

Case 930
5M Ant. Co.

Jm 13

PLAINTIFF'S
EXHIBIT

JM 1042

Aug. 29, 1950

E. R. POWELL

2,520,169

METHOD AND APPARATUS FOR FIBERIZING MOLTEN MATERIAL

Filed Sept. 29, 1948

2 Sheets-Sheet 1

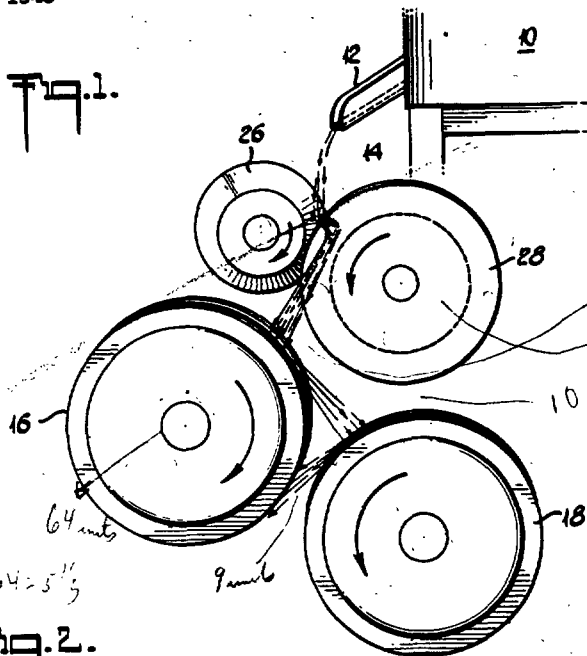
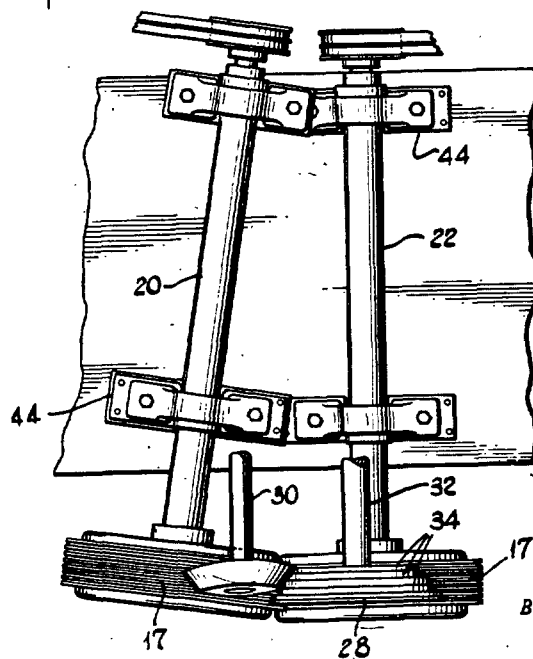


Fig. 2.



INVENTOR
EDWARD R. POWELL.
BY *Nirgil C. Kline*
ATTORNEY.

