July 28, 1953 R. M. DOWNEY 2,646,593

METHOD AND APPARATUS FOR FIBERIZING MOLTEN MATERIAL

Filed Nov. 4, 1950 2 Sheets-Sheet 1

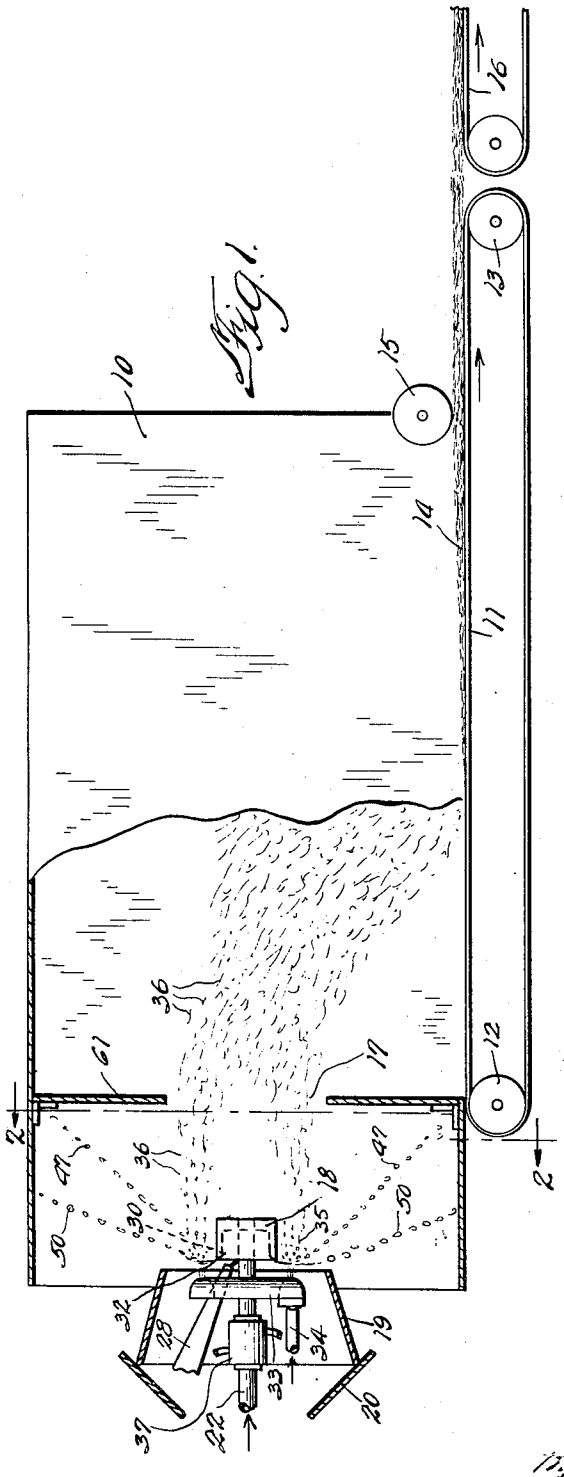


Fig. 1.

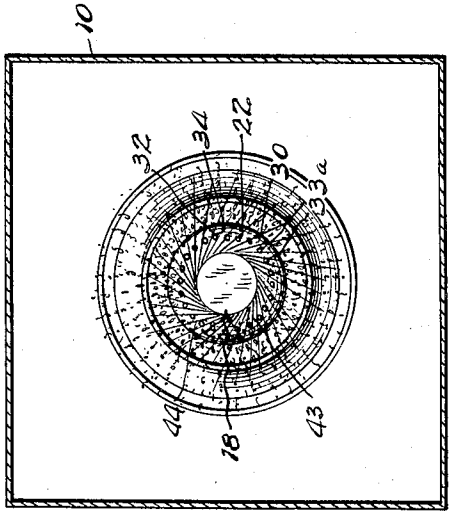


Fig. 2.

Inventor:
Richard M. Downey.
By: Theiss, Olson & Mecklenburger.
Attys.

