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E. H. NOVOTNY ET AL

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APPARATUS FOR CLEANING AND OPENING FRAGILE FIBERS

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2 Sheets-Sheet 1

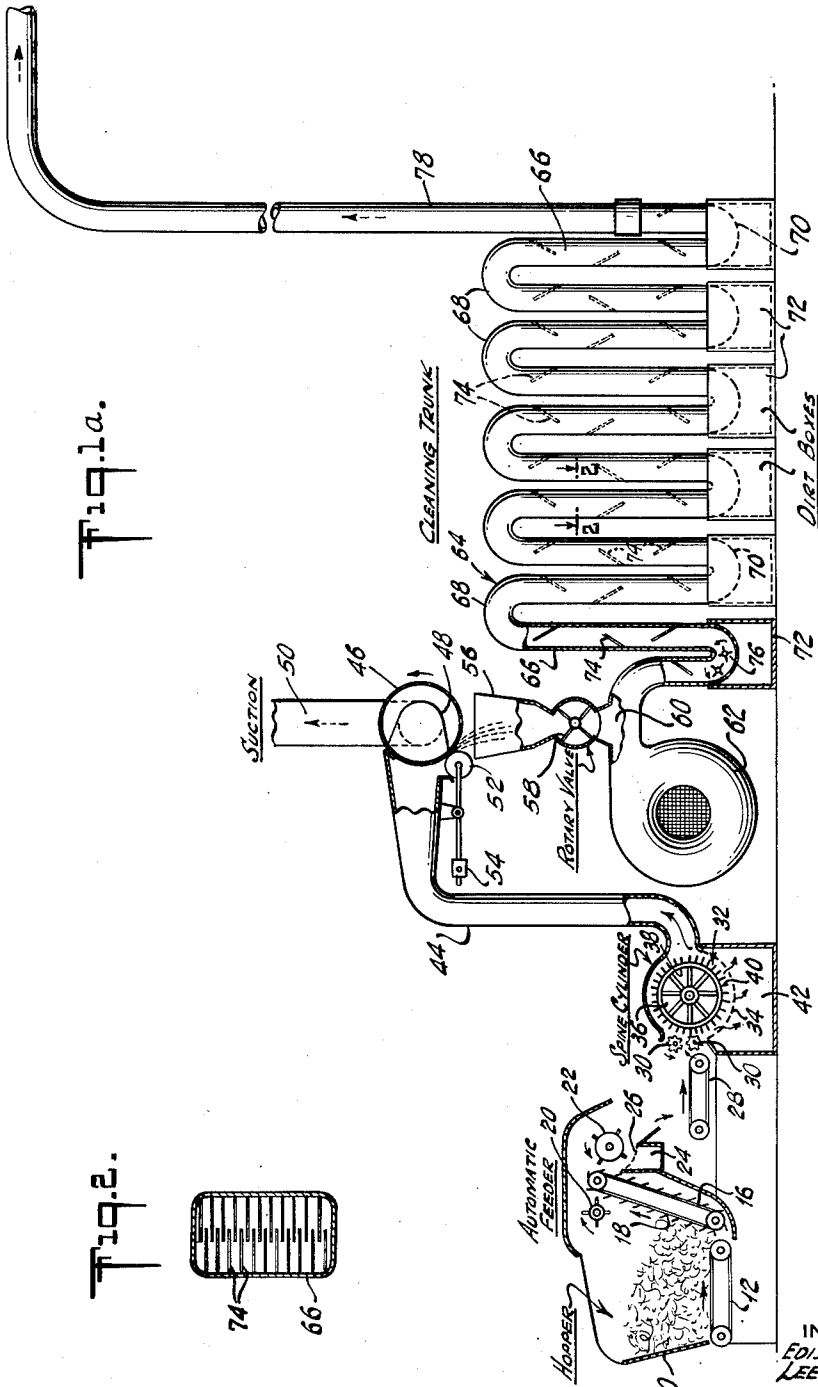


Fig. 1a.

Fig. 2.

