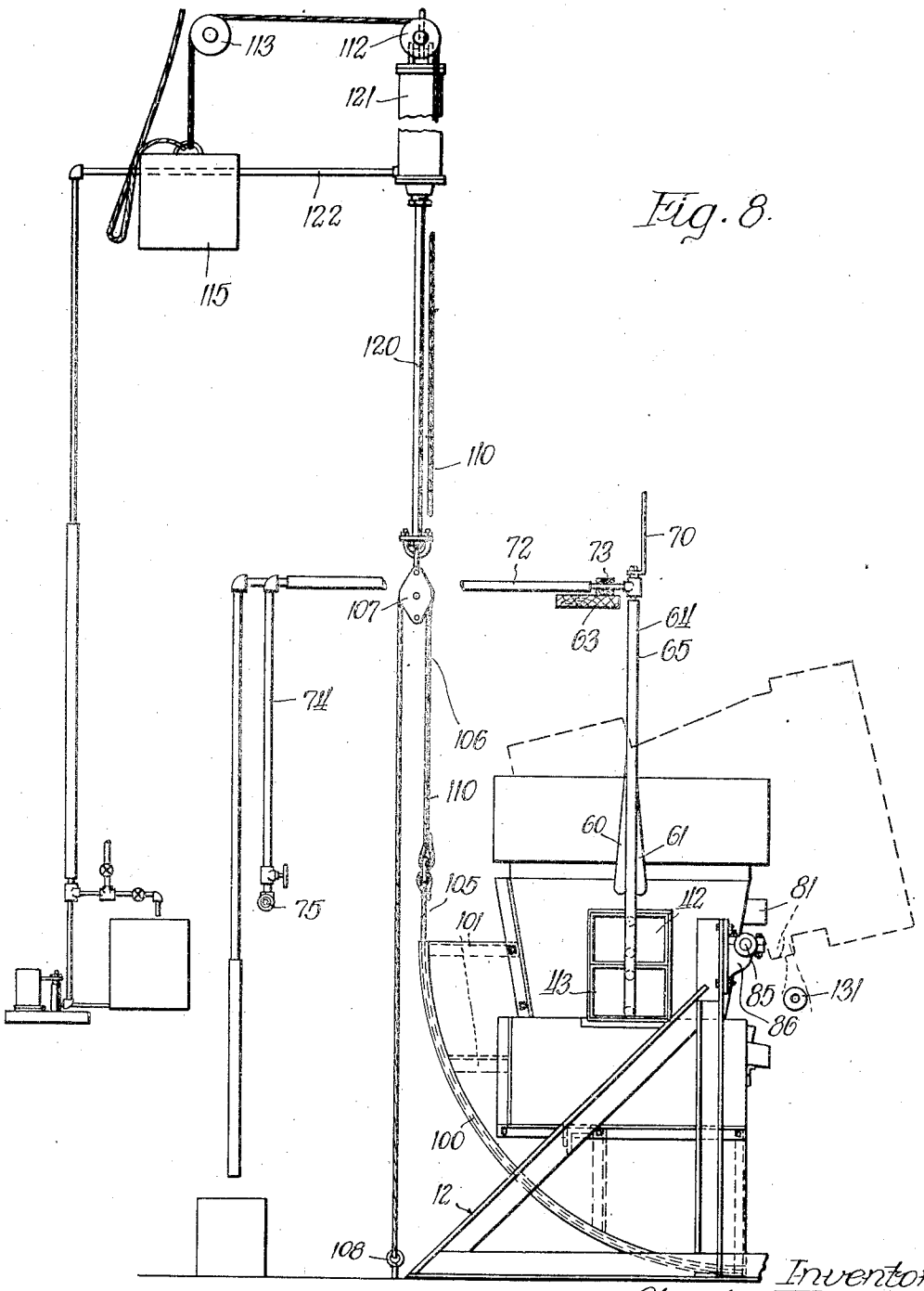


Fig. 8.

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UNITED STATES PATENT OFFICE

2,223,047

METHOD OF MAKING MINERAL WOOL

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Application March 9, 1936, Serial No. 67,868

9 Claims. (Cl. 49—77.5)

The principal object of the present invention is the provision of a new and improved method of making mineral wool. More specifically, the present invention has for its object a new and improved method of making mineral wool from a hitherto unused raw material, namely, coal ashes.