July 28, 1953 R. M. DOWNEY 2,646,593

METHOD AND APPARATUS FOR FIBERIZING MOLTEN MATERIAL

Filed Nov. 4, 1950 2 Sheets-Sheet 2

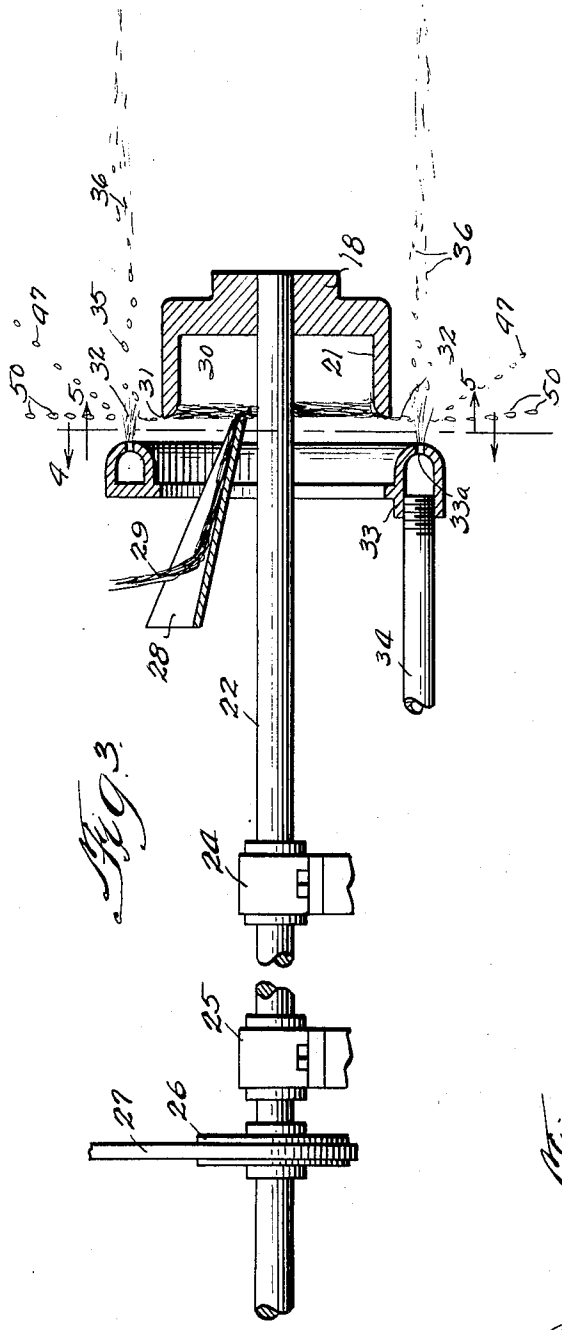
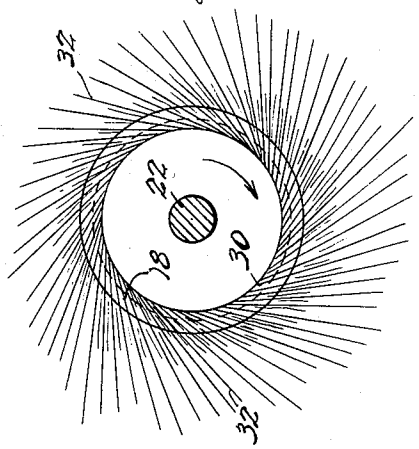


Fig. 3.

Fig. 5.



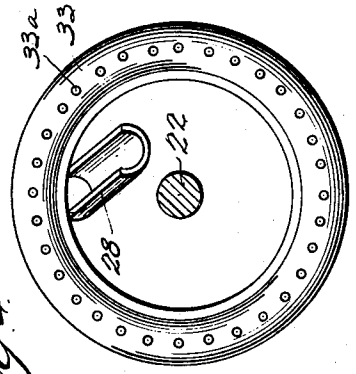


Fig. 4.

Inventor:
Richard M. Downey.
By Theiss, Olson & Mecklenburger.
Attys.

Patented July 28, 1953

2,646,593

UNITED STATES PATENT OFFICE

2,646,593

METHOD AND APPARATUS FOR FIBERIZING MOLTEN MATERIAL

Richard M. Downey, North Judson, Ind., assignor to United States Gypsum Company, Chicago, Ill., a corporation of Illinois

Application November 4, 1950, Serial No. 194,180
In Canada May 1, 1950

20 Claims. (Cl. 18—2.5)

1

The present invention relates to an improved method and apparatus for fiberizing molten material.