INVENTORS
EDISON H. NOVOTNY,
LEE M. HEDGES.
BY *Nirgal O. Kline*
ATTORNEY

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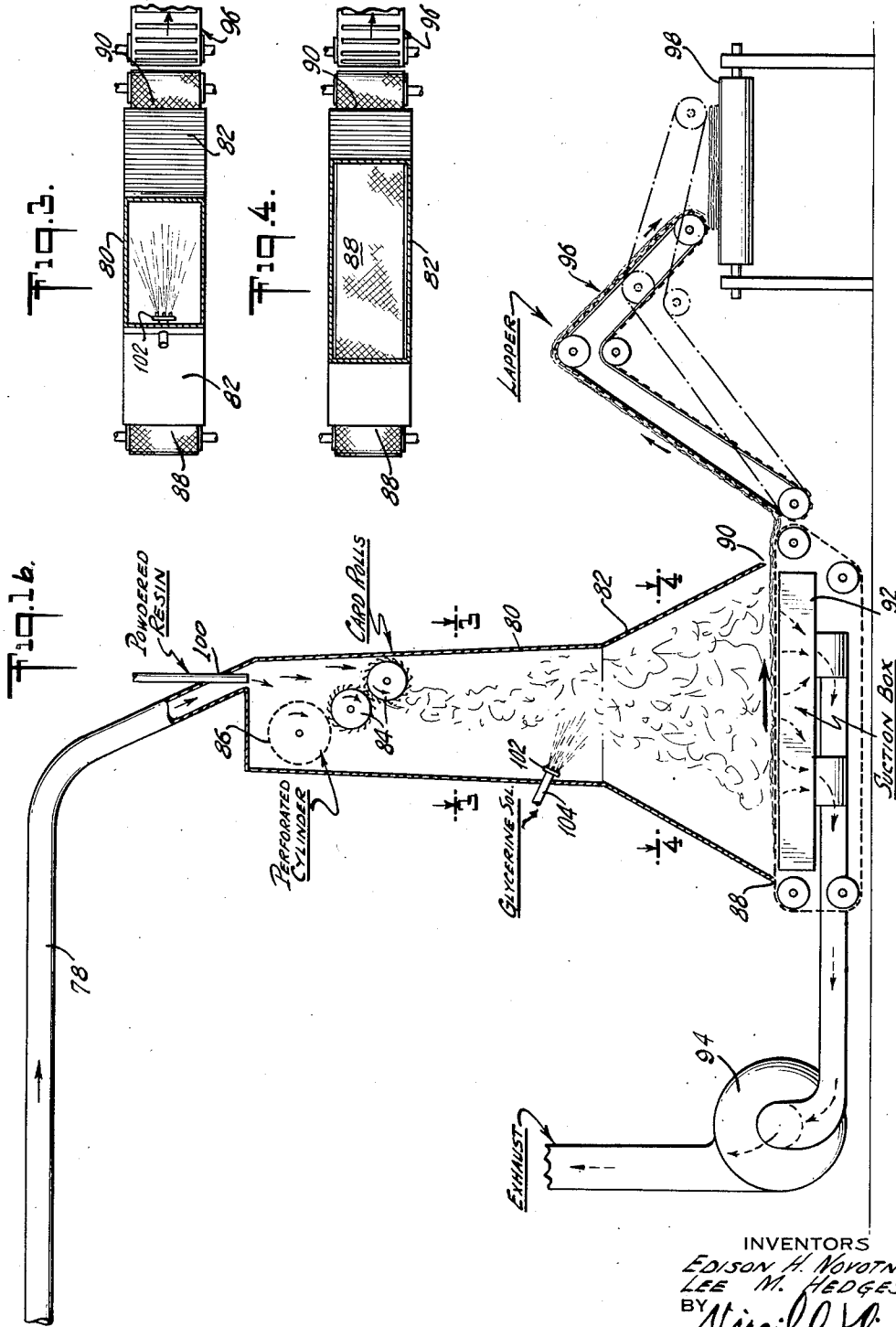
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INVENTORS
EDISON H. NOVOTNY.
LEE W. HEDGES.
BY *Nirgil O. Kline.*
ATTORNEY

