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B. WALLRATH ET AL

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METHOD AND APPARATUS FOR MAKING FIBROUS MINERAL MATERIAL

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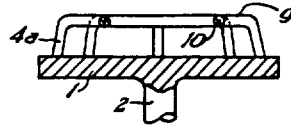


Fig. 6

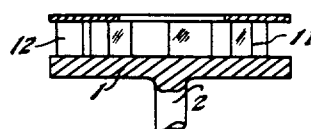


Fig. 8

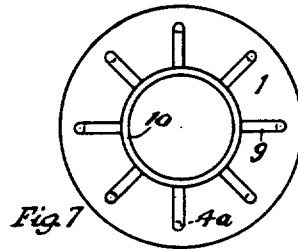


Fig. 7

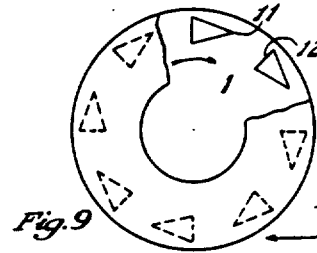


Fig. 9

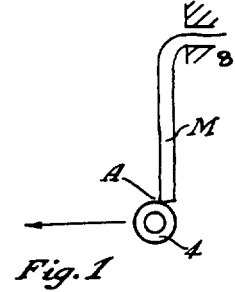


Fig. 1

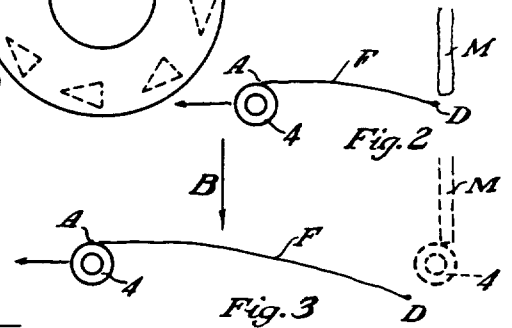


Fig. 3

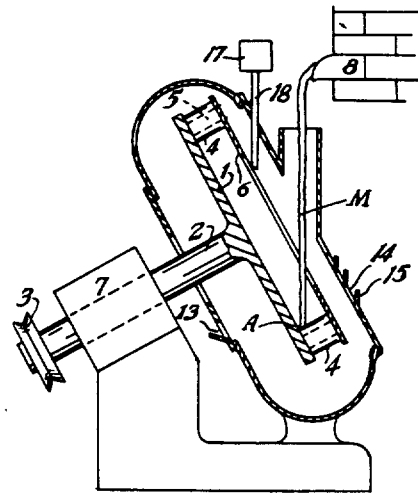


Fig. 4

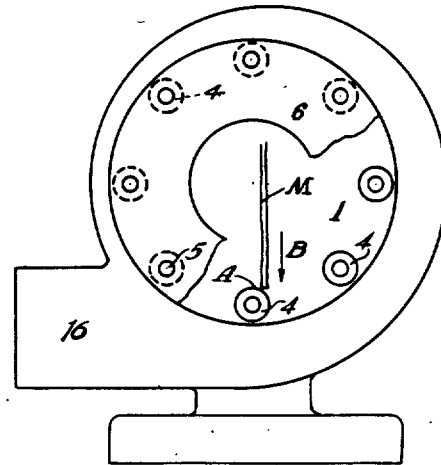


Fig. 5

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METHOD AND APPARATUS FOR MAKING
FIBROUS MINERAL MATERIAL

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8 Claims. (Cl. 83—81)

This invention relates to machines for converting viscous substances into filaments, and pertains more particularly to machines for making mineral wool from glass, slag, or other molten material.

Objects of our invention are; to provide means for increasing the hourly output rate of fibre from a machine of given size; to produce longer and finer fibres more nearly uniform as to length and diameter; to minimize the production of "shot," granules, or other particles which are detrimental in high-grade mineral wool.

