

Jan. 17, 1928.

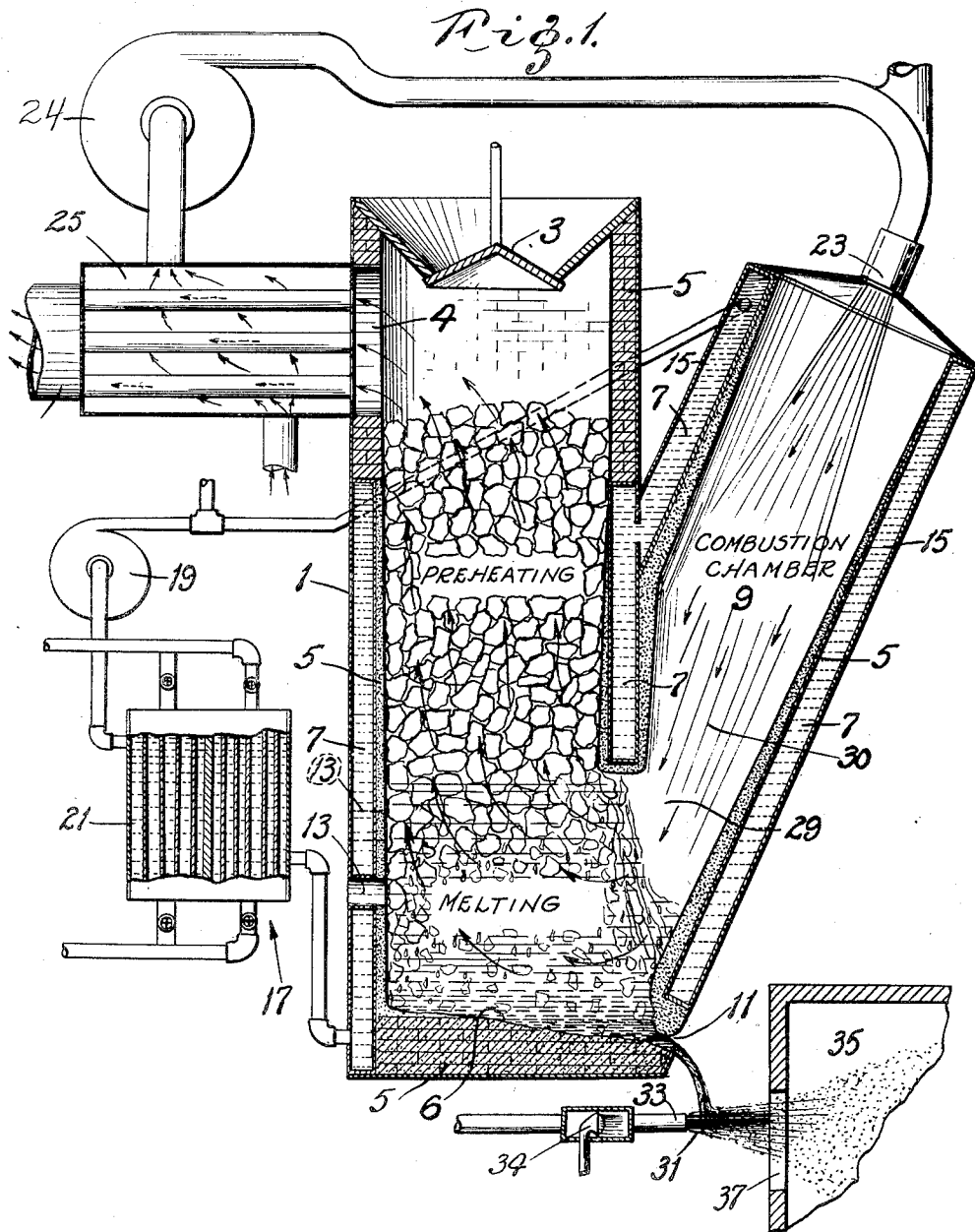
1,656,828

E. R. POWELL

METHOD OF AND APPARATUS FOR PRODUCING ROCK WOOL

Filed Jan. 5, 1927

3 Sheets-Sheet 1



Edward R. Powell,
Inventor.
By S. Haynes,
Attorney.

Jan. 17, 1928.