UNITED STATES PATENT OFFICE

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APPARATUS FOR CLEANING AND OPENING FRAGILE FIBERS

Edison H. Novotny, South Brunswick Township,
Middlesex County, and Lee M. Hedges, Somerville, N. J., assignors to Johns-Manville Corporation, New York, N. Y., a corporation of New York

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The instant invention relates to a process and apparatus for cleaning, opening and collecting fibers, and particularly to a process and apparatus applicable to relatively brittle, inorganic fibers, such as mineral wool fibers, as well as conventional textile fibers and mixtures of such fibers with mineral wool fibers.

The standard practice employed in the mineral wool field is to direct the fibers as they are formed into a collection chamber, the fibers being carried in an air suspension from which they settle onto a conveyor forming the floor of the chamber. Where a bonded product is desired, the binder in finely divided form is distributed in the suspension to become intermingled with the collected fibers. The fibrous felt thus formed is then carried directly to the finishing operations where it is converted into batts, blankets or nodules, as the case may be, or packaged as loose wool.

An inherent disadvantage of these operations is that during the formation of the wool, a substantial quantity of unfiberized particles, termed "shot" is also formed which becomes intermixed with the fibers to provide an undesirably high content of such unfiberized material in the felt and which is carried into the final product. Numerous attempts have been made to eliminate, or at least reduce the amount of the unfiberized particles but these attempts, at least for the most part, have not met with any great detail of success.

It has also been recognized that numerous types of textile fiber cleaning equipment are available, but these have not been considered appropriate for use on mineral wool and similar fibers, due to the relatively rough treatment to which the fibers are subjected and which causes mineral wool fibers to be broken or destroyed.

A principal object of the instant invention is the provision of a method and apparatus for opening and cleaning fibers to remove the preponderant proportion of the unfiberized particles and dirt therefrom, the method and apparatus embodying modifications of known textile cleaning operations in combination with a collection system by which the fibers, continuously with the cleaning operation, are collected in the form of a light, fluffy, low-density felted layer or web.

Another object of the invention is the provision of such method and apparatus which may be employed with different types of fibers, but which is specifically adapted to fragile, brittle fibers of the type of mineral wool, either alone or in conjunction with, other fibers. A further object of the invention is the provision of such method and

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apparatus which, when employed with a mixture of more than one type of fibers, will produce a substantially uniform distribution of the different fibers in the felted product.

5 The foregoing objects are attained by our method and apparatus which provide for the treatment of entangled masses of fibers, such as mineral wool fibers, or of such fibers, together with masses of other fibers, by relatively gentle
10 fiber opening and cleaning operations which separate the fibrous masses into substantially individualized fibers and remove the bulk of shot or other unfiberized particles from the fibers while, at the same time maintaining breakage of the
15 fibers at a minimum. The cleaned and opened fibers are carried continuously and as a suspension in the airstream which conveyed them through a part of the cleaning and opening system, into a collection chamber or tower where the
20 fibers are subjected to a final opening operation and are deposited by a relatively slowly moving air current onto a collecting surface, preferably a moving conveyor. The fibers gather on the conveyor in the form of a relatively uniform,
25 felted layer. If different types of fibers are to be employed, an intermixture of masses of the fibers are fed into the system, the fibers becoming individualized and substantially uniformly intermixed as they travel through the system, with the result that a homogeneous felt is obtained. The felted layer may be built up to a thickness that it may be used alone to form the final product, or a relatively thin layer may be produced which is converted into a body or blanket of the
30 desired thickness by conventional lappers, or the like. Where a bonded product is desired, a binder, suitably in powdered form, is intermixed with the fibers at any suitable point up to the actual fiber collecting or felting operation to become
35 distributed in the felted layer.

