Feb. 24, 1942. C. C. DAVIS 2,274,130

APPARATUS FOR SPINNING FIBERS

Filed Dec. 7, 1939 2 Sheets-Sheet 1

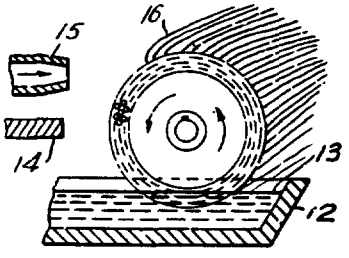

Fig. 1

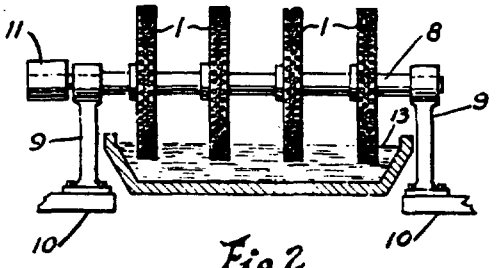

Fig. 2

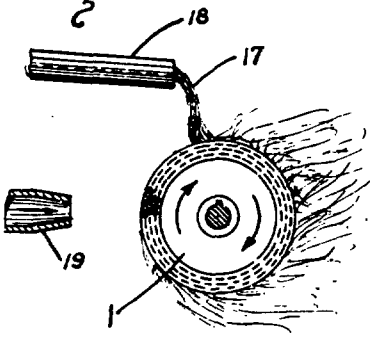

Fig. 3

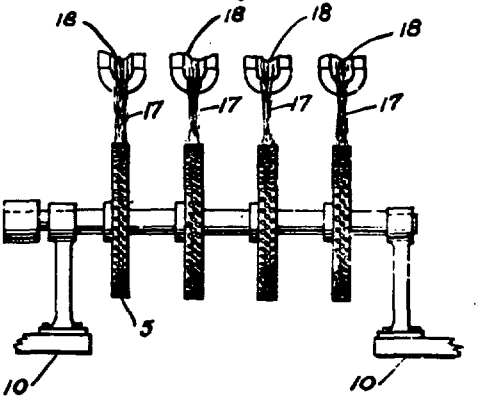

Fig. 4

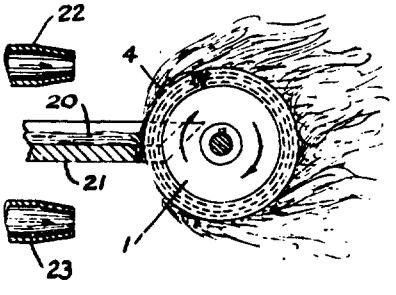

Fig. 5

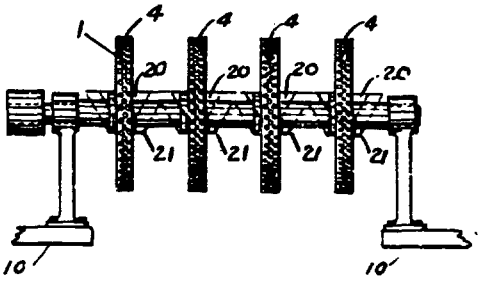

Fig. 6

INVENTOR.

Carlton C. Davis

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APPARATUS FOR SPINNING FIBERS

Carlton C. Davis, Wabash, Ind., assignor to American Rock Wool Corporation, Wabash, Ind., a corporation of Indiana

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8 Claims. (Cl. 83—91)

This invention relates to apparatus for and methods of spinning fibers from suitable molten materials by the application of centrifugal force. It also relates to improvements in a spinning wheel whereby the capacity of the wheel for producing fibers, either mineral or organic, is substantially increased.

An object of this invention is to provide means and methods whereby mineral materials may be rapidly and efficiently spun into mineral fibers with the application of centrifugal force.

Another object is the provision of a method and a means for manufacturing a superior grade of mineral or organic fibers.

The art of producing mineral fibers from suitable molten mineral materials by the application of centrifugal force is old. It is well recognized by those skilled in the art that the fibers produced by this method are definitely superior in quality to the fibers which are formed by shredding the molten materials with a steam or air blast. Fibers spun on a rapidly rotating wheel are long and silky and in many respects compare favorably with the far more expensive mineral fibers which are formed by extrusion, and are used in the production of woven mineral textiles.