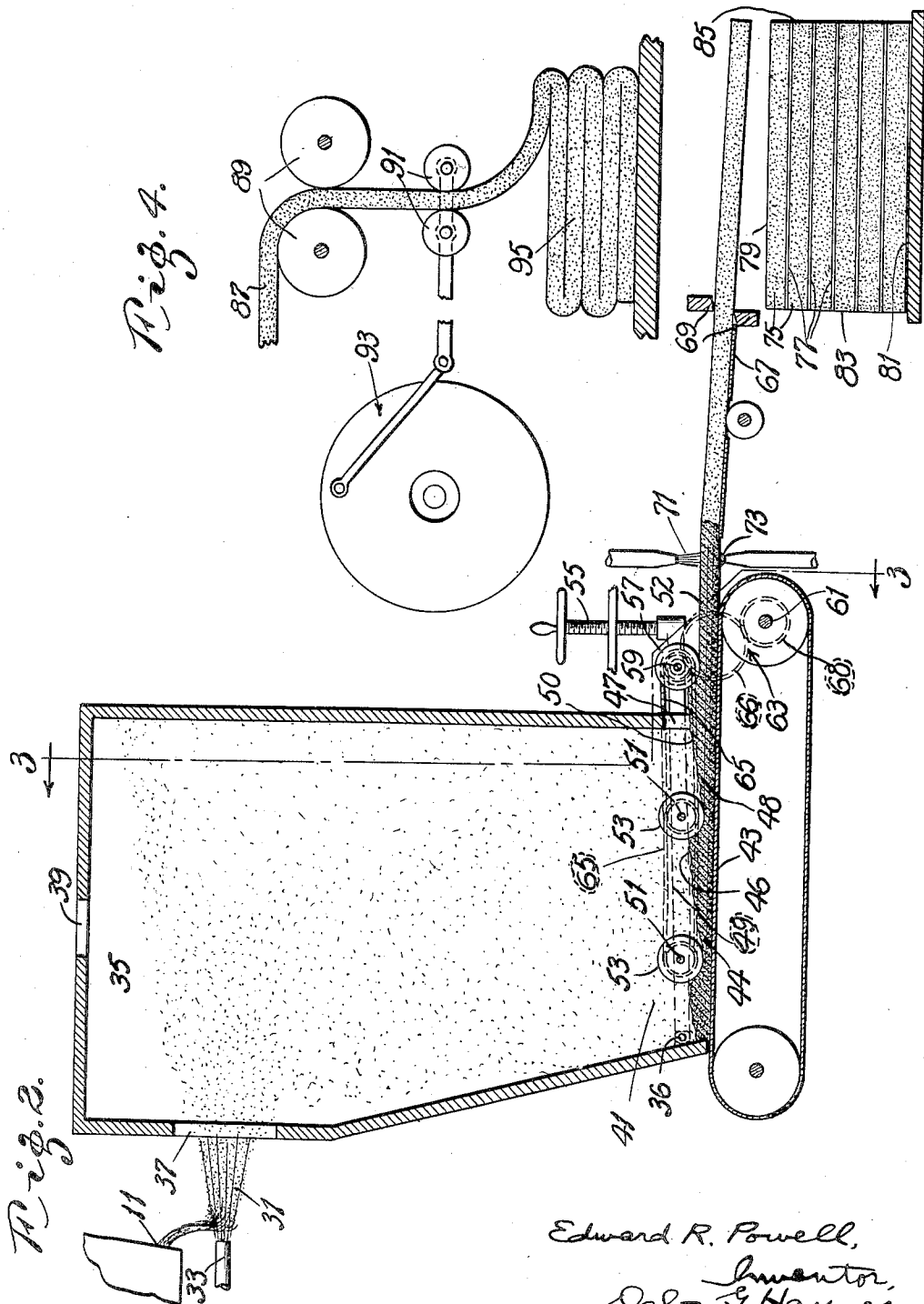
E. R. POWELL

1,656,828

METHOD OF AND APPARATUS FOR PRODUCING ROCK WOOL

Filed Jan. 5, 1927

3 Sheets-Sheet 2



Edward R. Powell,
Inventor,
Delor & Haynes,
Attorney

Jan. 17, 1928.

1,656,828

E. R. POWELL

METHOD OF AND APPARATUS FOR PRODUCING ROCK WOOL

Filed Jan. 5, 1927

3 Sheets-Sheet 3

Fig. 3.