40 A further object of the invention is the provision of such method and apparatus in which the fibers, at the time of their collection, are in a zone of substantially zero static pressure, whereby the fibers are lightly felted into a low-density, lofty layer or web. This is accomplished by employing a relatively low velocity air current to carry the fibers to the felting conveyor and by
45 maintaining a zone of negative pressure below the conveyor, only sufficient to assure deposit of the fibers thereon.

50 A still further object of the invention is the provision of the step of and means for imparting adhesive characteristics to the fibers after they have been cleaned and opened but before

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the felting operation to improve the handleability of the felt for subsequent finishing operations antecedent to any binder setting step.

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

Fig. 1a is a diagrammatic elevational view, with parts in section, of a portion of the apparatus employed in the instant invention for carrying out the method thereof;

Fig. 1b is a diagrammatic elevational view, with parts in section, of the remainder of the apparatus;

Fig. 2 is a sectional view on an enlarged scale, taken on the line 2—2 of Fig. 1a;

Fig. 3 is a sectional view, taken on the line 3—3 of Fig. 1b; and,

Fig. 4 is a sectional view, taken on the line 4—4 of Fig. 1b.

Referring now to the drawings, equipment for carrying out the method of the instant invention includes some modified conventional apparatus and specially designed apparatus, all in novel combination. The cleaning and opening section of the equipment is illustrated for the most part in Fig. 1a and includes a hopper 10 adapted to receive bunches or masses of the fibers to be processed, such fibrous masses normally including unfiberized particles, such as shot, dirt, and the like. The bottom of the hopper is formed as a continuously moving conveyor 12 traveling in the direction indicated by the arrow to carry the fibrous material forward to conveyor 16 traveling in the direction indicated by the arrow and having a succession of flights 18. Flights 18 consist of laterally attached wooden slats with pins so arranged that their points are set to be inclined toward the direction of travel. The pins gather the fiber clumps and carry them upward to a leveling device 20. The leveling device 20 comprises a paddle roll, rotated in the direction indicated by the arrow, and is located adjacent the upper end of conveyor 16 to remove excess material carried by the conveyor and insure uniform delivery of the fibrous material. The fibrous material is removed from conveyor 16 by spike roll 22. A dirt box 24 having an openwork upper wall 26 is preferably placed under roll 22. A conveyor 28 driven in the direction indicated by the arrow, is positioned to receive the material discharged by the spike roll and deliver it to coacting corrugated feed rolls 30, which feed the fibrous material into a spike cylinder 32. The latter includes a lower or bottom wall 34 of openwork or perforate construction and a spike or picker roll 36 suitably comprising a drum 38 having a plurality of radially extending spikes 40. Perforate wall 34 overlies a dirt or shot box 42.

A duct 44 leads from the spike cylinder to a condensing drum 46, the latter having an openwork or screen mesh surface. A suction box 48 is located within the drum, the mouth of the suction box being coextensive with the end of conduit 44. Suction box 48 is connected by a duct 50 to any suitable air-withdrawal means (not shown). The lower wall of duct 44 terminates a short distance from the surface of drum 46 to provide an exit passage for the material collected on the drum, this exit being yieldably closed by a seal roll 52 pivotally supported for movement toward and away from the drum, and suitably weighted as at 54 to maintain contact with the layer of material on the drum. The above de-

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scribed condensing drum varies somewhat from a standard textile condenser but is similar in principle and may be replaced by the same.

A hopper 56 is located below the condensing drum to receive the material discharged thereby, the bottom of the hopper being closed by a rotary valve 58 adapted to be driven at a controlled speed. Valve 58 discharges into a conduit 60 leading from the pressure side of a fan or blower 62 to a cleaning trunk indicated generally at 64. The cleaning trunk consists of a plurality of similar sections, each including vertical runs 66, preferably rectangular in cross-section, as shown in Fig. 2, connected at their opposite ends by return bends 68 and 70 of similar cross-section. The lower return bends have outer walls overlying dirt boxes 72 and formed of screen wire of, say, 3 to 6 mesh, to allow non-fibrous material and dirt to pass therethrough without, at the same time, causing entanglement of the fibers. Each of the runs is provided with rows of vibratory fingers 74, alternately projecting from the opposite walls of the run and sloping in the direction of travel of the material through the run. The fingers of each row are relatively closely spaced, say at 1' intervals. A pair of spike rolls 76 is mounted for rotation in the direction indicated by the arrows, in the return bend at the entrance to the trunk, to avoid clogging at this point. A conduit 78 leads from the cleaning trunk to a fiber collection chamber.