The invention concerns itself primarily with an improved method for converting molten vitreous material such as slag, glass, or fusible rock, into filamentous form or fibers such as are generally known as slag wool, glass wool, or mineral wool, and the like.

The production of mineral fibers such as slag wool, glass wool, rock wool, or mineral wool, has been the subject matter of many patents and processes, and a large variety of different kinds of apparatus has been devised to accomplish the fiberization of such molten vitreous materials.

In the past this has almost always been done by directing a powerful blast of a gas, usually steam, either superheated or not, against a stream of molten slag or similar material with the result that the stream would become disintegrated into individual droplets which, under the momentum imparted thereto by the steam blast and due to the resistance offered to their progress by the air through which they were propelled, would elongate themselves into more or less fine fibers. If this were done with insufficient speed the fibers were rather coarse and short, and usually carried on their far end a small globule which almost invariably detached itself and formed what is known as "shot." If the viscosity of the molten material was high enough and the speed of the gaseous distintegrating blast great enough the fiber would be fairly long and there would be relatively little shot. However, thoroughly to disintegrate a stream of downwardly flowing slag required a very powerful blast of gas, and almost invariably that part of the stream which was furthest away from the point of impingement of the blast would not be properly fiberized.

Attempts have been made to overcome this difficulty by subdividing molten material such as slag into as many fine streams as possible prior to having it encounter the disintegrating blast. This, however, almost invariably led to a considerable cooling of the material whereby its viscosity was very greatly increased, with the result that the fibers were thick and generally quite unusable. Another method which has found some favor is to attempt to impart to molten slag and the like sufficient velocity by mechanical means instead of by a gaseous blast. For instance, it has been proposed to hurl molten slag and similar vitreous material from the periphery of a rapidly rotating disc with a speed

2

high enough to cause the desired fiberization of the peripherally discharged droplets.

However, this requires rather high speeds. For example, with a disc 11 inches in diameter and with slag at the usual temperature at which it discharges from a melting cupola, it was found that it required a peripheral velocity of around 12,000 to 14,000 feet per second, which for a disc of this size meant a rate of revolution of around 4500 to 5000 revolutions per minute.

It will be readily appreciated that such speeds are accompanied by considerable danger of the explosion of the disc, and, moreover, require considerable application of power to attain the desired speed.

A further alternative has been to pour the melted slag upon a very rapidly rotating cylinder, but there the length of the contact between the molten material and the surface of the cylinder was so short that enormous speeds were necessary to obtain fiberization.

The present invention solves this problem in an exemplary way by providing an apparatus and method for the production of fine silky mineral fibers from either slag, glass, meltable rock and the like, by a method which involves both preliminary centrifugal distribution of the molten material and the propulsion of the material by means of a gaseous blast.

It is therefore one of the objects of the present invention to provide a method and apparatus for the efficient conversion of melted slag, glass, melted rock, and the like into mineral fibers, and the collection thereof into the form of an adherent sheet or bat.

It is a further object of the present invention to disintegrate molten vitreous material by centrifugal means into a plurality of very closely adjacent individual tangentially discharged molten streams which encounter a transverse strong gaseous fiberizing blast which changes their direction and converts them into fibers.

It is a further object of the invention to effect a separation between fibers, shot, and slugs of metal, such as iron, which latter occasionally accompanies slag, such as may be used as the raw material for carrying out the process features of the present invention.

It is also an object of the present invention to provide an apparatus, and means associated therewith, for fiberizing molten material and to effect the above-mentioned objects.

In order that the present invention may be more thoroughly understood, reference is directed to the concurrently filed drawings, in which:

Figure 1 is a diagrammatic representation of the fiberizing apparatus shown in conjunction with a suitable collection and bat-forming device with which it is associated, the device being shown in vertical elevation and partly in vertical section;

Fig. 2 is a vertical cross section through the apparatus shown in Fig. 1 taken along the line 2—2 thereof;

Fig. 3 is a side view, partly in vertical section, of the more essential parts of the apparatus as shown in Fig. 1, but on a considerably larger scale;

Fig. 4 is a cross section along the line 4—4 of Fig. 3; and

Fig. 5 is a similar cross section, facing in the opposite direction, and taken along the line 5—5 of Fig. 3.