The fibers produced with a steam or air blast can hardly be compared with the fibers which are formed on a spinning wheel. The blast-shredded fibers include a very large proportion of "shot" and other nonfibrous portions. These nonfibrous portions not only do not have any substantial insulating value, but are so objectionable that they may well be termed "The curse of the mineral wool industry." These objectionable portions often, and in applicant's opinion generally, do constitute at least 50 per cent of all the commercial grades of blown mineral wool, except "granulated wool" which has been previously treated to remove some of the "shot." In granulating the wool, however, the mineral wool fibers are rolled and tumbled in such a manner that the larger proportion of the fibrous portion is crushed or broken to a serious extent. These nonfibrous portions are also objectionable for the reason that these portions readily pierce the hands of the operators in the factory and of the applicators in the field.

Mineral wool fibers formed in the steam blast have the further disadvantage of being extremely irregular in size, shape, diameter, flexibility, tensile strength, and other physical characteristics. Because of these irregularities, it is almost impossible to produce commercially acceptable blown mineral wool blankets or batts with these fibers without the employment of relatively expensive adhesives or casings, which being combustible render the batts unsuitable for use in stoves, furnaces, and the like. The adhesives generally employed in manufacturing these blankets or batts are not only combustible, but are inflammable to such an extent that their use constitutes a distinct fire hazard both in the production and in the shipment of these batts. It is a matter of record that a number of fires have occurred in batts which have been packed and stored for such a long period of time after the batts were manufactured that the fires were believed to have been caused by the spontaneous combustion of the binding material in these batts.

Despite the superiority of the centrifugally spun mineral fibers, these spun fibers have never generally supplanted the blast-shredded fibers in the heat insulating industry. The inability of the centrifugally spun fibers to compete on a commercial basis with the blown product is chiefly due to the fact that heretofore, insofar as is known to the applicant, no one has been able to provide a spinning wheel capable of producing mineral fibers rapidly and economically.

The low producing capacity of the conventional spinning wheel has long been a serious obstacle or bar to the wide introduction of a far superior grade of mineral wool to the public at a very low price at which mineral wool must be sold. This low capacity was apparently due to an inherent limitation, found in the operation of the spinning wheel.

If a small amount of lava be continuously applied to the conventional spinning wheel, a thin coating or film is formed continuously on the operating surface of the wheel and is continuously thrown off in the form of fibers. This coating or film, however, is too thin to provide a satisfactory rate of production. If larger amounts of lava are applied to the wheel, nearly all, except the portion forming the before mentioned film or coating, apparently slips or slides over the film in such a manner that the wheel is unable to impart its angular velocity, or even approximately its angular velocity, to the outer portion of the lava on the wheel. Much of this outer portion is, therefore, not thrown off the spinning wheel at a velocity sufficient to streamline this outer portion of the molten material into fibers. The manner in which the conventional wheel operates apparently limits the output of the wheel to the small amount of lava which comes in direct contact with the outer

surface of the wheel and momentarily forms this film or coating.

Numerous attempts have been made to overcome this difficulty by the provision of small abutments or striking bars on the operating surface of the spinning wheel, but these abutments, in practice, hurled the molten material off the wheel in masses which were too large to become thoroughly fiberized before these masses were chilled.

After considerable research and numerous failures, applicant has discovered that the low capacity output of the conventional spinning wheel was due to the fact that the outer operating surface of the conventional spinning wheel is nonporous or imperforate and, therefore, provides no means whereby any large amount of lava could be adhered or secured to the wheel for even that fraction of a second necessary for this wheel to impart its angular velocity to the lava, and that, therefore, the greater proportion of any substantial amount of lava applied to the wheel would be thrown off of the spinning wheel at a speed too low to fiberize the molten material before it became frozen.

The present invention, therefore, contemplates the provision of an improved spinning wheel having porous, recessed, or perforated portions provided in the spinning surfaces of the wheel in such a manner that these portions act as temporary reservoirs or "vacuum cups" in which appreciable quantities of the lava are given, at least, the approximate angular velocity of the spinning wheel before they are thrown off of the wheel.

The other objects and advantages of this invention will become apparent from the following specification and the accompanying claims and drawings.

In the drawings:

Figures 1 and 2 are partly sectional and partly elevational views showing the preferred apparatus of my invention as it is used in spinning mineral fibers from molten material which is hurled up from a pool or reservoir by the spinning wheel.

Figures 3 and 4 are partly sectional and partly elevational views showing the spinning wheel of Figure 1, as this wheel is preferably used in spinning mineral fibers from molten materials which are poured in a stream upon the spinning wheel.

Figures 5 and 6 are partly sectional and partly elevational views of the spinning wheel of Figure 1 showing this wheel as it is preferably used in spinning mineral fibers from a more or less horizontally moving stream of molten material which flows against the outer portions of the wheel.

Figure 7 is a partly elevational and partly sectional view showing a modified form of a spinning wheel, which is particularly adapted to be rotated around a vertical axis.