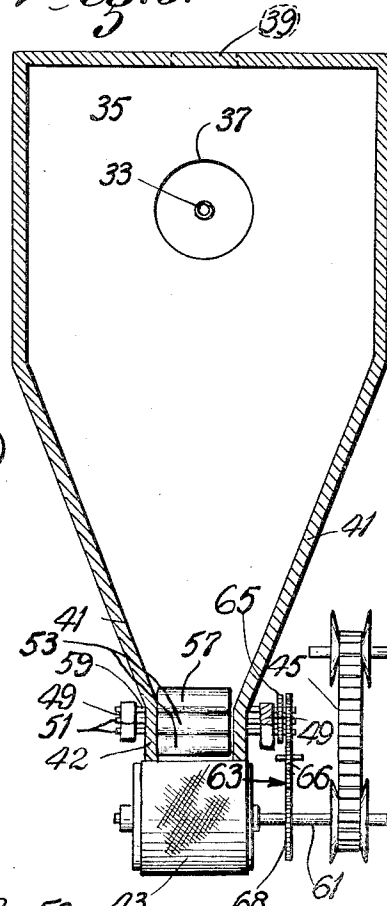


Fig. 5

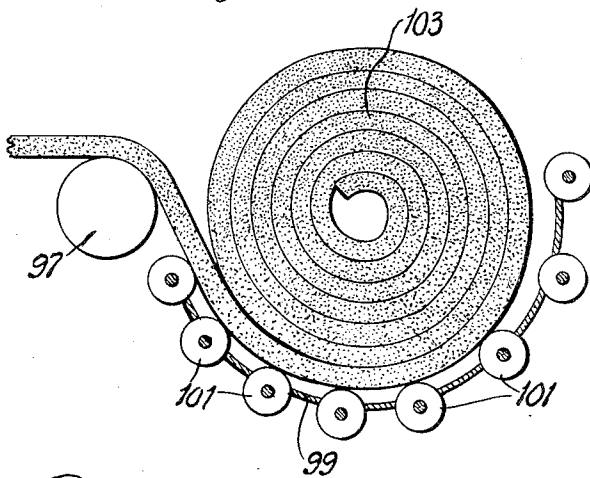


Fig. 6.

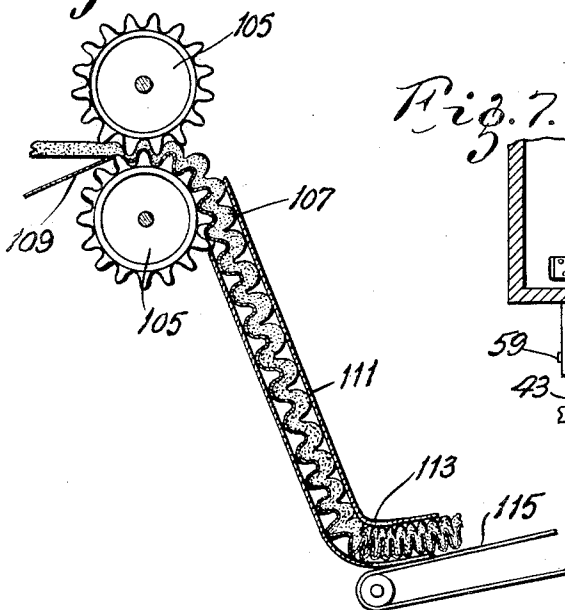
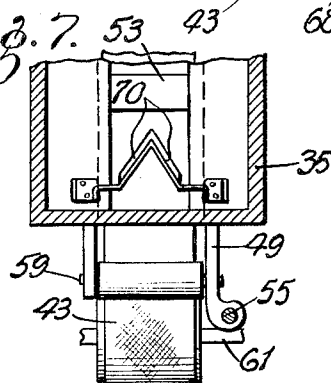


Fig. 7.



Edward R. Powell,
Inventor.
Delos S. Haynes,
Attorney

UNITED STATES PATENT OFFICE.

EDWARD R. POWELL, OF ALEXANDRIA, INDIANA.

METHOD OF AND APPARATUS FOR PRODUCING ROCK WOOL.

Application filed January 5, 1927. Serial No. 159,228.

This invention relates to a method of, and apparatus for producing a more stable and permanent rock or mineral wool; and with regard to certain other features to an improved felted and/or laminated product composed of said improved wool.