The apparatus consists of a mineral wool collecting chamber 10, the bottom of which is closed by means of a conveyor 11 which operates, for example, over the pulleys 12 and 13, and upon which there gradually accumulates a more or less coherent mat of mineral wool fibers 14. A suitable sealing and confining roller 15 serves to prevent the escape of the mineral wool fibers from the chamber 10 and also slightly to compress the mat 14 and to give it its desired dimensions.

The mat thus produced is further conveyed on a second conveyor 16 to point of use, with which the present invention is not particularly concerned.

The blow chamber 10 has an inlet or throat 17 defined by baffles 61 in front of which there is located the main fiber producing instrumentality 18, in the form of a hollow rimmed rotor.

There are also provided outwardly flaring walls 19 and baffles 20, which serve primarily for the protection of the operators, but which are readily removable for inspection and repair of the fiberizing apparatus 18.

Referring now particularly to Figs. 3 through 5, it will be seen that there is provided a rotor 18 which may conveniently take the form of a hollow cylinder having an internal wall or surface 21, which may be parallel with the axis of rotation or may be inclined thereto so as to diverge outwardly. This rotor 18 is keyed or otherwise secured to a horizontally disposed shaft 22.

Suitable bearings 24 and 25 serve to support the shaft, there also being provided a pulley 26, keyed to the shaft, over which runs a suitable driving means, such for example as the belt 27.

A suitable conducting chute 28 serves to direct a relatively thin stream 29 of molten glass, slag or the like to a point so located that the stream 29 will be directed to the inner surface 21 of the rotor 18 without touching the shaft 22, the rotor being rapidly rotated at about 700 to 1500 revolutions per minute.

As a result of the dropping of the stream 29 of molten slag on to the surface 21, there will be immediately built up an annulus 30 of molten slag. This annulus gradually works its way over the edge 31 of the rotor 18, to be discharged from the periphery thereof under the centrifugal force as an annular mass of small closely adjacent streams 32 of melted slag.

Due to the rapid rotation of the rotor 18 and of course of the annulus 30 which partakes of this motion, the visual appearance of this mass of material is that of an annular relatively thin ring or aura. Photographs taken at a speed of $\frac{1}{10,000}$ of a second have proven that this is an illusion due to persistence of vision, the actual

fact being that there are formed hundreds of small individual streams 32 of molten slag which are projected along straight lines which are tangents of the periphery of the rotor.

It will be self-evident from consideration of the physics involved that each particle of the melted slag, as it leaves the circular edge 31 of the rotor 18, will tend to travel in a straight line tangent to the circle that defines the said circular edge 31. The pictures have proven this. The appearance is roughly diagrammatically illustrated in Fig. 5, each little stream (there are actually over 700 in a disc 1 foot in diameter) being collectively designated by the reference numeral 32. This is the condition with the stream shut off.

It has been definitely ascertained, so far as the discharge of the molten material from the edge 31 of the rotor 18 is concerned, that the speed is insufficient to fiberize the slag. What appears to happen is that the slag is thus subdivided into an extremely large number of individual little streams 32 which are in an ideal condition to have imparted to them the necessary momentum to convert them into fibers. For the purpose of doing this there is provided a blasting ring or nozzle 33 through which a suitable gas, for example steam, may be passed from the supply line 34. This is arranged concentric with the rotor and has a slightly larger radius than the latter.

The steam issues from a number of individual small openings 33a which can best be seen in Fig. 4 in which, however, only a much smaller number than those actually used is shown.

The steam, which passes out of the annular nozzle 33 under a force of from 70 to 90 pounds per square inch, strikes the small streams 32 of the thus subdivided slag at a point about 1 to 1½ inches from the edge 31 of the rotor 18, and at a point about from ¾ of an inch to 1 inch from the outlet of the openings 33a.

By intercepting the outwardly traveling streams 32 with the annular steam blast, these streams are diverted into a new path, forming horizontally impelled potential fiber-forming particles 35, which, by reason of the high velocity imparted thereto, soon become attenuated into individual fibers 36 that fall down in the blow chamber 10, and collect in the form of the already mentioned mat 14.