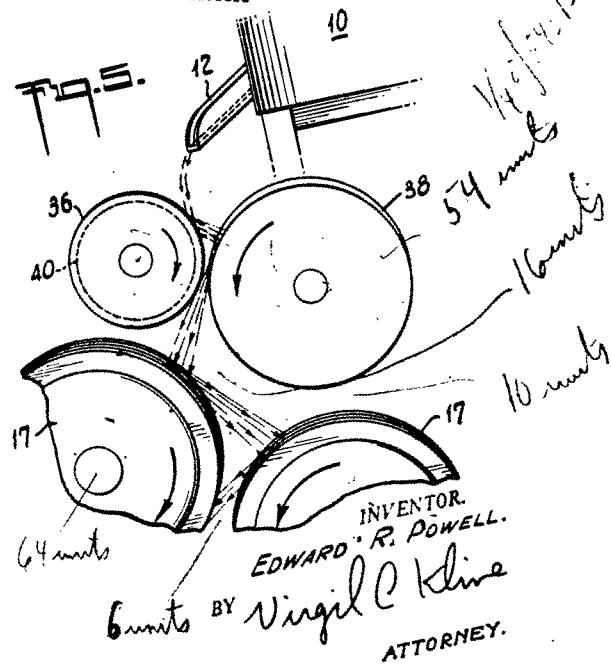
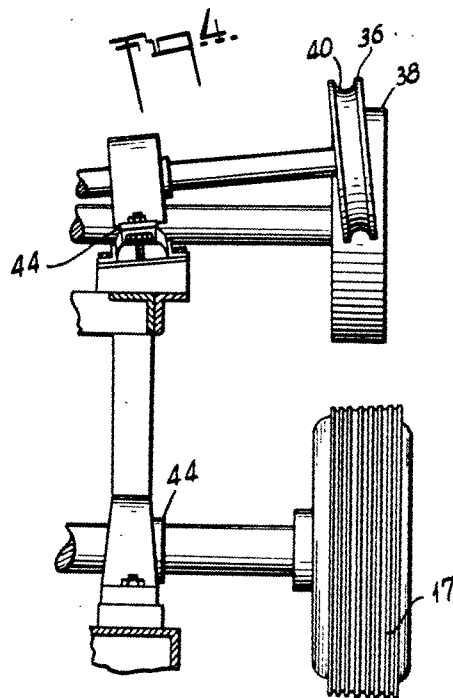
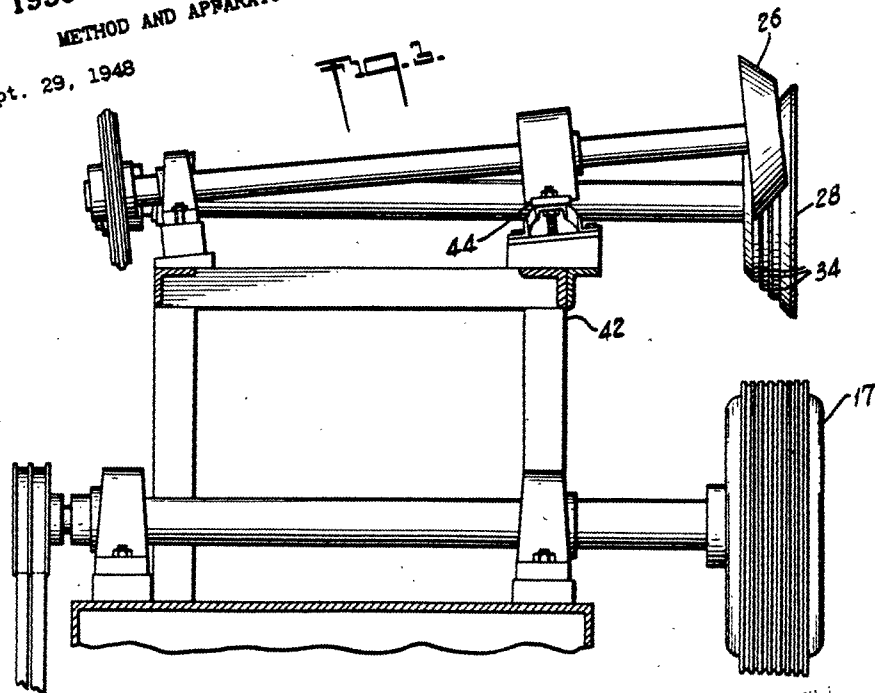
MTC 017036

Aug. 29, 1950

Filed Sept. 29, 1948

E. R. POWELL
METHOD AND APPARATUS FOR FIBERIZING MOLTEN MATERIAL

2,520,169
2 Sheets-Sheet 2



MTC 017037

UNITED STATES PATENT OFFICE

2,520,169

METHOD AND APPARATUS FOR FIBERIZING
MOLTEN MATERIALEdward R. Powell, North Plainfield, N. J., assignor
to Johns-Manville Corporation, New York,
N. Y., a corporation of New York