Among the several objects of the invention may be noted the provision of a method and apparatus for making a rock or mineral wool which is substantially free of sulphides, whereby the stability and permanency of the compounds composing the wool is increased; the provision of improved felting of said wool so as to obtain the strongest product possible and at the same time the maximum insulating efficiency which the material can maintain; the provision of adjustable apparatus adapted to produce said improved wool quickly and cheaply in various thicknesses and textures and densities; and the manufacture of an improved product comprising a laminated insulating block, the insulating efficiency of which is greater than that of an equivalent solid block, especially in applications to damp and humid installations. Other objects will be in part obvious and in part pointed out hereinafter.

The invention accordingly comprises the elements and combination of elements, features of construction, arrangement of parts, and the steps and sequence of steps which will be exemplified in the structure hereinafter described, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawings, in which are illustrated various possible embodiments of the invention,

Fig. 1 is a diagrammatic vertical section of a furnace, also showing certain desirable auxiliaries;

Fig. 2 is a diagrammatic vertical section of a blow chamber and includes also an enlarged detail showing the preferred method of laminating the product;

Fig. 3 is a lateral section of said blow chamber taken on line 3—3 of Fig. 2;

Fig. 4 is a view similar to the enlarged portion of Fig. 3 but illustrates a modified form of the product;

Fig. 5 is a view similar to Fig. 4, illustrating a second modified form, of the product;

Fig. 6 is a view similar to Fig. 4 illustrating a third modified form of the product; and

Fig. 7 is a fragmentary plan view of a roller showing the application of sideward guides thereto.

Corresponding reference characters indicate corresponding parts throughout the several views of the drawings.

Referring now more particularly to Fig. 1, there is illustrated at numeral 1 a furnace comprising, among other elements, a cupola equipped at its upper end with a conventional hopper-and-bell charging door 3 and an outlet flue 4. The walls and bottom 5 of the cupola 1 are composed of fire brick or other fire resisting materials at all points except around the melting and pre-heating zones, at which zones a water jacket 7 is used. The bottom 6 may be dumped in the conventional manner when it is desired to clean out the cupola 1.

The lower end of the cupola communicates with a combustion chamber 9 and is provided with an outlet 11 for permitting an efflux of molten material. Suitable tuyères 13 are provided in the jacket walls of the cupola for controlling air flow to the charge, primarily for purposes of controlling the temperature of the cupola charge so that all of the charge does not melt down at once to block the draft.

In the present embodiment of the invention, the combustion chamber 9 is of elongated form and slopes upwardly from the point 29 of communication with the cupola proper. The walls of this chamber 9 are also provided with a water jacket 15 which may communicate with said jacket 7 of the cupola.

A closed water circulating system 17, including a circulating pump 19, drives water through the jackets 7, 15. A closed heat exchanger 21 serves to reclaim heat from the jacket water for use in other processes, not herein described. The purpose of the closed jacket water system is to exclude the presence of harmful amounts of impurities which might cause a burning of the cupola wall plates by lowering the heat conductivity of said walls if the impurities became encrusted thereon.

The surfaces of the combustion chamber

9 and the preheating and melting zones of the cupola become lined during use with a layer of chilled slag.

At the upper end of the combustion chamber 9 is provided a powdered fuel burner 23, preferably for coal, the inlet air supply of which is drawn through an air preheater 25 by a blower 24, which forces the air to the burner 23. The preheater 25 is placed in the conventional manner in the breeching of the flue 4, provided near the top of the cupola 1.

The flame 30 of the burner 23 is directed down the chamber 9 and is provided with an excess of air for purposes to be described. Its normal tendency is to enter the cupola 1 and rise therein, the resulting heated gases finally passing out at the flue 47. Oil, gas or other suitable fuels may also be burned; but coal or coke is the most economical at present, that is, in most locations.

The theory and operation of the cupola is as follows:

Argillaceous limestone containing (broadly) silica, alumina, lime and magnesia (and a trace of sulphur as an inherent impurity), or slag (containing higher percentages of sulphur as inherent impurities) is loaded into the cupola in lump size. It takes up the approximate position shown in Fig. 1.

It is to be understood that so-called rock wool is made directly from the rock which contains only the slight trace of sulphur; while so-called mineral wool is made from the slag which contains the higher percentages of sulphur. In either case, however, the sulphur may become detrimental to the resulting wool product if the sulphur is permitted to take a sulphide form, although a sulphate form is less harmful.