The product produced by the apparatus and method of the present invention shows a significantly higher fiber content than is exhibited by the product of prior art processes. Mineral wool has been made which contains as high as 70% fiber by weight, and, in any event, the apparatus and method are consistently capable of producing wool containing at least 50% of fiber by weight. The economic advantages accruing to fiber yields of this order compared to the 30% yield of the prior art will immediately be apparent.

An additional advantage inherent in the present invention is the possibility presented of effecting a partial separation of shot and fiber at the time the fiber is formed. Any material whose kinetic energy is sufficiently high to allow it to penetrate the force vector of the steam blast continues in a direction of travel only slightly altered from its original path, whereby a divergence is effected between the paths of "shot" and the path taken by the fiber. Thus a separation may be effected. One method of separation is illustrated in Fig. 1, where baffle 61 is erected at the entrance to a conventional collecting chamber. The baffle 61 is so arranged as to form an

opening 17 into the collecting chamber. The fiber 36 passes through opening 17 into the collecting chamber while shot or bead 47 are thrown against baffle 61, and thus do not find their way into the fibrous product. The bead 47 may be remelted if desired. The arrangement of opening 17 and baffle 61 also serves to separate iron which frequently is formed in small amounts by reduction in the melting of slag, rock, etc. This separation is also highly desirable, as iron and its oxides tend to cause discoloration of mineral wool products. Iron particles 50 being so removed from the product are shown in Fig. 1.

For suitable permanence of equipment it is desirable to use heat resistant materials, as molten slag ordinarily flows from the cupola at a temperature of 2700–3000° F. Stainless steel is quite desirable as a material of construction, but it is also possible to cool the shaft and rotor with a liquid or gaseous coolant. Water is quite suitable.

Steam pressures and steam volumes required are generally in line with conventional practice in these respects. Steam pressures required are on the order of 60–100 pounds per square inch, and the weight of steam should be at least slightly in excess of the weight of slag.

One of the outstanding advantages of the present apparatus and method lies in the production of the vertically disposed annulus of molten material which serves as a more or less constant source of supply for the tangentially peripherally discharged streamlets 32. If a disc were used instead, the rate of production would be immensely slower as only a very thin stream of slag can be discharged onto a disc, while the present method allows of the treatment of large amounts of material.

The outstanding advantage of the present apparatus and method for making mineral wool lies in the very high production capacity attainable, the relatively low amount of shot, and the ease of control.

If desired, binders and waterproofing materials may be applied to the fibers by any suitable means, these being outside of the scope of the present invention.

I claim:

1. Apparatus for fiberizing molten material comprising a hollow cylindrical slag-distributor open at one end and closed at the other and rapidly rotatable about a horizontal axis, means for delivering molten material to the interior surface of said distributor from its open end, and means for directing an annular blast of a gas coaxially with said axis and in a direction from the open toward the closed end of said distributor against molten material discharged from the edge of said distributor under the centrifugal force developed by its rotation.

2. Apparatus for fiberizing molten material comprising a hollow cylindrical rotor open at one end and closed at the other, means for rotating said rotor on a horizontal axis, means for delivering molten material to the internal wall of said rotor from its open end, and means for directing an annular blast of gas in a direction from the open toward the closed end of said rotor against molten material peripherally discharged from the edge of said rotor under the centrifugal force developed by its rotation.

3. Method of making vitreous fibers which comprises melting a vitreous material, forming a relatively thin stream thereof into a rapidly rotating substantially vertically disposed annulus from which latter outwardly moving groups of thin streams of said material extend in a vertical plane, and forcing against the sides of said streams a horizontally moving annular blast of a rapidly moving gas with force sufficient to change the direction of movement of said streams and propelling the same with sufficient momentum to draw them into filaments prior to their solidification.

4. Method of making slag wool which comprises forming molten slag into thin streams of molten slag moving outwardly in a substantially vertical plane and attenuating said streams into fibers by directing a substantially annular horizontally moving blast of a rapidly moving gas against the sides of said streams of molten slag.

5. Method of converting molten mineral material into fibers which comprises discharging a stream of such molten material upon a rapidly rotating annular surface rotating about a horizontal axis to eventuate a confined rotating annulus of said molten material rotating about a substantially horizontal axis, moving continuously the edge of said annulus to the end of its confining surface to discharge therefrom centrifugally into an outwardly moving plurality of finely divided streams, and blasting said streams into mineral wool by a blast of gas intercepting the path of travel of said streams to provide a horizontally moving mass of mineral wool.