Application September 29, 1948, Serial No. 51,750

12 Claims. (Cl. 18—2.6)

1

The present invention relates to the manufacture of mineral wool and, more particularly, to an improved apparatus and method for converting a molten mineral material into fibers. The application is a continuation in part as to all common subject matter with my copending application, S. N. 742,064, filed April 17, 1947 now abandoned which, in turn, was a continuation in part of copending applications, S. N. 485,009, filed April 29, 1943, now Patent No. 2,428,810 and S. N. 555,359, filed September 22, 1944. The term "mineral wool" is employed in the instant application as in my said prior applications in a generic sense to include wool or fibers formed from rock, slag, glass, mixtures thereof and like raw materials.

Heretofore molten raw materials of the type referred to above have been converted into fibers in a number of ways, including the commonly used method of disintegrating a stream of the molten material by the action of a high pressure steam jet. More recently, it has been proposed to fiberize the material by a spinning process in which the stream is discharged onto spinners or rotors rotated at high speed, the centrifugal forces set up causing portions of the material to leave the rotors and to be drawn into fibers. The instant invention has for its principal object the provision of an improved apparatus and method of the latter type which will handle larger quantities of the molten material, provide a greater fiber yield, and produce finer and more uniform fibers.

One of the major difficulties of adapting the spinning method to operations on a commercial scale has been the inability of the equipment to effectively handle the output of the modern cupola conventionally used in mineral wool operations. An object of the instant invention is the provision of an improved apparatus and method employing a plurality of rotors or spinners which secure a wider distribution or spreading of the molten material to substantially increase the fiberization area and, hence, the capacity and efficiency of the operation.

Another object of the invention is the provision of a method and apparatus in which the movement of the molten material is gradually accelerated as it passes through the equipment and, at the same time, the stream is gradually divided or spread, whereby conversion of the greater portion of the stream into fibers with only a

2

minimum of unfiberized particles or shot is achieved.

It has been found that by the present method a fiber yield as high as 45% can be obtained on a commercial scale in contrast to the conventional blowing operations where it has been unusual to obtain yields greater than, say, 27% of the molten slag. Furthermore, the fibers produced are longer and finer than those obtained by the prior processes and a cleaner, more shot-free product is achieved.

My invention will be more fully understood and further objects and advantages thereof will become apparent when reference is made to the more detailed description which is to follow and to the accompanying drawings in which:

Fig. 1 is a diagrammatic, front elevational view of an apparatus embodying the invention;

Fig. 2 is a top plan view of the fiberizing apparatus of Fig. 1;

Fig. 3 is a side elevational view of the fiberizing apparatus of Fig. 1.

Fig. 4 is a view similar to Fig. 3 but with parts broken away, illustrating a minor modification of the invention; and

Fig. 5 is a view similar to Fig. 1 but illustrating the modification of Fig. 4.

Referring now to the drawings, there is shown an apparatus comprising a melting furnace 10 which may be of any suitable type, such as a cupola, tank furnace, or the like. The furnace includes a discharge trough 12 from which a stream of molten material is drawn from the furnace and discharged in position for fiberization. The raw material melted in the furnace and converted into the molten stream may be rock, slag, glass, mixtures thereof, or other liquefiable materials, suitable for conversion into fibrous wool by the method hereinafter described, all such materials being herein referred to as "mineral materials".

The major fiberizing operation is performed by a pair of rotors 16 and 18 having relatively wide, peripheral surfaces 17 and 19, respectively. The rotors are mounted for rotation on shafts 20 and 22, respectively, the shafts as best illustrated in Fig. 2, preferably extending at a slight angle, say, an angle of 9° to each other.

Rotors 16 and 18 are driven in opposite directions, as indicated by the arrows, and at rela-

tively high speeds. The rotors are of heat-resistant steel or other alloy of a character to resist the high temperature of the material, which may run as high as 2300° F., without excessive erosion or wear. The surfaces of the rotors are also preferably provided with a series of grooves 24, suitably of U-shape, to insure the bonding of a ring or rings of the molten material thereto, although bonding of the rings is not necessarily dependent on such grooves. It has been found that, even if plane surfaced rotors are used, after the rotors are subjected for a period of time to the action of the molten material, the latter will tend to bond to the surfaces. However, the use of more positive means for this purpose, such as the grooves 24, is preferred.