By mineral wool is ordinarily meant a fine fibrous "wool-like" material, made by blowing a small falling stream of molten rock or similar material, such as metallurgical slag, with a jet of steam or air. The action of the jet of fluid is to blow the molten stream into fine fibrous material which is hardened by the time that the fibers fall to the floor some distance away from the jet of fluid, either steam or air, under pressure.

The commercial form of rock wool in considerable use today is commonly made by melting an argillaceous limestone in which the molecular ratio of acid oxides (principally silica and alumina) to basic oxides (principally lime and magnesia) is about one to one. The rock is quarried, transported to the plant and melted with coke in a cupola, from which the molten stream issues and is blown with steam or air from a nozzle into a chamber or other space arranged to receive the rock wool.

Instead of melting rock or the like, sometimes the slags resulting from the smelting of various metallic ores, such as lead and copper, have been found to be suitable for remelting in a cupola and blowing into a mineral wool, the product being usually referred to in this case as "slag wool." Attempts to blow the molten slags directly from the smelters without cooling and remelting have commonly been unsuccessful, due principally to a lack of control of the temperature and rate of flow of the slag from the smelting furnaces. Also, slags from iron blast furnaces have been used, but in this case there are sulfides present with the result that when the wool is later exposed to the moisture in the air chemical reactions take place by which various sulfur acids are formed. These acids are likely to corrode any metal with which the wool may come into contact, and for this reason iron blast furnace slag wool has a rather limited application in the industry.

Some of the disadvantages encountered in the production of mineral wool by the processes mentioned above have been the high cost of production and the difficulty of securing a uniform product. Where the rock has to be quarried and transported to the mineral wool plant, relatively expensive fuel (usually coke) purchased to melt the rock, and steam generated, usually at low efficiencies in a small size boiler plant, with which to blow the molten rock, it will be clear that such mineral wool is a relatively expensive product. Also, since practically the only method of controlling the temperature, viscosity and chemical content of the molten material is by changing the ratio of rock or slag to the coke charged in the cupola, it can be seen that the control of the molten material is very far from being either instantaneous or automatic, since in most plants it is a matter of hours before the material charged in at the top of the cupola can influence the temperature or composition of the molten material coming from the tap hole.

With these factors in mind, the principal object of the present invention, as stated above, is a relatively great reduction in cost of producing mineral wool and it is a further object of the present invention to improve the quality and uniformity of mineral wool. More particularly, it is an object of the present invention to utilize ashes from coal fired boiler plants and the like, the disposal of which at present is ordinarily an item of expense rather than profit, in the formation of a new and improved product, namely, mineral wool. By the use of the present invention, not only will the cost of the raw material for the mineral wool be completely eliminated, but the same is true of the cost of the fuel required to melt the raw material in the cupola. Since both of these items of expense are eliminated, the cost of production of the product is very greatly reduced.

A further important object of the present invention is the provision of new and improved means by which the temperature, and more particulary the viscosity, of the molten stream of material from which the wool is blown can be continuously maintained at any desired predetermined value, thereby insuring the production of wool of uniform characteristics at all times.

Still further, another object of the present invention is the production of a new and improved mineral wool in which, as to chemical content, iron oxide, probably in the ferrous state (FeO), can be substituted for the lime and magnesia usually employed at the present time as part of the basic component of an oxide mixture capable of being blown into a mineral wool. As mentioned above, ordinary rock wool available at the present time contains acid oxides, such as silica and alumina, and basic oxides, principally lime and magnesia, in about equal proportions. So

far as I am aware, it is new to employ iron oxide, rather than lime and magnesium oxides, as part of the basic component of the mixture to be blown, with only a small proportion of lime and magnesia. In this connection, I also recognized that a material containing an appreciable percentage of iron oxide could not be melted successfully in a cupola furnace with coke, since the iron oxide is quite easily reducible at temperatures above the melting point of the ash and would react with the coke to form metallic iron, thereby changing both the composition and temperature of the molten material. Therefore, according to the principles of the present invention I provide other means for controlling the temperature of the molten ash as it runs out of the furnace, the means being so constructed and arranged that the temperature and viscosity of the molten furnace ash can be accurately adjusted to the most advantageous point for the blowing of the wool. Therefore, a further object of the present invention is the method of producing mineral wool by melting the raw materials in an oxidizing apparatus, rather than a reducing apparatus as has hitherto been used in the production of rock wool, slag wool and the like.