We attain these objects and certain others which will appear later in the specifications by using a rotor of improved structure, arrangement and mode of operation described and claimed herein; and by a novel co-operative arrangement of the rotor and its housing for the purpose of better discharging the fibres from the machine without harming them.

Our claimed improvements are exemplified in the construction and mode of operation of a machine for making such fibres or filaments.

Before describing our improvement in detail it will be helpful to note briefly the modes of operation of certain earlier mineral wool machines. For many years molten slag has been disintegrated by being poured through high pressure jets of air or gas that blew away particles of the viscous material and strung them out into fibres. In other machines the molten stream has been impinged by paddles rotating at high speed, each splattering a bit of the material into spray and driving it at high speed like sparks from an emery wheel, into the surrounding air ahead of the paddles where a portion of the particles threaded themselves out by their own momentum. In still other earlier machines molten slag was poured onto the flat surface of a rapidly revolving horizontal disk, where it spread out, was subjected to great centrifugal force, and when it reached the rim divided itself into "shot" that flew off into space, each "shot" drawing itself out into a thread during its centrifugal flight, because of its own momentum.

All of such known machine types alluded to were characterized by segregating molten particles of shot from a supply body, giving each particle a high velocity and a free-flight into the air, whereby reason of its own momentum, each piece was expected to convert itself into fibre. But always a considerable portion of undesired granular material was developed along with the desired fibres.

Certain disadvantages of those earlier methods, although apparent to the trade for many years

were retained by most makers of mineral wool machines up to the development of our present invention.

Our improvement departs from the hitherto accepted ideas that wool threads should originate in a free-flying molten particle or shot whose momentum constituted an essential factor for converting it into a filament. We have found that better fibres, longer and more uniform in diameter and commercially void of granules can be formed by avoiding as far as possible the creating of any flying shot and also avoiding the use of high pressure air blasts or of centrifugal force or of momentum in the material being worked. Instead, we draw out the fibres from molten particles that are relatively stationary, utilizing their inertia instead of momentum.

Having explained the general purposes and nature of our improvement, reference may now be had to the accompanying drawing showing in preferred form a machine embodying our invention; typical structural modifications of the rotor and spinners also being illustrated to indicate the nature and scope of the claimed invention.

Figs. 1, 2, and 3 are schematic diagrams for the purpose of describing the function and apparent mode of operation of the rotor and spinners;

Fig. 4 is a vertical sectional view of the machine and the supply source;

Fig. 5 is a face view of the machine, the front cover of the casing having been removed;

Fig. 6 is a cross-sectional detail of a modified rotor structure;

Fig. 7 is a face view of the parts shown in Fig. 6;

Fig. 8 is a cross-sectional view of a further modified form of rotor; and

Fig. 9 is a face view of the same, the ring being broken away in part.

Brief reference will first be made to schematic Figs. 1 and 2.

We have discovered that high grade filaments can be created most effectively by allowing a small stream of molten material M to drop a short distance at relatively low velocity onto a series of filament-drawing or spinning members, as for example, pins or sleeves 4 traveling sidewise at relatively high velocity across the path of fall of the material, as indicated by the horizontal arrow, Fig. 1. The rate of fall is also the rate of feed to the spinners. Assuming the height of fall to be about one foot, the spinners 4 may travel in the order of about fourteen or fifteen thousand feet per minute.

The bottom end of the stream touches the upper surface of a spinner, Fig. 1, and some adheres

at A, while some also is dislodged and splatters off the pin due to the high speed of the pin. The splattered part or droplet D, Fig. 2, has at first no appreciable velocity sideways. The spinner 4 departs from the droplet at D so quickly as to instantaneously draw the droplet out into a thin filament F. So the droplet disappears, leaving practically no granular residue.

Apparently it is the inertia of the splattered particles released from the end of the falling stream by the wiping action of the top surfaces of the spinners that enables the droplets to be so completely drawn out into fine even fibres. The exact action is not known to us because of the brilliant glare and the high speed and the great numbers of fibres being generated simultaneously.