Supported above the main fiberizing rotors 16 and 18 are a pair of rotors 26 and 28. Rotors 26 and 28 are supported on shafts 30 and 32, respectively. Shaft 32 lies in an approximately horizontal plane substantially parallel to the planes of shafts 20 and 22, but shaft 30 preferably extends upwardly at a small angle to define an acute angle, say, an angle of about 6° between the planes of the shafts, as illustrated. Rotors 26 and 28, similarly to the other rotors, have surfaces of steel or other heat-resistant metal, capable of resisting the temperatures of the molten material without excessive erosion. Rotors 26 and 28 constitute what is, in effect, a stream spreading or distributing device, although, particularly rotor 28, also performs a fiberizing function as will be later pointed out.

In the form of the invention illustrated in Figs. 1, 2 and 3, the rotors 26 and 28 are of frusto-conical form with the coned surfaces preferably in reversed relationship. Rotor 26 may be smooth surfaced, as illustrated, while rotor 28 may be provided with one or more grooves 34 of relatively large cross-section. It will be appreciated that these grooves, as well as the grooves in the main fiberizing rotors, are shown of somewhat exaggerated size. In the embodiment illustrated in Figs. 4 and 5 the upper rotors, indicated in these figures by the reference characters 36 and 38, are of cylindrical, rather than conical form. Rotor 36 preferably has a deep groove 40, while the surface of rotor 38 is preferably smooth. This embodiment of the invention is otherwise similar to the previous embodiment.

The several shafts are supported from a suitable framework 42 on bearings 44. At least the front bearings are carried by yieldable mountings of any suitable or conventional type which will permit the rotors to move apart in the event a solid chunk of slag or fuel should fall between them. The rotors may be driven by individual motors or by a suitable drive, illustrated only diagrammatically, and mounted in any desired location on the frame structure 42. The drive is arranged so that the rotors 26 and 28 or 36 and 38, as the case may be, rotate in opposite directions, as indicated by the arrows in Figs. 1 and 5, with their upper surfaces approaching, and rotors 16 and 18 also rotate in opposite directions with their upper surfaces approaching, as previously mentioned.

In the operation of the apparatus described above, and in carrying out the method of the instant invention, the fiberizing device is positioned to have the molten material stream issuing from the cupola impinge against rotor 26 or 36, depending upon the embodiment of the invention employed, at a point to the right of a

vertical line through the axis of the rotor, as viewed in Figs. 1 and 5; that is, on a down-turning segment of the rotor. This is diagrammatically illustrated in Figs. 1 and 5 where the course of the main body of the stream to the initial rotor and from there through the equipment is indicated by broken lines. The rotors are tilted to have the shafts slant downwardly, shafts 20, 22 and 32 extending at an angle of about 12° to the horizontal, as indicated in Fig. 4 but retaining what is herein termed an "approximately horizontal" position. The main purpose of the tilting of the shafts is to avoid interference between the fibers being formed and the molten stream. Inasmuch as the fibers are drawn out in planes approximately at right angles to the shafts of the rotors by which they are formed, if the shafts are horizontal, at least part of the fibers are projected directly into the path of the stream. It will be appreciated that, as indicated in Fig. 1, the rotors are forwardly of the melting furnace 10.