In this connection it should be mentioned that, as a part of the present invention, and particularly as the part thereof which contemplates making use of a by-product that at the present time requires money to be spent for its disposal, I make use of "wet-bottom" or "slag-tap" furnaces. Furnaces of this type have been developed within the last few years and are particularly adapted to use pulverized coal. In furnaces of this type, the temperature is kept high enough so that the ash of the coal collects on the floor of the furnace in a molten condition and can be drawn or tapped off at will, either continuously or at intervals as may be desired. Ordinarily, the pulverized coal is blown into the furnace, this method of firing being particularly advantageous with coals having a low fusion point ash, such low fusion point frequently being due to the presence of iron oxide in the ash, the iron oxide being originally present in the coal, largely as iron disulfide or pyrites (FeS_2). Therefore, according to the present invention, I make use of the molten slag or ash from furnaces of this type, in which the slag or ash is relatively high in iron oxides, in the production of an improved mineral wool.

An additional object of the present invention is the provision of a small furnace or container so constructed and arranged to receive the molten ash from the boiler plant, which may or may not be a "wet-bottom" furnace or the like, and to control the temperature and viscosity of the molten material so as to facilitate the subsequent blowing of the same into mineral wool. Such small or intermediate furnace, which may be termed a conditioning furnace, may be heated in any suitable manner, either by fuel or electricity, preferably the latter. According to the principles of the present invention, heat is generated in the molten ash by passing an electric current through it, whereby the molten ash itself acts as the resistance in the circuit transforming the electric current into heat. By virtue of a conditioning furnace, the proper viscosity of the molten material may be maintained at all times for producing the best quality of wool.

A further object of the present invention, having particularly to do with the form and construction of the conditioning furnace, is the provision of new and improved means for passing a current through the molten coal ashes, which means includes water cooled electrodes. In this way the corrosive action of the iron oxide content of the molten ash will be eliminated as much as possible. Other features and advantages of the conditioning furnace will be apparent from the detailed description thereof.

A further object of the present invention is a new and improved means for controlling the viscosity of the molten ash or material. According to the principles of the present invention, the molten material itself is used as the resistance element in the heating circuit, this making it possible to maintain substantially constant viscosity by maintaining the resistance of the slag in the conditioning furnace substantially constant. This is due to the fact that the viscosity of a molten oxide mass or mixture is directly related to its electrical resistivity. It is recognized that the viscosity of the slag at the time the blast from the blowing nozzles strikes the same is one of the most important variables determining the quality of the mineral wool, and thus by virtue of the present invention, which contemplates keeping the viscosity of the molten ash constant, variations in the chemical composition of the molten material which ordinarily would affect the quality of the wool are rendered substantially harmless.

These and other objects and advantages of the present invention will be apparent to those skilled in the art after a consideration of the following detailed description.

In the drawings:

Figure 1 is a view showing a portion of the floor of a wet-bottom coal fired furnace and a portion of a conditioning or intermediate furnace receiving the molten slag or ash from the wet-bottom furnace;

Figure 2 is a larger view of the intermediate or conditioning furnace;

Figure 3 is a section taken substantially along the line 3—3 of Figure 2;

Figure 4 is a section taken substantially along the line 4—4 of Figure 3 and showing the insulated cooling water jackets and the electrically and thermally connected contact plates associated with the insulated cooling jackets;

Figures 5 and 6 are longitudinal and transverse sections taken through the roof of the conditioning furnace shown in Figure 2;

Figure 7 is an enlarged section taken vertically through one of the insulated cooling jackets; and

Figure 8 is a view illustrating one method of blowing the mineral wool by tilting the conditioning furnace about an axis substantially coincidental with the pouring spout of the furnace.

Referring now more particularly to Figure 1, the furnace which the present invention makes use of is indicated in its entirety by the reference numeral 1 and includes more or less conventional water tubes 2 and 3 and a furnace floor 4 upon which the slag or ashes from the combustion of the pulverized coal collect in molten state, as indicated at 5. Such furnaces are provided with a slag hole 6, either in the bottom or side of the furnace, through which the molten ash flows, more or less continuously. The intermediate or conditioning furnace is indicated in this entirety by the reference numeral 10 and includes suitable framework 12 carrying a refractory container 13, which will be referred to

in detail later, having a roof 14 in which a pouring opening 15 is placed. A trough 16 or the like may be arranged for conducting a flow of molten ash from the furnace 1 to the inlet opening 15 of the conditioning furnace 10. If desired, there may be several conditioning furnaces 10 for each principal furnace 1 so that by shifting the trough or other suitable means from one conditioning furnace to the other the continuous flow of molten coal ashes 5 may be accommodated.