For instance, calcium sulphide is detrimental to the resulting wool composition because it tends to react with the dilute acids often found in the moisture of the atmosphere. This reaction gives off hydrogen sulphide gas which is soluble in the atmospheric moisture. Hence, if any large percentage of sulphides of calcium or other elements are contained in the wool, it is rendered a substantially unstable composition or compound. Such a composition is therefore not a permanent or desirable material for purposes of construction. The sulphides also corrode many metals when wet, which is highly undesirable.

On the other hand, sulphates of calcium or other elements are harmless in the wool because they do not render it an unstable composition. There is little or no tendency for the action above described, to take place, that is, due to the presence of calcium sulphate or other sulphates.

Inasmuch as sulphur is a widely diffused element, present in most fuels and many rocks (at least in traces), it is desirable that

the process of making rock or mineral wool be carried out so that none of the sulphur will be reduced to the sulphide form or if already present as a sulphide, that it be oxidized to the sulphate form.

To carry the above principle into effect, the fuel is burned in a region such that complete combustion takes place before the products of combustion contact with the raw material to be fused, that is, the fuel is burned in the separate combustion chamber 9, preferably with an excess of air; instead of being burned with the material (as has been done heretofore) by packing it into the cupola with said material. Hence substantially no reducing action takes place near the rock in the present invention. Incidentally, the sulphur content of the fuel is prevented from being added to that of the rock and product thereof, to aggravate the recited difficulties.

The combustion of the fuel from the burner 23 is substantially complete when the inlet 29 to the cupola is reached. The cupola may be called a fusion chamber. All of the sulphur in the fuel is oxidized to sulphur dioxide and sulphur trioxide gases which pass out of the flue 4 to the stack (not shown) and do not contaminate the product in passing through the rock. The carbon is oxidized to carbon dioxide, the carbon monoxide content in the cupola being low. This represents a saving in fuel, as the heat of combustion to carbon dioxide is much greater than that to carbon monoxide.

The excess of air ensures that the products of combustion will remain in oxidized form and will not be reduced by organic or like matter in the rock material being fired.

If no sulphur exists in the rock in sulphide form, the above features alone avoid the presence of sulphides in the finished product. If sulphides are present, then another feature is used, hereinafter to be described.

The action of the hot gases in passing through the rock or slag in the cupola is to melt it down to a liquid rock which flows off at the outlet 11.

When sulphides are present in the raw rock or slag, it is necessary to oxidize them to sulphates if a sulphide-free rock wool is to be obtained. This cannot always be accomplished by an oxidizing flame because heat may be received indirectly by the material, which will melt and run down to the outlet 11 without being oxidized.

To prevent the above disadvantage, a fusible oxidizing agent is introduced with the rock, slag or other raw material at the charging door 3. Suitable oxidizing agents might comprise preferably solid sodium nitrate, sodium chlorate or manganese dioxide. These materials fuse with the melting rock and give off oxygen in the liquid, thereby

oxidizing the sulphides present to sulphates.

As in the case of the excess air, it is desirable to use an excess of the above oxidizing agents so that the action is positively complete. All excess oxygen will bubble to the surface of the melt and pass off as a harmless gas.

As is illustrated in Figure 1, the liquid rock trickles from the rock charge in the cupola and forms a pool from which the efflux at the outlet 11 is fed. As the charge in the cupola melts down, more raw rock may be fed in at the charging door 3. The fresh rock is preheated by the upflowing gases as said rock descends to the melting zone.

In the above manner a sulphide-free liquid rock is made to flow from the outlet 11.

In order to transform the liquid rock into the fluffy or wooly fibrous mass required for purposes of insulation, it is permitted to descend from the outlet 11 into the path of a rapidly moving steam (or air) jet 31 issuing from a nozzle 33. For purposes of improving the final product, under certain circumstances, a binder material is introduced into the nozzle 33 by means of the secondary jet 34 to be projected with the jet 31. The rapidly moving steam of the jet 31 draws the precipitating melted material out into innumerable fine atomized glassy threads at the forward end of many of which is formed a minute ball or drop. In settling down, most of the resulting fibers of rock or mineral wool lose the ball or drop; but whether attached or detached the small drops usually appear in the resulting mass of glassy threads, unless they are permitted to drop out.

It remains to felt down the rock wool and in the process permit the removal of many of the small drops.