Molten material issuing from the cupola and forming a molten stream is in a highly fluid, incandescent condition and, for economy, the stream is of considerable size of, say, 1/2" diameter. The condition of fluidity employed for the molten material in mineral wool fiberization by the conventional steam jet process is an example, although somewhat more fluid streams may be used if desired. The rotors are driven at successively higher speeds to constantly accelerate the movement of the molten material on its way to fiberization. Also, the contact with the first rotor is at only a slight angle to avoid spattering this very large and fluid stream. As the stream is gradually dispersed, it is possible to direct it more directly against the surfaces for better bonding. Thus, the impact on the first rotor surface is nearly tangent to it while the impact on the surface of rotor 16 may be substantially perpendicular. The molten material impinging upon rotor 26 or 36 is only lightly bonded, if bonded at all, and is discharged at a greatly accelerated speed and in a spread, distributed, or partially disintegrated condition onto the peripheral surface of rotor 28 or 38, as the case may be. The spreading of the material apparently is caused in most part by the separation of the stream into a plurality of components as it leaves the initial rotor. In the embodiment of Figs. 1-3, spreading is further encouraged by the fact that some of the material is discharged at approximately right angles to the rotor axis, and other of the material is discharged approximately normal to the conical surface. However, it has been found that the rotors of the form shown in Figs. 4 and 5 produce adequate spreading of the stream and, inasmuch as it is easier to control the operation, their use is often preferred.

The material discharged on rotor 28 or 38, as the case may be, is partially bonded thereto to form a molten ring, but is mostly projected tangentially from the rotor in a spread, distributed, or partially disintegrated stream which, at least for the most part, strikes rotor 16. Some of the material may also pass directly from rotor 28 or 38 to rotor 18. The material discharged onto rotor 16 is partially bonded thereto to form a ring of incandescent material, the grooved surface promoting such bonding, and the excess material over that bonded is discharged by rotor 16 onto rotor 18 where it, together with any material reaching rotor 18 directly from rotor 28 or

36 bonds to the surface of the rotor to form an incandescent ring of the molten material, bonding of the material again being promoted by the grooved surface. Any excess of the molten material over that bonded may again be projected back against rotor 16, this action continuing until the excess material is bonded to one or the other of the rotors.

The high speed rotation of rotors 16 and 18 causes portions of the incandescent rings to be thrown or drawn from the rotors by the centrifugal forces created, these portions being drawn out into long, fine fibers. Although rotors 16 and 18 perform the main fiberizing function, rotor 28 or 38, depending upon which is used, also operates as a fiberizer to a substantial extent. Rotor 26 or 36 may also fiberize to a minor extent, but its primary function is that of receiving the stream of molten material, increasing its velocity, and initiating its distribution on the other rotors.

Critical features of the invention, as previously pointed out, are the increase in velocity and the spreading or gradual disintegration of the stream as it passes to the main fiberizing rotors, whereby the material bonds thereto rather than being thrown off or splattered and lost as would be the case if a concentrated, high volume stream of the type here used was discharged directly and perpendicularly onto the high speed rotor or rotors.

The particular dimensions of the rotors are not critical within reasonable limits and may be selected on the basis of the capacity desired: i. e., the quantity per hour of molten material to be delivered by the melting furnace. However, the size relationship between these elements is preferably approximately that illustrated in the drawings. Also, the particular peripheral speeds at which the rotors are driven will depend upon the operating conditions, such as the fluidity of the molten material, and the like, but again, for purposes of example, it may be stated that, in employing a substantially conventional mineral wool melt, successful operation was obtained by driving rotors 26 or 36 and 28 or 38 at peripheral speeds in the ranges of 2500 to 5000 feet per minute and 6500 to 10,000 feet per minute, while rotors 16 and 18 were driven in ranges of 12,000 to 16,000 feet per minute and 14,000 to 20,000 feet per minute, respectively. The peripheral speeds of the rotors, the fluidity of the melt, and the like, may be varied to meet given conditions, as pointed out above. It will be understood, however, that the molten material must be of a sufficiently high temperature, the specific temperature range depending upon the character of the material, to maintain the molten material on the surfaces of the bonded rings in a highly fluid or incandescent state to permit fiberization to take place.

The fiber formed as described above may be collected in any suitable manner and a binder may be introduced if desired, either before or after initial fiber collection, the particular apparatus for these purposes forming no part of the instant invention.