Referring now to Figs. 4 and 5, a rotor comprising a disk-like member 1 is mounted for rotation in its own plane around an axis 2, being driven as by a pulley 3 from a source of power, not shown. On the face of the member 1 and arranged in a circle are upstanding pins or projections spaced apart in the peripheral direction, as shown in Fig. 5. A preferred structure for such a pin is shown in Fig. 4, where a heat-resistant tubular sleeve 4 is mounted on a pintle 5 fixed to the member 1. Preferably, an annular ring 6 is fixed to the outer ends of all of the pintles, as shown, to give strength and rigidity to the members and to facilitate the filament-spinning action and the fibre removing action of the rotor in use. For purposes of description we term the members 5 and 4, or their equivalents, "spinners."

The axis 2 of the disk 1 is mounted in an inclined bearing 7 so as to rotate in a plane at an acute angle to the vertical, as shown in Fig. 4. By this arrangement the spinners are so arranged that the molten material to be worked can drop in a stream from source 8 either directly onto the spinner 4, or else onto the disk 1 close to the spinner, as shown in Figs. 4 and 5. The contact point of the material with the spinners, or with the disk adjacent the spinners, is near the bottom of the circle of revolution defined by the spinners, as is shown in Fig. 5.

Although we have just described the preferred spinner structure as consisting of the pintle 5 and the sleeve 4, other spinner arrangements may be employed, for example that shown in Figs. 6 and 7, where upstanding rods 4a, either slightly inclined toward the axis 2 as shown, or perpendicular to the member 1, are fixed at one end to the disk, their other ends being bent radially inward as at 9 and secured to a ring 10. A further modified structure is shown in Figs. 8 and 9, where the pin is of polygonal cross-sectional shape and presents a prow-like advancing edge 11 which is preferably outside of the circle of revolution described by the geometrical centers of the projections. The trailing ends of the projections may be flat, as shown at 12, or any other suitable shape.

The machine may be made in various sizes and capacities, but as an example of a practical commercial working unit the following proportions have been found satisfactory:

A disk with a rotor pin circle 10 inches diameter revolves at 5600 revolutions per minute, being a pin speed of approximately 15,000 feet per minute. There are eight pins around the circumference, spaced about a third of a foot apart, so that between successive pins there is a free space for escape of freshly formed fibres, F, 75

Fig. 3, about 4 inches long. The place of discharge of fibres from the rotors will be in a zone corresponding to the bottom part of the circle of revolution where the material is supplied to the spinners.

Due to the rotor and spinners, a current of air is set up in the direction indicated by the arrow B, Figs. 3 and 5, between successive pins, tending to waft the newly formed filaments radially outward and thus prevent their breakage by the next advancing pin. In other words, the spinners create their own fibre-clearing action by creating the outward air flow at B.

It is to be noted that the air circulation here mentioned is not a blast or jet as employed in the earlier devices alluded to for the purpose of disintegrating the molten material.

Having described the rotor and its mode of operation, we shall now explain the housing and its co-operative action with the rotor or spinner for the purpose of removing filaments from the machine without breaking them and without clogging the outlet. The casing is like that of a conventional helical air blower with axial air intake and tangential discharge for air and fibres. The whirling of the rotor sets up a current of air, as above described, drawing it in through openings 13 at the back of the casing, and if desired, through similar openings 14 at the front of the casing, as shown in Fig. 4. The openings may be adjusted as to size by providing them with louvers 15, as shown. Regulating the louver openings controls the volume of air permitted to circulate through the casing, between the pins and out through the discharge opening.

Too much air would cool and solidify the filaments too soon, making them too coarse; but by varying the speed of the rotor and the size of the air openings in the casing, the machine can be quickly adapted to suit any physical or chemical composition of the molten material at various degrees of viscosity so as to produce thin even filaments practically void of granules.