Turning now to Figures 2 to 6, which best illustrate the details of one form of conditioning furnace which has been found to be successful in carrying out the principles of the present invention, the furnace 10 consists of end walls 20 and 21 and side walls 22 and 23, and a bottom wall 24 sloping downwardly toward a tap hole 25. The bottom, side and end walls are formed of refractory material, commonly employed where high temperatures are encountered, and preferably the side and end walls 20, 21 and 22, 23 are water jacketed so as to prevent overheating. The bottom 24 is not water jacketed but is more heavily lined with refractory brick or similar material, due to the possible danger of the formation and collection of molten iron in the furnace. When iron does collect, the plug 26 (Figure 3) may be removed and the molten iron drawn off through the slag tap 25. The roof 14 of the furnace is also formed of refractory material, such as fire brick or the like, and is provided with the inlet or receiving opening 15, as best shown in Figures 1 and 5. It may be water jacketed if necessary. The water jacketing of the sides and ends of the furnace may be accomplished in any known manner, such as a jacket 27 adapted to contain water or other cooling medium and surrounding the ends and sides with openings 28 and 29 for the jacketed electrodes, to be referred to later.

According to the present invention, operatively disposed plate electrodes 31, 32 and 33, 34 are disposed on opposite side walls 22 and 23 of the furnace on the inside thereof and in the openings 28 and 29 in the furnace jacket 27. These plate electrodes are insulated from each other and are provided with conducting bars 37 (Figure 7) which connect the plate electrodes both thermally and electrically with the water jacket inserts indicated at 40, 41 and 42, 43. These water jacket inserts are insulated with respect to the other portions of the cooling jacket system, as best indicated in Figure 7. In this figure the water jacket inserts 42 and 43 have insulating strips 45 and 46 secured to the upper and lower edges by bolts 49 and 50, and the two water jacket inserts at one side of the furnace, thus insulated from one another, are bolted together as at 51 and to the upper water jacket 27 and a lower attaching plate 52 by bolts 53 and 54 (Figure 4). It is to be noticed that the conductor bars 37 connecting the contact plates with the insulated water jacket inserts pass through the refractory material making up the side of the furnace. The bars 37 are so proportioned as to conduct heat from the contactor plate to the water jacket at a predetermined rate sufficient to maintain the contact plates 31, 32 and 33, 34 at a temperature low enough to prevent destruction by the molten material in the furnace. In other words, to maintain the electrodes within the desired temperature limits, depending on the viscosity required, the refractory material resists to a certain extent the flow of heat from the plates 31, 32, 33 and 34 to the associated water jackets, while the heat conducting bars 37 passing through the refractory material conduct a certain amount of heat from the inner plates to the outer water jackets.

Cooling water is directed to and withdrawn from the furnace shell 27 by means of water connections 60 and 61 (Figure 2), the upper ends of these connections being supported in a suitable frame 63. Each of the insulated water jacket inserts 40, 41, 42 and 43 is provided with two flexible copper metal hose sections, indicated in Figures 2, 4 and 7 at 64 and 65. These sections serve not only to supply water to each of the water jacket inserts but also to conduct the required electrical current to or from the water jacket inserts. A frame 63 is provided at each side of the furnace 10 and supports the upper ends of the flexible copper metal hose sections 64 and 65. Bus bars 70 (Figure 2) are electrically connected with the copper hose sections adjacent the points where the latter are supported on the frames 63, and at the same point suitable water pipes 72 (Figure 8) are connected through supporting and insulating sleeves 73 carried on the frame 63. The water supply connections include pipes 74 leading to a supply main 75. Obviously, of course, other forms of supply, both as to cooling water and electrical current, may be employed where desired. Also, while I have shown only two jacketed electrodes on opposite side walls for purposes of illustration, a greater number is preferably used.

The furnace 10 is mounted for tilting movement on the frame 12 so that the furnace may be tilted for discharging its load of molten coal ash. As best shown in Figure 3, the end wall 21 of the furnace 10 is provided with a pouring hole 80 provided with a spout 81, and as best indicated in Figures 1 and 3 the furnace includes a trunnion shaft 85 which is mounted in bearings 86 and 87 forming a part of the supporting framework 12. The shaft 85 passes close to the pouring spout 81, and as indicated in Figure 3 the curvature of the lower wall of the pouring opening 80 and the adjacent portions of the spout 81 is substantially arcuate about the axis of the trunnion shaft 85. The frame or pedestal 12 is of more or less conventional construction, being built up of angle irons welded or bolted together and fastened to the floor by any suitable means, such as lag screws or expansion bolts 88. Clips 90 are welded or bolted to the framework 12 so as to support the furnace 10 in level position. The furnace itself carries a quadrant 100, best indicated in Figure 8, which is secured to the furnace shell in any suitable manner, such as by angle irons 101 or the like, and the quadrant 100 is preferably, but not necessarily, made up of a section of tubing split longitudinally and bent to the proper radius.