The construction has been found to deliver a greatly increased fiber yield over the earlier types of rotor fiberization apparatus. The original stream which may have a diameter of, say, $\frac{1}{2}$ " is greatly expanded in width when received on the surfaces of the main fiberizing rotors. The production of fine fibers is enhanced through the

acceleration of the stream and its reduction from an original, relatively solid stream to, what is in effect, a partially disintegrated stream or streams of droplets.

Having thus described my invention in rather full detail, it will be understood that these details need not be strictly adhered to but that various changes and modifications may suggest themselves to one skilled in the art, all falling within the scope of the invention as defined by the subjoined claims.

What I claim is:

1. In an apparatus for converting a molten raw material to fibers having means for discharging a fluid stream of the molten material, the improvement comprising means in the path of the stream for spreading the stream laterally, said stream spreading means including a rotor having a coned peripheral surface, a shaft supporting said rotor for rotation with said surface in the path of the stream, a second rotor having an oppositely coned peripheral surface, a shaft supporting said second rotor for rotation with its surface adjacent the first rotor, said shafts extending at an acute angle to each other; a third rotor having a peripheral surface, means mounting said rotor for rotation with its peripheral surface in the path of the spread stream, a fourth rotor having a peripheral surface in the path of the material discharged by said third rotor, and means for rotating said rotors.

2. In an apparatus for converting a molten raw material to fibers having means for discharging a fluid stream of the molten material, the improvement comprising means in the path of the stream for spreading said stream laterally, said stream spreading means including a rotor having a peripheral surface, a shaft supporting said rotor for rotation with said peripheral surface in the path of the stream, a second rotor having a peripheral surface, and a shaft supporting said second rotor for rotation with its surface adjacent to the surface of the first rotor to receive the material from the first rotor, a third rotor having an unobstructed, molten material retaining peripheral surface, means mounting said third rotor for rotation with its peripheral surface in the path of the material discharged by said stream spreading means, whereby a portion of the material of said stream is retained on said surface and another portion is thrown off, a fourth rotor having an unobstructed, molten material retaining peripheral surface, means mounting said fourth rotor for rotation with its peripheral surface in the path of the material discharged by said third rotor, and means for rotating said rotors.

3. In an apparatus for converting a molten raw material to fibers having means for discharging a fluid stream of the molten material, the improvement comprising means for spreading the stream, said spreading means including a frusto-conical rotor, a shaft supporting said rotor for rotation on an approximately horizontal axis, a second frusto-conical rotor in reversed relationship to said first rotor, a shaft supporting said second rotor for rotation on an approximately horizontal axis and means for rotating said rotors in opposite directions; a third rotor having a peripheral surface with means to retain molten material thereon, a shaft mounting said third rotor for rotation with its peripheral surface in the path of material discharged by the spreading means, whereby a portion of

the material is retained on the rotor and another portion is thrown off, a fourth rotor having a peripheral surface with means to retain molten material thereon, a shaft for mounting said fourth rotor for rotation with its peripheral surface in the path of the material thrown off by said third rotor, and means for rotating said third and fourth rotors in opposite directions at high speeds.

4. An apparatus as defined by claim 2, having means for yieldably supporting the shafts for the rotors.

5. A method of making mineral wool from a molten mineral material comprising discharging a stream of the molten material onto the peripheral surface of a rotating rotor, discharging the material from the rotor onto the peripheral surface of an adjacent rotor rotating at a higher peripheral speed to spread and divide the stream, discharging the spread and divided stream at a relatively high velocity onto the peripheral surface of a third rotor to form an incandescent ring thereon from a portion of the material, discharging another portion of the material from the third rotor onto the peripheral surface of a fourth rotor to form an incandescent ring thereon, and rotating said third and fourth rotors at higher speeds than said first and second rotors to form fibers from said incandescent rings.