The following method of felting is based on the fact that rock or mineral wool comprises a brittle fiber and will not permit of tearing, rending or reassembling, as is practicable in making textile and asbestos products. The strongest felt which can be made of rock wool is that which is naturally formed by the gentle and gradual pressure that the material exerts as it falls in the chamber into which it is blown by the steam jet.

By felting in the above manner the maximum insulating efficiency of which the material is capable is obtained. This is because a maximum number of the fibers lie with their lengths parallel to the horizontal planes of the material. Rock wool, when felted in this way, comprises a pliable material which may be formed to fit various surfaces or into various recesses.

Referring now more particularly to Figure 2, the improved method of felting will be described:

A blow chamber 35 is provided with an

inlet mouth 37 adapted to receive the steam jet 31 which carries the spray of melted, atomized and fast hardening fibrous materials. An outlet 39 for air and steam is provided at or near the top of said chamber 35.

Referring to Figure 3, it will be seen that the bottom portions 41 of the chamber 35 taper inwardly and downwardly in hopper form. These portions 41 have smooth sides and descend to regions in proximity to the upper reach of a moving conveyor belt 43. The portions 41 and the ends of the chamber 35 cooperate with said conveyor 43 in a manner such that the blown wool does not escape from the chamber before it is desired to have it do so. This is done by means of a narrow channel 42 of width equal to the width of the layer of finished wool, which may be from two to eight feet or so.

The conveyor 43 is driven from a conventional variable speed drive 45 and is adapted to carry the rock wool from the blow chamber by way of an opening 47.

Just above the conveyor and outside of the chamber 35 is pivoted at 36 a roller-supporting frame 49 which supports a plurality of roller axles 51. These axles reach through suitable slots in the channel 44 and carry rollers 53 within the channel 44. The rollers 53 are approximately the width of said channel. At the end of the frame 49, opposite the pivot 36, the frame 49 is provided with an adjusting screw 55 for the purpose of raising and lowering said last-named end.

Another roller 57 is carried on the frame 49 outside of the opening 47.

The above described construction positions the rollers 51 inside of the channel 44 and above the conveyor 43; and the roller 57 outside of the chamber, above the conveyor. The arrangement of rollers with respect to the length of the channel 44 is such that the elevation of each of the plurality of rollers is greater than that of the preceding one (reading Fig. 2 from left to right). It is to be understood that any other suitable number of rollers may be used, three being shown by way of example.

The outside roller shaft 59 is driven from the conveyor drive 61 by means of a gear drive 63 and in turn drives the rollers 51, 57 by means of a sprocket-and-chain system 65. The gearing is such that the surface speeds of the rollers are about equal to the surface speed of the conveyor belt and in the same direction. The idler wheel 66 thereof is movable about the center of its driving gear 68 so as to accommodate adjustment from the screw 55.

From the above it may be seen that a large space is provided above for permitting the wool to fluff and feather out, to form fine particles and fibers. Then, as the wool

settles, the hopper sides and the wool's own weight compress it gently until it rests on the moving conveyor 43. The conveyor is made of foraminous material of a rather fine mesh which permits dropping out of the fine beads or balls in the blown material. The left-hand roller compresses the wool deposited ahead of it as said wool is fed thereunder by the conveyor. This puts a lower strip or layer 44 of compressed wool between the two inner rollers upon which wool 46 deposits to be compressed into a second layer 48 on said first layer 44 by the second roll. Two contiguous layers of wool emerge from the second roller, upon which more wool 50 is deposited to be fed from out of the blow chamber and beneath the last outside compressing roller 57 to form a top layer 52. It is to be understood that the compression is light and does not provide distinct layers in the finished sheet, although a stratifying effect is had. The layers are merely referred to herein for convenience.

As stated before, as many rollers may be used as desired, depending upon the number of layers required. The slope of the line of rollers and distance apart govern the thickness and/or texture but this may be adjustably varied by varying the speed of the conveyor drive 45. The variation in texture and/or thickness is thus had because a different time is allowed for accretion of wool as the conveyor speed is changed.

The advantage in laying the wool down in layers instead of compressing it to the desired thickness in one operation, lies in the fact that the fibers lie in more parallel planes near the surfaces on which given accretions rest. Hence, by starting new accretions at intervals on flatter surfaces of the material itself, the most efficient felt having fibers running substantially perpendicular to the direction of heat flow is obtained. The breaking and mashing of upstanding fibers into folded and irregular positions is also reduced. The roll pressure being light, a substantially homogenous sheet is the final result.