Figure 8 is an upper plan view of the spinning wheel shown in Figure 7.

Figure 9 is a somewhat enlarged partly sectional and partly elevational view of the preferred form of spinning wheel shown in Figures 1 to 6 inclusive.

Figure 10 is a side elevational view of the wheel shown in Figure 9.

Figure 11 is a partly sectional and partly elevational view showing a modified form of a spinning wheel which is particularly adapted for spinning mineral fibers from a descending stream of molten lava while the wheel is being rotated about a horizontal axis.

Figure 12 is a partly sectional and partly elevational view of a perforated spinning wheel which is adapted to spin mineral fibers by any of the methods shown in Figures 1 to 7 inclusive.

This invention contemplates the employment of a spinning wheel, the operating surface of which is porous, perforated, recessed, indented or etched for the purpose of preventing the lava from flying from the wheel under conditions unfavorable for fiberization without unduly limiting the amount of the lava applied to the wheel. The efficient spinning capacity of the spinning wheels of the prior art, insofar as their operation is understood by the applicant, is definitely limited by the relatively small amount of lava which becomes adhered to or wets the outer spinning surface of these wheels.

Unfortunately, however, it is only possible to wet the wheel with a relatively thin film or coating of lava. This film becomes readily fiberized, but when any substantially additional coating or mass of lava is applied over this film, the additional lava slips or slides over the surface of the thin film in such a manner that the lava forming the added coating or mass is thrown off the wheel at a velocity too low to become properly fiberized.

According to applicant's invention a substantially increased spinning capacity may be obtained either by

(1) Increasing the area of the wheel's outer spinning surface in proportion to its size and weight, or by

(2) Providing numerous porous, recessed or perforated portions which are adapted to serve as reservoirs in which the lava is retained momentarily and is thereby given the approximate angular velocity of the wheel, or by

(3) A combination of these two methods.

In the above mentioned drawings four embodiments of this invention are shown for the purpose of illustrating, but not limiting, the scope of applicant's invention.

Referring now to Figures 1 to 6 inclusive and also to Figures 9 and 10, the preferred form of the invention makes use of a spinning wheel 1. This wheel includes a suitable hub 2, a suitable web or disk 3, and a preferably large rim 4. This rim has a circumferential wall portion 5 and two side wall portions 6, each of which are provided with numerous spaced apart recessed portions or cup-shaped cavities 7. It will, of course, be understood that the term "cup-shaped cavity," as used herein and in certain of the appended claims, is employed in a general sense and is not to be construed with so narrowly as merely to include a bowl-shaped cavity.

These recessed portions or cup-shaped cavities form a novel feature of this wheel and may vary widely in form and in dimensions without departing from the spirit of this invention. It will, however, be found unnecessary to make these portions greater than ⅓ of an inch either in width or in depth and that much smaller recessed portions will function in a satisfactory manner. These recessed portions, may be formed by any suitable method such as, for instance by drilling, indenting, or by even deeply etching the spinning surface of the wheel, according to the size of recessed portions desired. It is, however, highly desirable that a sufficient number of these portions be employed to provide an appreciable increase in the amount of lava which may rotate with the approximate angular ve-

locity of the wheel before the lava is hurled off the wheel.

In Figures 2, 4, and 6, four of the wheels 1 are shown rigidly secured in spaced apart relationship to each other on a shaft 8 which is rotatably mounted on journal members 9 which are carried on a movable and vertically adjustable frame having separated supports 10. The shaft may, of course, be rotated by any suitable means such as, for instance, by a pulley 11.

In Figures 1 and 2, these wheels 1 are shown mounted above a forehearth 12 of any suitable melting furnace or tank (not otherwise indicated) in such a position that the rim portion 4 may be rapidly rotated in contact with the upper portion of a pool of lava 13 which may be maintained at the proper temperature and level by the operation of the melting tank. Above this forehearth there is preferably provided a roof portion 14 to reduce the amount of heat energy radiated and to prevent any excessive cooling of the lava.

A plurality of nozzle members 15 are preferably employed for the purpose of directing a stream of air, steam or other suitable fluid against each of the wheels substantially as shown. These fluid streams may have a fairly low velocity as it is only necessary that the newly formed fibers 16 be gently blown away from the wheels and be thereby prevented from clinging to the wheels and from being brought into contact with the lava pool. In certain instances, however, it may be desired to provide a blast of high velocity for the purpose of producing a combination of centrifugally spun fibers and blast blown fibers.