6. In an apparatus for converting a molten raw material to fibers having means for discharging a fluid stream of the molten material, the improvement comprising means for accelerating the stream including a rotor located to have its peripheral surface in the path of the stream to receive the material and discharge it therefrom, means for rotating said rotor, a second rotor having a peripheral surface to receive material discharged by the first rotor, means for rotating said second rotor at a higher peripheral speed than the first rotor; and fiberizing means including a third rotor having a molten material retaining peripheral surface, means mounting said rotor for rotation with its peripheral surface in the path of material discharged by the accelerating means, a fourth rotor having an unobstructed, molten material retaining peripheral surface, means mounting said fourth rotor for rotation with its peripheral surface adjacent said third rotor, and means for rotating said third and fourth rotors at a speed greater than that of said first and second rotors.

7. In an apparatus for converting a molten raw material to fibers having means for discharging a fluid stream of the molten material, the improvement comprising means for spreading and accelerating the stream including a substantially cylindrical rotor having an annular surface, means supporting said rotor for rotation with its annular surface in the path of the stream, a second, substantially cylindrical rotor having an annular surface and means supporting said second rotor for rotation with its annular surface adjacent the first rotor; and fiberizing means including a third rotor having an unobstructed, molten material retaining, annular surface, means mounting said third rotor for rotation with its annular surface in the path of the spread stream, a fourth rotor having an unobstructed, molten material retaining annular surface, means mounting said rotor for rotation with its annular surface in the path of material discharged by said third rotor, and means for rotating said rotors.

8. In an apparatus for converting a molten raw material to fibers having means for discharging a fluid stream of the molten material, the improvement comprising means in the path of the stream for spreading and accelerating the stream, said stream spreading and accelerating means including a substantially cylindrical rotor having a peripheral surface, means supporting said rotor for rotation with said surface in the path of the stream, a second substantially cylindrical rotor having a peripheral surface, and means supporting said second rotor for rotation with its peripheral surface adjacent the first rotor, a third rotor having an unobstructed, molten material retaining peripheral surface, means mounting said third rotor for rotation with said surface in the path of the spread stream, a fourth rotor having an unobstructed, molten material retaining peripheral surface, means mounting said fourth rotor for rotation with its peripheral surface in the path of material discharged by said third rotor, and means for rotating said rotors at successively higher peripheral speeds.

9. In an apparatus for converting a molten raw material to fibers, said apparatus having means for discharging the molten material, the improvement comprising, a rotor in the path of discharged material to receive material and project it therefrom, a second rotor in the path of material projected by said first rotor to receive material from said first rotor and project it therefrom, a third rotor having an unobstructed, molten material retaining annular surface positioned to receive material projected by said second rotor, a fourth rotor having an unobstructed, molten material retaining annular surface positioned to receive material from said third rotor, and means for rotating said rotors.

10. The method comprising, discharging molten mineral wool forming material and converting the same into fibers by intercepting discharged material on a rotating annular surface and projecting material therefrom, intercepting material projected by said surface on a second rotating annular surface and projecting it therefrom, intercepting material projected by said second annular surface on an unobstructed, molten material retaining annular surface rotating at high speed and discharging material therefrom to another unobstructed, molten material retaining annular surface rotating at high speed.

11. In an apparatus including means for discharging a stream of molten material, devices positioned in the path of the discharged material for converting the material into fibers, said devices comprising a first pair of rotors having annular surfaces to receive molten material of the stream and convert a portion of the same into fibers and to accelerate the movement of another portion of the material, and a second pair of rotors having unobstructed, molten material retaining annular surfaces to receive material of said other portion and form fibers therefrom, and means for rotating said rotors.

12. The method comprising, discharging molten mineral wool forming material and converting the same into fibers by intercepting discharged material on a rotating annular surface and projecting material therefrom, intercepting material projected by said surface on a second rotating annular surface and projecting it therefrom, intercepting material projected by said second annular surface on an unobstructed, molten mate-

rial retaining annular surface rotating at high speed and discharging material therefrom to another unobstructed, molten material retaining annular surface rotating at high speed, the angles of impact of the material against said annular surfaces increasing from relative tangency with respect to said first surface to substantially right angular relationship with respect to the last surface.