The fiber collection chamber (see particularly Fig. 1b) and its operations constitute an integral part of applicants' apparatus and method combination but, at the same time, are of utility in other circumstances and accordingly have been described and claimed per se in applicants' co-pending application filed of even date herewith. The collection chamber comprises a tower having an upper section 80 of relatively restricted cross-section (see Fig. 3) and bottom section 82 of relatively enlarged cross-section and having outwardly flaring side walls (see Fig. 4). Conduit 78 is connected into the upper wall of the tower adjacent one side wall, as illustrated. Cooperating card rolls 84, driven in the directions indicated by the arrows, are located within the upper section 80 below the exit end of conduit 78, the card rolls closing off a portion of the area of the section 80 to passage of the fibers, except between the card rolls. Substantially the remainder of the area is closed off to the passage of fibers by a perforated or otherwise air-pervious cylinder 86 driven in the direction indicated by the arrow.

The floor of the collection chamber is formed by a conveyor 88 of foraminous or open-work, air-pervious construction, the conveyor being driven in the direction indicated by the arrow to carry the fibers deposited thereon through an exit port 90. A suction box 92 is located below the upper reach of conveyor 88, the suction box being connected to the exhaust side of a fan or blower 94.

Devices for handling the continuous felt or web formed on conveyor 88 are located adjacent the forward end of the conveyor, these taking any suitable form. In the construction illustrated, the handling devices include a lapper 96 of conventional design adapted to lay the web in a plurality of successive folds laterally of a continuously driven conveyor 98.

No drives for the several rolls, conveyors and other moving parts have been shown, but it will

be appreciated that these may be of any conventional type to allow control of the relative speeds of movement of the several parts.

Equipment is provided for applying binders and adhesives to the fibers at suitable points after the fiber cleaning operation. For example, as illustrated in Fig. 1b, a pipe 100 connected to a supply of a dry powder (not shown) enters the collection chamber and has a discharge end or nozzle located substantially at the place of entry of the fibers to direct the binder downwardly into the fibers moving to the card rolls. However, the binder may be introduced at an earlier point in conduit 78, or below the card rolls 34, if desired. An adhesive, in addition to or in lieu of the binder, is also preferably distributed on the fibers and for this purpose a sprayhead 102, connected by a pipe 104 to any suitable source of adhesive supply (not shown), is mounted adjacent the wall of the collection chamber and substantially above the floor thereof to project a spray of the adhesive into the suspension of fibers as they are carried toward conveyor 83.

In the operation of the apparatus described above and in carrying out the method of the instant invention, the fibrous masses to be treated are deposited in hopper 10. The fibers may be of any suitable type but as previously pointed out, the apparatus and method are particularly applicable to relatively fragile fibers, such as mineral wool fibers, which cannot withstand the conventional openings and cleaning operations of cards, garnetts, and the like. Also, where an end product is desired comprising an intermixture of two different types of fibers such, for example, as organic fibers intermixed with mineral wool fibers, the material deposited in the hopper may constitute a mixture of masses of such fibers.