In Figures 3 and 4, four separate spaced apart streams of lava 17 are shown issuing from any four suitable spaced apart lava discharge conduits 18 and being discharged upon the recessed circumferential portions 5 of the wheels 1. With this arrangement four nozzles 19 are preferably provided for the same reason as are the nozzles 15 of Figure 1.

Figures 5 and 6 show four streams of lava 20 being discharged from four conduits 21 directly against the rim portions 4 of each of four wheels 1 in such a manner that all of the circumferential and side wall portions of the rims 4 may act upon the lava. With this arrangement two sets of four spaced apart nozzles 22 and 23 may be directed substantially as shown against these wheels so that air or other fluid streams may be blown against both the upper and lower portions of these wheels.

It has been proven by numerous tests that the rate at which the wheels spin the mineral fibers is definitely increased by the provision of these recessed portions. In the spinning operation, however, the wheels are necessarily spun too fast for the eye to observe the exact manner in which any of the recessed portions function, but the action of the wheels as a whole indicates that when lava is applied to the spinning wheels in any suitable manner the recessed portions provide numerous momentary reservoirs to receive the lava and also provide a gripping means whereby the slipping or sliding of the lava is greatly reduced and the lava is more effectively adhered to the wheel. The operation of the wheels also indicates that the recessed portions after becoming wholly or partially filled with lava function somewhat as suction cups and thereby retard the rate at which the molten materials are thrown out of these depressed portions and are spread over the outer spinning surface of the wheel. These wheels are believed to function in the above described manner, but regardless of the exact manner in which the wheels operate, it is an established fact that under any fair operating conditions a larger amount or greater proportion of the lava is prevented from unduly sliding or slipping on the wheel and from being thrown off of the wheel at a velocity too low to become completely fiberized.

Figure 11 shows a wheel 25 which is similar in construction to the wheel 1 except that the rim of this wheel is provided with a large annular channel or grooved portion 26 and two side wall portions 27 which are adapted to hold the lava in this channel which is preferably provided with numerous spaced apart recessed portions or cup-shaped cavities 28 which serve the same purpose as the recessed portions 7 on the wheel 1. The spinning action of this wheel is the same as of the wheel, except that the effective spinning surface of the wheel 25 is limited to the circumferential portions of the wheel.

In Figures 7 and 8 applicant has shown a modified form of this invention which is particularly adapted to spin mineral fibers around a vertical or inclined axis. This apparatus makes use of an upwardly extending shaft 30 which may be rotatably secured in its operating position by a thrust bearing 31 and a journal bearing 32. On the upper end of this shaft there is secured a circular plate or drum 33 having a large centrally positioned recessed portion 34 in which is removably secured in any suitable manner a circular spinning disk 35 having a large number of spaced apart recessed portions 36. The upper surface of the disk 35 preferably extends above the upper surface of the recessed plate or drum 33, to prevent this plate or drum from interfering in any manner with the fiber spinning operation and to also prevent the upper surface of this recessed plate from being overheated or injured by the lava.

In operation, the shaft 30 may be driven by any suitable means, such as for instance, by a motor 37 and a stream of lava issues from any suitable supply means 38 and falls on the spinning disk 35. A part of the lava flows into these recessed portions 36 which serve the same purpose as do the recessed portions 7 on the wheel 1. A nozzle 39 is preferably provided for blowing the newly formed fibers in any desired direction.

An advantage of this construction is that the disk 35 may be formed of either metal or any suitable refractory material. This is due to the fact that the outer edge of the recessed drum reinforces the disk 35 and thus reduces any danger of the disk flying apart due to centrifugal force.

In Figure 12, another modified form of this invention is shown which makes use of a spinning wheel 40, which is provided with a plurality of closely spaced apart inner spinning disks 41 and two outer spinning disks 42 the latter of which are made preferably slightly larger in diameter than the disks 41 for the purpose of preventing the unfiberized lava from falling off of the wheel. These disks are spaced slightly apart from each other by any suitable means, such as for instance, spacer disks 43. Both the spinning disks 41 and 42 and the spacer disks 43 may be operatively secured together by any suitable means, such as an adjustable hub 44 consisting of an exteriorly threaded sleeve and collar means 45 and an internally threaded bolt 46. This wheel may be mounted on the shaft 8 instead of the wheels 1 and this wheel is particularly adapted

to split or divide a relatively large stream of lava into separate smaller streams of lava and to spin the lava in these smaller streams into mineral fibers. Each of the spaced apart disks is preferably tapered at its circumference and may be provided with a large number of relatively small holes or perforated portions 48.