Sometimes it is desirable to have more dense edges on a strip and these may be obtained by introducing inwardly slanting guides 70 ahead of each roller as illustrated in Fig. 7. The more dense edges prevent fraying out of the material when it is handled.

From the conveyor the material is preferably fed to a cutting plate 67 and cut into suitable lengths by shears 69 or other means. Before the plate 67 is reached the sheet of wool is further impregnated with binder material issuing in jets 71, 73. The binders described herein may comprise such substances as asphalt, sodium, silicate, casine, glue, wax or similar materials.

The improved product includes the ad-

vantages hereinbefore described. A further one rests in the manner of assembling the cut sheets of material into an insulating block, which comprises laying down a sheet of wool, then applying a sheet 77 of less porous material such as tar or roofing paper, then a sheet 75 of wool material and so on, until a predetermined size of laminated block is formed. This block may be held in assembled position by wire stapling, sewing, gluing or wrapping. Its advantage is due to the fact that when the air in the block expands and contracts under thermal changes, the air breathing action thereof does not take moisture to the interior of the block so readily as when a non-laminated assembly is used.

It is a well known fact that the presence of moisture in the interior recesses of insulating blocks results in a lower insulating efficiency because of the heat transmitting characteristics of said moisture. It is evident that the moisture cannot enter the center of the block over the short paths from the sideward faces 79, 81 because it cannot pass through the non-porous sheets of tar paper or the like. In other words, the moisture is forced to take a long path from the edges 83, 85 of the block and for a given period of breathing will not travel as far into the interior.

In Figure 4 is illustrated the manner in which another form of block may be constructed. In this form the strip of wool 87 manufactured in the manner previously described is fed downwardly through two lead rolls 89 and then downwardly between two guide rolls 91 linked to a reciprocating mechanism 93. The reciprocating mechanism 93 reciprocates the guide rolls 91 so that as the wool material 87 is fed downwardly it is folded back and forth in such a manner that a type of bale 95 is formed. This bale 95 is suitable for shipping purposes.

In Figure 5 is illustrated a third form in which the material may be handled after leaving the blow chamber. In this case the material is fed over a main guide roll 97 and then down into a cradle comprising a floor 99 and anti-friction rollers 101. The contour of the cradle is such that the material is rolled into a cylindrical shape 103. In this form it may be slipped into a paper envelope for shipment and may be unrolled at another point to be worked into other products.

In Figure 6 is illustrated a fourth form in which the material may be handled. In this last case two toothed rollers 105 are employed. The teeth of these rollers engage one another loosely so that a strip 107 of the wool material may be fed therebetween with a strip 109 of suitable paper or fabric. The function of the teeth is to press the wool and paper sheets into a composite corrugated

sheet. The corrugated sheet is fed down a chute 111 after leaving the rolls 105. The chute 111 is provided with a bend 113 at the lower end thereof which affords resistance to the corrugated sheet, whereby the previously loose corrugations are forced or pressed together in accordin-like fashion. From the bend 113 the finished corrugated product is fed to a conveyor 115 which is moving at a slower speed than the peripheral speed of the teeth on the rolls 105. The product formed by the last-named modification is especially adapted to be placed on cylindrical surfaces or other curved surfaces such as pipes and the like.

It will be seen from the above that a product is formed which is improved in several respects. It has a better chemical composition, because it is free of sulphides; it has better texture because of the manner in which it is laid down; and the final form of the material is better adapted to resist heat flow therethrough, especially at right angles to the sheet into which the material is built.

It is to be understood from the above that the introduction of the binder material at the nozzle in the steam pipe 33 and at the jets 71, 73 may be omitted for certain applications of the material.

Another point of novelty exists in the present invention, based upon the chemical proportions of the charge introduced into the fusion chamber or cupola 1. Up to this point the nature of the rock charge has been only broadly outlined.

For instance, in the prior art a typical analysis of resulting rock wool would be (more specifically):

Substance.	Per cent by weight.
Silicon oxide (SiO_2)	40 (acid)
Aluminum oxide (Al_2O_3)	17 (neutral)
Iron oxide (FeO) or (Fe_2O_3)	6 (basic)
Calcium oxide (CaO)	21 (basic)
Magnesium oxide (MgO)	13 (basic)
Miscellaneous	3
Total	100

The above list shows a ratio of one to one of silicon to basic materials. The result is that a tendency to slacking is had which disintegrates the wool in its applications. Another is that the wool will decompose in dilute mineral acids.