The fibrous masses are volumetrically metered by the feeder to conveyor 28 and thence are fed into the passageway between perforate wall 34 and the spikes of the spike or picker roll 36 where they are combed and partially disentangled and unfiberized particles and dirt are discharged into dirt box 42. The fibers are then picked up by the airstream created in conduit 44 and carried against the surface of roll 46 under the force of the airstream to form a condensed layer thereon which is carried by the roll past the edge of the suction box and seal roll 52 and discharged into hopper 58. Rotary valve 59 discharges the partially opened fibrous masses at a predetermined rate into conduit 60 leading to the cleaning trunk 64. The fiber masses delivered by the rotary valve are carried through the cleaning trunk at a velocity in the range of 2,000 to 3,000 ft./min. by the positive airstream set up by blower 62. During their passage they are combed and opened by contact with fingers 74 and, at the same time unfiberized particles, dirt and the like are discharged therefrom to fall to the bottoms of the trunk sections and into dirt boxes 72 through the screen mesh forming the outer walls at these points. The airstream continues into conduit 78 and carries the cleaned and substantially opened fibers therewith and discharges them into the upper end of the collection chamber or tower above card rolls 84.

The fibers entering the collection chamber are carried onto the card rolls 84 and pass therebetween for a final opening and fiber individualizing operation. The airstream entering with the fibers passes through the perforate wall of cylinder 86 and into the collection chamber to form an air current flowing past and beyond the card rolls at a greatly reduced velocity, due to the

greater cross-sectional area of the collection chamber as compared to duct 78, in which the fibers discharged by the card rolls are suspended. The air current, decreasing in velocity as it approaches conveyor 83 due to the increased cross-sectional area of the lower section of the collection chamber, carries the fibers toward conveyor 83. Blower 94 is operated by controlling its speed or the volume of air withdrawn by it in a manner to set up a suction in suction box 94 to create only the negative pressure required to overcome the resistance of the passage of air through the forming felt. An area of practically zero static pressure just above the conveyor is thus obtained. This is of primary importance and serves several important functions. It eliminates the necessity of a seal roll at exit port 90, due to the equalized pressure within and without the collection chamber. Also, and of primary importance, the felted web is not compressed or disturbed after it is formed and, hence, is of very low density and is in a lofty state. The process has been used in making felted blankets of bulk densities as low as one-half pound per cu. ft. from conventionally manufactured mineral wool fibers.

Where the finished product is to contain a binder, the unset binder material, preferably a powdered resin such as urea-formaldehyde, phenol-formaldehyde or other resinous or binding material of either the thermoplastic or thermosetting type, may be introduced into the suspension at any point after the fiber cleaning stage. Preferably the powdered binder is introduced at the upper end of the collection chamber through conduit 100 whereby it becomes intimately intermixed with the suspension of fibers and is uniformly distributed in the felted layer collected on the conveyor 83.

In accordance with the preferred practice of the invention, an adhesive material is also applied to the fibers in the suspension before the collection. The adhesive may be of different types but it has been found preferable to use a glycerine solution, for example a 10% glycerine water solution. The purpose of this addition is to impart sufficient cohesion to the fibers to impart the necessary uncured felt bond to enable the lightweight felted web to be lapped and subjected to other finishing operations prior to the setting of the binder. This adhesive must be of such a nature as to not interfere with the cure of the binder, and must not be so sticky as to cause undue adherence of the fibers to the forming chamber walls or to the forming conveyor. The glycerine solution mentioned above has been found to be ideal for this purpose.

Conveyor 83 may be driven at a slow speed to build up a layer of sufficient thickness to produce the final product. However, it is usually found preferable to drive the conveyor at a higher speed to form a relatively thin, lofty felt and build up the felt into a blanket of the desired thickness by a lapping operation. For this purpose the relatively thin felt is delivered to the lapper conveyor and laid in successive folds transversely of conveyor 83. In either case, that is whether the layer is built up to the desired thickness on conveyor 83 or is lapped to provide a blanket of the desired thickness, the blanket may be subjected to any usual or conventional finishing operations to convert it into bonded batts or blankets or into loose wool, nodulated wool, and the like.