The initial action of the air current as it passes out between the pins at B is, as stated, to permit the trailing end of the filament to be deflected outwardly so it will not be broken by the next pin. Also an effect of the air vents 13, 14 around the casing is to produce a substantial air flow from the outlet 16 whereby the filaments F, Fig. 3, are carried lengthwise along the outlet nozzle and flow with the air stream, and parallel therewith, so that a large percentage of the filaments are delivered without breakage.

It will now be apparent that by the means above described the molten material is made to hit directly upon the pins, or upon the disk in close proximity to them, thus avoiding the undesirable feature of former disk devices that permitted the molten material to strike the surface of the disk near its axis and flow outwardly across it to the rim where it was disintegrated and thrown off by centrifugal force. Here the molten stream, upon hitting the pin has its bottom end sheared away, as it were, as fast as it falls, so the fluid has its physical character changed instantly into fine filaments; a result which, so far as we are aware, has not been attained to any such a degree of completeness in rock wool machines heretofore produced.

We have found that the character of the filament is dependent upon the transverse speed of the pins across the end of the stream; the temperature of the material; the ingredients in the material; the temperature of the projections;

and the control of the amount of air moving around the projection. The outlet of the housing may be horizontal, as shown, or vertical, but the most satisfactory position is one that delivers the material slightly upward from the horizontal. It may be noted that the air circulation is in no sense a blast such as was necessary to form filaments by the earlier blowing process.

In our device only a few ounces of pressure from the rotor are needed, whereas from 60 to 110 pounds per square inch is usually required for the production of wool by the blast or air jet method.

A suitable liquid, paraffin oil, for example, is used for coating the filaments and tempering them. The tempering liquid is fed from a container 17 through a pipe 18 to the disk 1 at or near the place where the molten stream meets the spinners, as indicated in Fig. 1. By this arrangement a minimum amount of tempering fluid can be used for a given amount of newly formed filaments, and none of the fluid is wasted, since it is all applied directly at the place where the filaments are generated.

The machine above described has the following important advantages in use: its small size renders it inexpensive to build and install, and the small amount of power required to convert material into filaments represents a considerable saving in operating cost. The machine moreover is adaptable for small or large production on an economical basis, that is to say, a given machine need not be run at its maximum capacity in order to produce maximum economy. The machine will convert materials with a wide range in proportions of the various chemical elements, whereas in other types of machines referred to the attendance of an especially skilled workman was required for such control. No special attention is required to maintain a closely regulated incoming flow of material. Also the direction of discharge is under control and no special arrangements of rooms, chambers, or hoppers are required to deliver the material from the machine.

Having thus described our invention, what we claim and desire to secure by Letters Patent is:

1. In a machine for use in the manufacture of mineral wool; in combination, a disk-like member mounted for rotation at relatively high speed in a plane acutely angularly related to the vertical; upstanding spinner projections thereon arranged in a circle and spaced apart peripherally, a ring member connecting the ends of said projections; means for flowing in a generally vertical direction a stream of molten material at relatively low feed velocity to the inner peripheral surfaces of said spinner projections during their revolution; the relative arrangement of said supply stream and spinners being such that the bottom of the stream contacts with the spinners only at a point near the bottom of their circle of revolution; and a casing surrounding said rotor having an axial air inlet and a tangential discharge outlet adjacent the bottom of the circle of revolution defined by the spinners.

2. In apparatus for making mineral wool, a disk mounted for rotation in a plane acutely angularly related to the vertical, spinners fixed to said disk in circular peripherally spaced arrangement and extending from the face of said disk in a direction substantially parallel with the axis of rotation of said disk, and means for feeding a stream of viscous molten material to the inner peripheral surfaces of the spinners, each spinner

comprising a member of polygonal cross-sectional shape presenting a prow-like advancing edge offset outwardly from the geometric circle of revolution of the spinners.