EDWARD R. POWELL

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
998,358	Lessing -----	July 18, 1911
2,136,988	White -----	Nov. 15, 1938
2,153,739	Buss -----	Apr. 11 1939
2,243,122	Ramseyer -----	May 27, 1941
2,428,810	Powell -----	Oct. 14, 1947

May 18, 1954

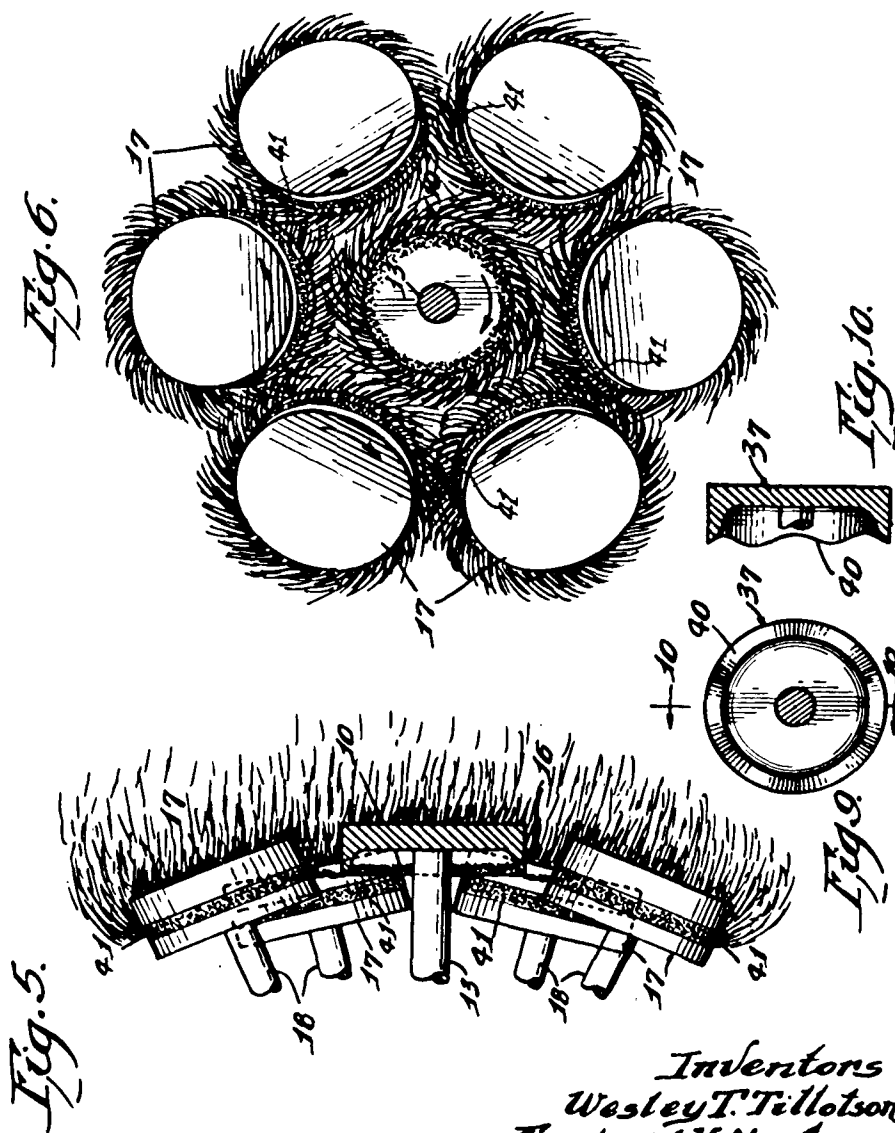
W. T. TILLOTSON ET AL

2,678,466

APPARATUS AND METHOD OF FIBERIZATION OF MINERAL WOOL

Filed Jan. 16, 1953

3 Sheets-Sheet 3



Inventors
Wesley T. Tillotson
Frederick H. Norton.
By. Wilson & Egan
Attorneys

MTC 017045