The wool material resulting in the present invention comprises a typical analysis as follows:

Substance.	Per cent by weight.
Silicon oxide (SiO_2)	57 (acid)
Aluminum oxide (Al_2O_3)	12 (neutral)
Iron oxide (FeO)	5 (basic)
Calcium oxide (CaO)	15 (basic)
Magnesium oxide (MgO)	9 (basic)
Miscellaneous	2
Total	100

It will be seen that the above comprises practically a two to one ratio between silica and basic materials, which gives the resulting wool a more hard and glassy composition which will not slack or dissolve. A ratio of silica to basic materials of from one and one-half to one, to two to one is suitable for preventing this slacking or disintegrating effect. The improved composition is attained by selecting the proper raw material, such as by adding a high silica rock.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As many changes could be made in carrying out the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. The method of manufacturing molten material for rock and mineral wools comprising melting a mass of suitable raw material in the presence of hot gases from an oxidizing flame.

2. The method of manufacturing molten material for rock and mineral wools comprising melting a mass of suitable raw material in the presence of hot gases from an oxidizing flame fired by powdered fuel.

3. The method of manufacturing molten material for rock and mineral wools comprising adding an oxidizing material to the raw material and fusing the materials in the presence of hot gases from an oxidizing flame.

4. The method of manufacturing molten material for rock and mineral wools comprising adding an oxidizing material to the raw material and melting the materials in the presence of hot gases from an oxidizing flame fired in a separate compartment.

5. The method of fusing material for rock and mineral wools comprising engendering an oxidizing flame, and fusing the raw material by passing therethrough the hot gases from said flame.

6. The method of fusing material for rock and mineral wools comprising engendering an oxidizing flame, passing the hot gases from said flame through the raw material to fuse said raw material, and blowing the fused material into a chamber provided with a felting conveyor and simultaneously mixing said material with a binding material.

7. Means for fusing material for rock and mineral wools comprising a fusion chamber adapted to be filled with raw material, a separate combustion chamber communicating with said fusion chamber at the lower end thereof, said combustion chamber being formed upwardly, means for engender-

ing an oxidizing flame in the combustion chamber and means for passing the products from said flame through said material in the fusion chamber.

5 8. Means for fusing material for rock and mineral wools comprising a fusion chamber adapted to be filled with raw material, a separate combustion chamber communicating with said fusion chamber at the
10 lower end thereof, said combustion chamber being formed upwardly, means for engendering an oxidizing flame at the inlet portion of the combustion chamber, and means for passing the products from said flame
15 from the combustion chamber to and through the material in said fusion chamber.

9. The method of manufacturing rock and mineral wools comprising introducing the raw material and an oxidizing agent into
20 a fusing chamber, means for engendering a flame in a chamber, passing the products of said flame into and through the material in said fusion chamber whereby the material is melted and drawing the liquid material
25 from the fusion chamber at a point adjacent the region of communication between the fusion and combustion chambers.

30 10. Apparatus for manufacturing improved rock and mineral wools comprising a fusion chamber adapted to be filled with raw material, a separate combustion chamber communicating with said fusion chamber,

means for engendering an oxidizing flame in the combustion chamber and means for passing the hot gases from said flame through
35 said material in the fusion chamber, a blow chamber, means for drawing molten material from the fusion chamber and blowing fibrous material into the blow chamber and a moving conveyor engaging the lower end
40 of said blow chamber to carry out said material as it settles.

11. Apparatus for manufacturing improved rock and mineral wools comprising a
45 fusion chamber adapted to be filled with raw material, a separate combustion chamber communicating with said fusion chamber, means for engendering an oxidizing flame in the combustion chamber and means
50 for passing the hot gases from said flame through said material in the fusion chamber, a blow chamber, means for drawing molten material from the fusion chamber and glowing fibrous material into the blow chamber,
55 a tapering lower region in said chamber including a channel, a conveyor in said channel adapted to receive settling wool and rollers placed over said conveyor in ascending elevation in the direction of conveyor
60 movement.

In testimony whereof, I have signed my name to this specification this 31st day of December, 1926.

EDWARD R. POWELL.