In operation a large stream or mass of lava is divided by the tapered circumferential portions, 49 of the inner spaced apart disks 41 and the separated lava flows between the disks 41 and 42. The lava then spreads out over the flat surface portions of these disks. The perforated portions 48 serve to receive and momentarily retain a portion of the lava which is, of course, in operation quickly acted upon by centrifugal force. The lava tends to cling to these perforated portions, but it is, of course, promptly discharged upon the outer flat portions of the disks from which the lava is rapidly thrown off of the wheel in the form of fibers.

The wheel 40 is designed to produce an unusually large quantity of wool for its size and weight, but the spinning disks and especially the inner disks 41, if care is not used, may become overheated. It is, therefore recommended that a strong cold air or other fluid stream be blown between each of these disks by any suitable nozzle means (not shown). The perforated portions of the disks aid materially in cooling the wheel by permitting a centrifugally induced stream of air to pass through the wheel. The inducing of this air stream, however, materially increases the power required to rotate this wheel at a high velocity, and if a very high fiber output is not required, it will be found advantageous to make the two outer disks 42 imperforate and merely blow the stream of air between the various spinning disks.

It will, of course, be understood that the spinning wheel must be operated at a fairly high velocity to provide enough centrifugal force to economically and effectively spin the lava into fibers. It is, therefore, apparent that the molten material, which is to be spun almost immediately into fibers, after it has fallen upon the spinning wheels does not remain in the recessed portions or even on the surface portion of the spinning wheels longer than a very small fraction of a second. For this reason when such terms as "rapidly," "gradually" and "momentarily" are used herein, they should be considered in relation to high rate of speed at which the molten materials move on the outer surface of the spinning wheel.

It will also be understood that the spinning apparatus of this invention is adapted to spin any suitable viscous materials into fibers and that the viscous materials may be either of mineral or organic origin.

I claim:

1. A spinning wheel apparatus of the character described, said apparatus including a rotatably mounted wheel having a circumferential spinning surface portion and an inwardly extending spinning surface portion on each side of said circumferential spinning portion, each of said surface portions being provided with numerous inwardly extending cavities adapted to increase the lava retaining capacity of said spinning wheel.

2. A spinning apparatus for centrifugally spinning mineral wool fibers from suitable molten material, said apparatus including a rotatably mounted body, means for rapidly rotating said body and means for feeding said materials to said body, the body being substantially circular in cross section and being provided with a spinning surface having numerous small spaced apart cup-shaped cavities therein adapted to receive and momentarily retain portions of the molten material applied to said surface during the rotation thereof.

3. A spinning wheel for centrifugally spinning mineral wool fibers from suitable molten material provided with a spinning surface having numerous small cup-shaped cavities therein adapted to receive and momentarily retain said material when said material is fed to said surface while said surface is being rotated.

4. A spinning wheel for centrifugally spinning mineral wool fibers from suitable molten material provided with a spinning surface having numerous small cup-shaped cavities adapted to receive and momentarily retain said material when said material is applied to said surface while said surface is being rotated, said spinning surface being in a plane substantially at right angles to the axis of rotation of said wheel.

5. A spinning wheel for centrifugally spinning mineral wool fibers from suitable molten material provided with a spinning surface having numerous small cup-shaped cavities adapted to receive and momentarily retain said material when said material is applied to said surface while said surface is being rotated, said spinning surface being on a rim portion of said wheel and in a plane substantially at right angles to the axis of rotation of said wheel.

6. A spinning wheel for centrifugally spinning mineral wool fibers from suitable molten material provided with a spinning surface having numerous small cup-shaped cavities adapted to receive and momentarily retain said material when said material is applied to said surface while said surface is being rotated, said spinning surface being on a rim portion of said wheel and in a plane substantially parallel with the axis of rotation of said wheel, said cup-shaped cavities on the rim portion extending toward the center of said wheel.

7. A spinning wheel for centrifugally spinning mineral wool fibers from suitable molten material provided with a spinning surface having numerous small cup-shaped cavities adapted to receive and momentarily retain said material when said material is applied to said surface while said surface is being rotated, said spinning surface being on the rim portion of said wheel and in a plane substantially at right angles to the axis of rotation of said wheel, said cup-shaped cavities extending in a direction substantially parallel with the axis of rotation of said wheel.

8. A spinning apparatus of the character described for centrifugally spinning mineral wool fibers from suitable molten material, said apparatus having a rotatably mounted body portion provided with a substantially smooth annular spinning surface having multitudinous substantially uniformly distributed small wells thereon extending into the external surface but not through the same and being of substantially uniform size and shape, said wells forming molten material reservoirs to receive and momentarily retain portions of molten materials received by said surface, means to feed molten mineral materials to said surface and means for rapidly rotating said body.

CARLTON C. DAVIS.