A tilting cable 105 is fastened at its lower end to the forward portion of quadrant 100 and at its upper end is connected to a cable 106 passing over a sheave 107 and extending downwardly to a fixed point 108. A counterbalancing cable 110 is also fastened to the flexible section 105 and passes over suitable pulleys 112 and 113 where the end of the cable 110 supports a counterweight 115. The sheave 107 is carried at the lower end of a plunger 120 which passes into a cylinder 121 which has suitable connections 122 to a source of fluid pressure. By suitable controls, pressure may be directed into the cylinder 121 to raise the plunger 120 and shift the furnace 10 from the position shown in Figure 8 in full lines to the

position shown in dotted lines, tilting the furnace about the axis of the shaft 85. Molten material within the furnace 10 will therefore be poured out of the spout 81.

As best shown in Figure 1, a steam supply connection 130 leads to a blowing nozzle 131 disposed at one side of the stream issuing from the pouring nozzle 81. The rate of flow of the blowing fluid, such as steam under pressure, and the rate of tilting of the furnace are so controlled that the fluid pressure blows the entire molten stream laterally, as at 132, forming the product commercially known as mineral wool.

The bus bars 70 are connected in any suitable manner with a source of current and suitable controls serve to maintain a flow of current, providing that the furnace contains molten slag or coal ash, from one pair of contacts or plates to the other. It was mentioned above that the viscosity of a molten oxide bath is directly related to its electrical resistivity. By the use of suitable electrical controls, the resistance of the slag in the furnace may be maintained constant and by virtue thereof the viscosity of the mass of molten material in the furnace will also be maintained constant. This is an important feature of the present invention, for it is the viscosity of the slag at the time the blast from the blowing nozzle hits it that is the most important variable determining the quality of the mineral wool. The above mentioned controls are so arranged that if the resistance of the slag between the paths of contactor plates increases, an increase in power will immediately reduce the resistance, for the higher the temperature of any molten oxide bath, the lower its electrical resistance becomes. On the other hand, if the resistance across the two sets of contactor plates falls, a lowering of the power input will immediately permit the slag bath to cool off slightly so that both its resistance and viscosity will again increase.

One of the important advantages of using molten coal ashes, entirely aside from their availability as a by-product of no value at the present time, is that the mineral wool produced from coal ashes contains an appreciable percentage of iron oxides and is much softer than the ordinary commercial rock wool in which the basic constituent is composed practically wholly of the lighter metal oxides, as for example, calcium oxide and magnesium oxide. The molten material containing basic oxides in which the major portion is made up of iron oxides will best flow freely at about a temperature of 2400° F., and if blown at this temperature the best results are secured, the fibers being soft and flexible and have an average diameter, I have found, of from 2 to 6 microns, the average diameter usually being about 3 microns. The proportion between the acid and basic oxides of a mixture capable of being blow into a mineral wool will, of course, vary with the type of coal burned in the furnace and also to some extent upon the conditions under which the furnace operates. For example, by using a given coal with a given furnace, I produced mineral wool from boiler coal ash having approximately 54% silica and alumina oxides and approximately 46% iron oxides (Fe_2O_3). In ordinary commercial rock wool, the iron oxide content amounts to not more than 2 or 3% by weight. I have also found that the mineral wool that I have produced by the above process scarcely ever contains as much as one tenth of 1% of sulphur. As a matter of fact, usually the sulphur content of the molten ash from the furnace rarely contains any more sulphur than the above amount, and even this small amount is not stable and is apparently oxidized and driven out in heating and blowing of the molten material. While it is true that many coals may contain up to 5% sulfur, and it would seem that the coal ash coming from the furnace might also contain appreciable quantities of sulphides, yet, however, this is not the case, for sulphides are stable only under reducing conditions and in basic slags, whereas a boiler furnace is a fuel oxidizing, not reducing, apparatus. For this reason, since practically all commercial coal ashes form acid, rather than basic slags, such small amounts of sulfur as may initially enter the slag are rapidly driven therefrom.