It will be appreciated from the above description of the method and apparatus that the instant invention provides for the cleaning and

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opening of mineral wool fibers or other fibers, or mixtures of fibers, and their felting into lightweight, homogeneous products. Fibers of different types may be employed in any proportions to obtain products containing mixtures of fibers, or may be successively put through the machine. The apparatus is versatile in operation and can be adjusted, by controlling the relative rates of movement of the several cleaning elements and of the travel of the fibrous material therethrough, to remove little or the greater portion of the dirt and non-fibrous material, depending upon the type of product desired, and similarly may be adjusted to open fiber clumps or nodules to a greater or lesser degree, depending upon the quality and refinement desired for the finished product. The products obtained are of extremely low density, lightweight and uniformly felted. Due to the gentleness of the opening and cleaning action, the process is not excessively destructive to even relatively fragile and brittle fibers such as mineral wool. The apparatus and method have the further advantage that their operation is not tied directly to the fiber production as is the case in conventional mineral wool manufacture. That is, the mineral wool obtained from the blowchamber of the mineral wool producing apparatus may be stock piled until such time as the cleaning and felting operations are to be performed.

Having thus described our 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 we claim is:

1. In an apparatus for cleaning, opening and felting entangled fibers containing unfiberized particles, means for opening and disentangling the fibers, a cleaning trunk defining an enclosed serpentine path, means for delivering the fibers to the trunk, means for setting up an air current in said trunk to carry the fibers therethrough, a collection chamber, fiber opening means in said collection chamber, means for connecting said trunk and collection chamber to deliver said airstream and said fibers therein above said fiber opening means, an air-pervious conveyor forming a floor of said collection chamber, and air-withdrawal means below said conveyor.

2. In an apparatus for cleaning, opening and felting entangled fibers containing unfiberized particles, means for opening and disentangling the fibers, a cleaning trunk defining an enclosed serpentine path, means for delivering the fibers to the trunk, means for setting up an air current in said tank to carry the fibers therethrough, a collection chamber, cooperating fiber opening rolls in said collection chamber, means for connecting said trunk and collection chamber to deliver said airstream and said fibers therein to said collection chamber above said cooperating fiber opening rolls, an air-pervious conveyor forming a floor of said collection chamber, and an air-withdrawal means below said conveyor.

3. In an apparatus for cleaning, opening and felting entangled fibers containing unfiberized particles, means for opening and disentangling

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the fibers, a cleaning trunk defining an enclosed serpentine path, means for delivering the fibers to the trunk, means within the trunk for further opening the fibers, means for setting up an air current in said trunk to carry the fibers therethrough, a collection chamber, fiber opening means in said collection chamber, means for connecting said trunk and collection chamber to deliver said air-stream and said fibers therein above said fiber opening means, an air-pervious conveyor forming a floor of said collection chamber, and air withdrawal means below said conveyor.

4. In an apparatus for cleaning, opening and felting entangled fibers containing unfiberized particles, means for opening and disentangling the fibers, a cleaning trunk defining an enclosed serpentine path, means for delivering the fibers to the trunk, means within the trunk for further opening the fibers, means for setting up an air current in said trunk to carry the fibers therethrough, a collection chamber, cooperating fiber opening rolls in said collection chamber, means for connecting said trunk and collection chamber to deliver said airstream and said fibers therein to said collection chamber above said cooperating fiber opening rolls, an air-pervious conveyor forming a floor of said collection chamber, and an air withdrawal means below said conveyor.

5. An apparatus for opening, cleaning and felting entangled fibers containing unfiberized particles comprising, means for opening and disentangling the fibers, a cleaning trunk defining an enclosed serpentine path, means for delivering the fibers to the trunk, means for setting up an air current in said trunk to carry the fibers therethrough, a collection chamber, fiber opening means in said collection chamber, means for delivering said fibers to said collection chamber at a region thereof above said opening means, an air pervious conveyor forming a floor of said collection chamber, and air-withdrawal means below said conveyor.

6. An apparatus for opening, cleaning and felting entangled fibers containing unfiberized particles comprising, means for opening and disentangling the fibers and dislodging unfiberized particles therefrom, a collection chamber having coating fiber-opening rolls therein, an air pervious conveyor below said fiber-opening rolls, means including air-current forming means for delivering the fibers to the chamber at a region above said fiber-opening rolls, and air-withdrawal means below said conveyor.

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