3. In apparatus for producing mineral wool, a rotor comprising a disk-like member mounted for rotation in its own plane, spinner projections thereon extending from the face of said member in a direction substantially parallel with the axis of rotation of said member and arranged in a circle and spaced apart about the peripheral margin of the disk-like member, means for rotating said member at relatively high speed, a casing surrounding said rotor having an axial air inlet and a tangential discharge outlet whereby rotation of said rotor causes a flow of air through said casing, means for flowing a stream of molten material in a direction acutely angularly related to the plane of the said member and at relatively low velocity to the inner peripheral surfaces of the said spinners during their rotation, said supply means and said rotor being so related that the stream contacts the spinners only at one point of the circle of revolution defined thereby, whereby the stream is converted into fibres by the action of said spinners, the fibers thus formed being conveyed from the spinners by the air passing through said casing.

4. In a machine for use in the manufacture of mineral wool, in combination, a disk-like member mounted for rotation at relatively high speed in a plane acutely inclined to the vertical, upstanding spinner projections thereon spaced apart peripherally, means for flowing in a generally vertical direction a stream of molten material at relatively low feed velocity to the inner peripheral surfaces of said spinner projections during their revolution, the relative arrangement of said supply stream and spinners being such that the bottom of the stream contacts with the spinners only at a point near the bottom of their circle of revolution, a casing surrounding said rotor having an axial air inlet and a tangential discharge outlet whereby the rotation of said disk-like member creates a flow of air through said casing to convey from said casing the fibres formed by the action of said spinners upon said stream.

5. In a machine for use in the manufacture of mineral wool, in combination, a disk-like member mounted for rotation at relatively high speed in a plane inclined at substantially 30° to the vertical, upstanding spinner projections thereon spaced apart peripherally, each of said spinners being in the form of a bar circular in cross-section and secured to said member at one of its ends, and means for flowing in a generally vertical direction a stream of molten material at relatively low feed velocity to the inner peripheral surfaces of said spinner projections during their revolution, the relative arrangement of said supply stream and spinners being such that the bottom of the stream contacts with the spinners only at a point near the bottom of their circle of revolution.

6. In apparatus for producing mineral wool, a rotor comprising a disk-like member mounted for rotation in a plane acutely inclined to the vertical, spinner projections thereon in the form of cross-sectionally substantially circular bars extending from the face of said member in a direction substantially parallel with the axis of rotation of said member and spaced apart in a circle about the margin of the disk-like member, means for rotating said member at relatively high speed,

a casing surrounding said rotor having an axial air inlet and a tangential discharge outlet whereby rotation of said rotor causes a flow of air through said casing, said tangential discharge being adjacent the lowest point of the circle of revolution defined by the spinners, means for supplying a stream of molten material at relatively low velocity to the inwardly presented peripheral surfaces of the said spinners during their rotation, said supply means and said rotor being so related that the stream contacts the spinners only at a point near the bottom of said circle of revolution, whereby the stream is converted into fibres by the action of said spinners, the fibres thus formed being conveyed from the spinners by the air currents created by said rotor and passing through said casing.

7. In a machine for making mineral wool, in combination, a disk-like member mounted for rotation at relatively high speed in a plane acutely inclined to the vertical, upstanding spinner projections thereon spaced apart peripherally of said member, and supply means for flowing in a generally vertical direction a stream of molten material at relatively low feed velocity to the inwardly presented peripheral surfaces of said spinner projections during rotation of said member, the relative arrangement of said supply means and spinners being such that the bottom of

the stream contacts with the spinners only at a point near the bottom of their circle of revolution.

8. The process of producing mineral fibres which comprises moving an element at high speed in a circle about an axis parallel with the element and in a plane inclined acutely to the vertical, directing a continuous integral stream of molten mineral material in a generally vertical direction and substantially radially relative to the path of movement of said element and causing the stream to contact the element on its inwardly presented face and near the bottom of its circle of movement, converting the material of the stream into fibres by repeated contact between the element and the stream and movement of the element across the stream while preserving the integrity of the stream until it is engaged by the element, setting up a current of air in a path from the inside outwardly past the circle of movement of said element to convey the fibres as they are formed away from the region of their formation, and guiding said air current and the fibres conveyed thereby away from the region of fibre formation in a single compact beam tangentially related to the circle of movement of the element.

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