Thus, according to the present invention, I am enabled to take a waste by-product, that is, molten coal ashes which is not only of little or no value at the present time but is usually an item of expense on account of the need for disposal thereof, and convert this waste by-product into a highly useful and valuable by-product in the form of a mineral wool of uniform quality and superior characteristics, and at a cost far lower than any of the present methods for making a similar grade of mineral wool. Specifically, by the utilization of the waste molten ashes from slag bottom pulverized fuel fired boilers, the entire cost of quarrying, transporting and melting rock or slag for the production of mineral wool is avoided; due to the substitution of iron oxides for calcium and similar oxides in the composition of the mineral wool, I obtain a softer, more desirable product than the ordinary commercial rock wool type of mineral wool and without excessive temperature requirements in the blowing of the molten material; and due to the use of a heat-controllable intermediate furnace for holding and conditioning the molten raw material placed between the melting furnace and the blowing nozzle, I am able to control the uniformity of the product without any appreciable time lag and much more accurately and continuously than it has been possible to do in the previous state of the art.

While I have described above the details of my new and improved method of making mineral wool, it is to be understood that they are not limiting, but illustrative, and that all variations therein as fall within the scope and purport of the appended claims are to be considered as part of my invention.

What I claim, therefore, and desire to secure by Letters Patent is:

1. The method of producing mineral wool from coal without substantial addition of other material, which comprises burning coal containing a useful percentage of iron in an oxidizing atmosphere and at a temperature which fuses the incombustible ash content, collecting the fused ash in fluid form, and forming the fused ash into wool.

2. The method of producing mineral wool from coal without substantial addition of other material, which comprises burning soft coal in powdered form in an oxidizing atmosphere at a temperature sufficient to reduce the ash to molten form, collecting the molten ash while still fluid, and forming the fluid ash into mineral wool.

3. The method of claim 2 characterized by adding heat to the molten ash after it has been collected to bring it to substantially a predetermined temperature and viscosity, and maintaining the temperature and viscosity constant,

whereby its viscosity is substantially uniform during the formation of the mineral wool.

4. The method of producing mineral wool from coal substantially without the addition of other material, which comprises burning finely divided coal which has a low fusion point ash while suspended in a current of air, the combustion being carried on in an oxidizing atmosphere and at a temperature which melts the ash, collecting the molten ash while it is in fluid form, and converting the molten ash into fibers to form mineral wool.

5. The method of claim 4 characterized by bringing the molten ash after it has been collected to substantially a predetermined temperature and viscosity, and maintaining the temperature and viscosity constant, whereby its viscosity is rendered substantially uniform for blowing.

6. The method of producing a mineral wool from coal without substantial addition of other materials, the ash of which contains from 25 to 50% iron oxides and approximately 50% or more oxides of silicon and aluminum, which comprises burning the coal in powdered form in an oxidizing current of air at a temperature high enough to reduce the ash to fluid form, collecting the molten ash while in fluid form, adding heat to the molten ash after it has been collected to bring it to a predetermined temperature whereby the viscosity is predetermined, and forming the molten ash into mineral wool while it is at said predetermined viscosity.

7. The method of producing a mineral wool from coal, the ash of which contains acid oxides and basic oxides in approximately equal proportions with iron oxides forming the major portion of the basic oxides, without substantial addition of other materials, which method comprises burning the coal in powdered form in an oxidizing current of air at a temperature high enough to reduce the ash to fluid form, collecting the molten ash while in fluid form, adding heat to the molten ash after it has been collected to bring it to a predetermined temperature, whereby the viscosity is predetermined, and forming the molten ash into mineral wool while it is at said predetermined viscosity.

8. The method of producing mineral wool from coal without substantial additions of other materials, the ash of which has a low fusion point and contains acid and basic oxides with iron oxides, including both ferrous and ferric oxide, forming the major portion of the basic oxides, which method comprises burning the coal in pulverized form in an oxidizing current of air at a temperature high enough to reduce the ash to fluid form and without reducing the iron oxides to metallic iron, collecting the molten ash while in fluid form, adding heat to the molten ash after it has been collected to bring it to a predetermined temperature, whereby the viscosity is predetermined, and forming the molten ash into mineral wool at said predetermined viscosity.

9. The method of producing mineral wool from coal without substantial addition of other material, which comprises burning a coal, the ash of which is fusible and contains silica and iron, in powdered form in an oxidizing atmosphere and at a temperature sufficient to reduce the ash to molten form, withdrawing the heat of combustion from the combustion zone by fluid convection, collecting the molten ash while still fluid, and forming the molten ash into mineral wool.

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