6. Apparatus for the production of mineral wool fibers which comprises a hollow cylindrical rotor open at one end and closed at the other and mounted for rotation about a horizontal axis, means for rotating said rotor, means for delivering a stream of molten mineral-wool-forming material onto the interior cylindrical surface of sad rotor from the open end thereof, and an annular gas-blowing nozzle positioned to discharge a gaseous stream in the form of an annular blast concentric with the axis of rotation of said rotor against material tangentially thrown off the end periphery of said rotor, said blast being directed from the open toward the closed end of said rotor.

7. Method for the production of mineral wool fibers which comprises forming molten mineral-wool-forming material into an annulus whirling in a vertical plane about a horizontal axis, peripherally tangentially discharging from said annulus a large number of individual fine streams of said molten material, and abruptly changing the direction of travel of said streams by applying transversely thereto a strong blast of a carrier gas, whereby to convert said streams into mineral wool fibers moving in a generally horizontal direction.

8. Apparatus for fiberizing molten material which comprises a distributor bowl rapidly rotatable about a substantially horizontal axis, means for delivering molten material onto the interior side wall of said bowl from a source located beyond the open end of said bowl, and means for directing an annular blast of a gas in a direction from the open toward the closed end of said bowl coaxially with said axis against molten material discharged from the edge of said distributor bowl under the centrifugal force developed by its rotation.

9. Apparatus for making mineral wool and the like which comprises the combination of a collecting chamber having a receiving opening in a vertical wall thereof and a mineral fiber producing means positioned in front of and spaced from said opening, said means comprising a

source of molten mineral-wool forming material, a rotor mounted for rotation about a horizontal axis aligned with substantially the center of said opening, said rotor being in the form of a cylindrical bowl having its closed end toward said opening, means for conducting a stream of said molten material onto the interior wall of said bowl from a locus outside and beyond the open end of said bowl, whereby said stream as the result of the rotation of said bowl will form an annulus of molten material rotating about a substantially horizontal axis and from the periphery of which streams of molten material will be tangentially discharged, and an annular gas-blowing nozzle of a diameter greater than that of said bowl positioned so as to direct an annular stream of gas at high velocity against said streams to transform them into fibers and to move them coaxially with the axis of rotation of said bowl toward and through the said receiving opening of said collecting chamber.

10. A device for converting molten material into fibers which comprises the combination of a spinning-bowl open at one end and closed at the other, a horizontally positioned shaft to which said bowl is attached and by means of which it can be rotated, means for feeding molten material into said bowl from its open end to be peripherally discharged from the rim of said bowl in the form of tangentially outwardly traveling molten streams of material, and an annular blowing nozzle of a diameter greater than that of said bowl positioned a short distance beyond the open end of said bowl and having its discharge opening directed toward said bowl so as to blow coaxially with said shaft upon the said streams to change their direction and transform them into fibers and carry the latter to a locus beyond the closed end of said bowl.

11. A device for converting molten material into fibers comprising a shaft mounted for rotation of a horizontal axis, a spinning-bowl located on one end of said shaft and having its open end directed toward the other end of said shaft, means for conducting molten material from a point to one side of said shaft and from a source beyond the open end of said bowl onto the inside wall thereof, means for rotating said shaft, and an annular blowing nozzle having a larger diameter than that of said bowl surrounding said shaft and positioned outside of the open end of said bowl and capable of blowing a strong rapid annular blast coaxially of said shaft toward the open and of said bowl.

12. Apparatus for making mineral wool which comprises a horizontal rotatable shaft, a centrifugal distributor mounted at one end thereof and being in the form of a cylindrical cup open at one end with its sides extending backwardly toward the other end of said shaft, a trough for molten material alongside of said shaft and extending into said cup so as to direct a stream of molten material by gravitation onto the inner wall of said cup, and an annular blowing nozzle of a diameter greater than that of said cup surrounding said shaft and having its gas-discharge opening directed toward the open end of said cup so as to intercept streams of materials tangentially discharged from the rim of said cup and to blow them in a direction parallel with said shaft and beyond the closed end of said cup toward a point of collection.

13. Apparatus for making mineral wool which comprises a collection chamber having a receiving opening and a mineral wool fiber-producing means positioned in front of said opening, said fiber-producing means comprising a cylindrical rotor having an open end and a closed end, the latter facing toward said receiving opening, means for rotating said rotor, means for gravitationally dropping molten material onto the inside wall of said rotor from the open end thereof, and an annular blowing nozzle positioned in front of the open end of said rotor having its discharge orifices directed toward said receiving opening.

14. Method of making mineral wool and the like which comprises gravitationally flowing a stream of molten mineral material onto the interior side walls of a hollow cylindrical distributor having one open end and rotating on a horizontal axis to eventuate a confined rotating annulus of said molten material rotating on a horizontal axis and from the periphery of which streams of said material are tangentially discharged from the rim of the said open end, and horizontally blasting said streams into fibers by a gaseous blast originating from an annular nozzle positioned beyond the said open ended cylindrical distributor.

15. The method of separating slugs and beads from newly formed mineral wool comprising reducing suitable mineral wool forming materials to a liquid melt, depositing said melt onto the inside surface of a cup-shaped rotor rotatable about a horizontal axis, rotating said rotor at sufficient speed to form an annulus of liquid melt on the inside surface of said rotor, allowing said spinning melt to escape at the rim of said rotor in the form of streams, intercepting said streams with a gaseous fluid projected with sufficient velocity to attenuate most of said streams into fibers, leaving some of the melt in the form of outwardly traveling slugs and beads, conveying said fibers by means of the residual velocity of said gaseous fluid to an opening of restricted size in a fiber collecting chamber, and screening the unfiberized slugs and beads from entry into said collecting chamber.

16. In the method of claim 15, the step of imparting centrifugal force to the melt as it leaves the rim of said rotor, fiberizing a major portion of said centrifugally energized melt by means of a blast of gaseous fluid of desired velocity intercepting said melt, conveying the thus fiberized melt in the form of fibers to a restricted opening in a collecting chamber, and screening the unfiberized melt from entry into said collecting chamber.

17. The method of removing slugs, iron and unfiberized pellets of melt used in producing mineral wool fiber comprising the steps of melting suitable raw materials, placing said melt on the inside surface of a bowl rapidly rotating on a horizontal axis, forming an annulus of melt within said bowl, allowing the said annulus to slough off along the rim of said bowl in the form of streams consisting of molten material, said material being energized centrifugally before partition from said annulus, intercepting the thus energized streams with a transverse current of gas to fiberize the majority of said streams, conveying the resulting fibers to a restricted opening in a collecting chamber, and separately catching the unfiberized pellets and slugs.

18. Method of centrifugal separation of newly formed mineral wool fibers from slugs and beads associated therewith in the process of forming said fibers which comprises supplying molten mineral wool forming material to the interior wall

surface of a cup-shaped rotor rotatable about a horizontal axis, rotating said rotor at a speed sufficient to eventuate a confined annulus of said material therein, permitting said material to discharge from the rim of said rotor, intercepting said discharged material with a transverse annular gaseous blast, conveying the thus formed fibers into a collecting chamber through a constricted opening therein, permitting the slugs and beads, the portion of said material which is not converted into fibers by said blast, to continue their outward travel resulting from the impetus of the centrifugal energy imparted thereto, and collecting said slugs and beads separately from said fibers.

19. Method of fiberizing molten material comprising flowing molten fiberizable material into a hollow rotary distributor having one open and one closed end, rotating said distributor about a horizontal axis to effect tangential discharge of streams of said molten material from the rim of said open end and directing an annular blast of a gas substantially coaxially with the axis of rotation of said distributor from a position in front

of said open end and blowing toward said closed end thereof to fiberize said streams.

20. Method of fiberizing molten material which comprises rotating about a horizontal axis a hollow distributor open at one end and closed at the other, delivering molten material onto the internal walls of said distributor from its open end, the rotation of said distributor effecting the tangential discharge of numerous fine streams of said molten material under the centrifugal force imparted thereto by the rotation of said distributor, and blowing a strong annular blast of gas against said streams in a direction from the open toward the closed end of said distributor.

RICHARD M. DOWNEY.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,601,897	Wiley et al.	Oct. 5, 1926
2,318,244	McClure	May 4, 1943
2,328,714	Drill et al.	Sept. 7, 1943
2,497,369	Peyches	Feb. 14, 1950