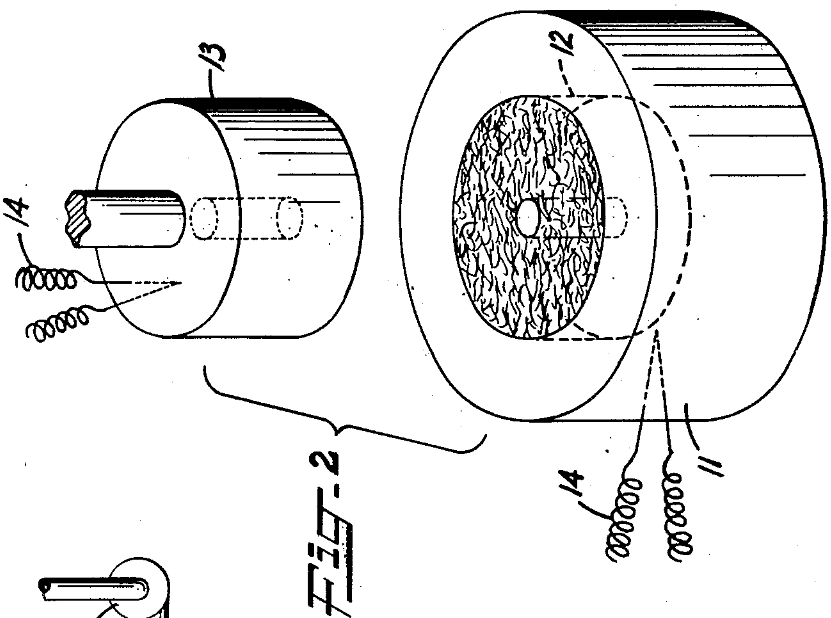
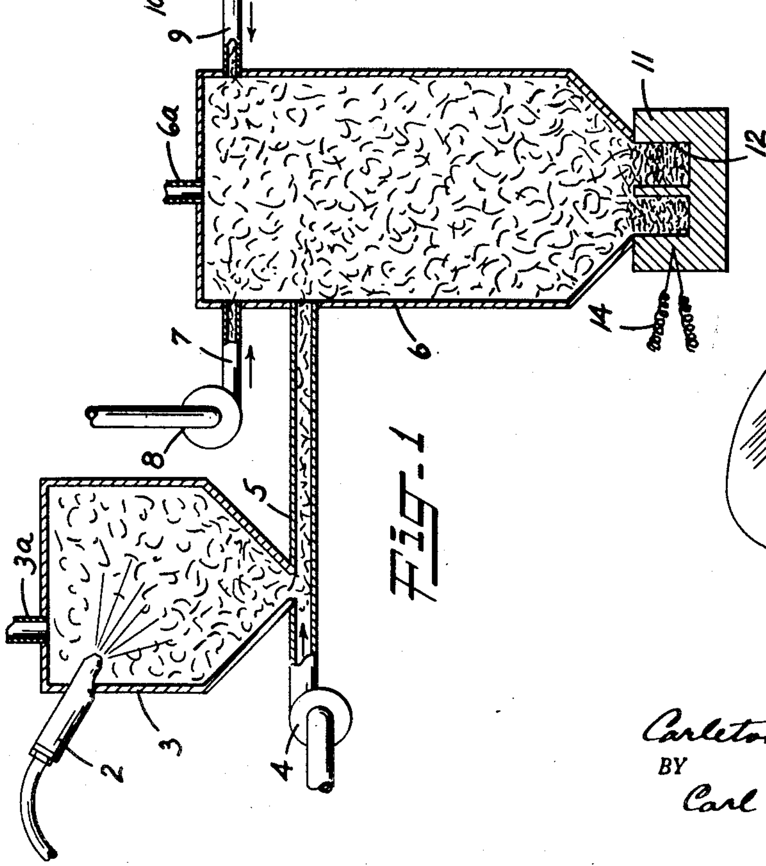
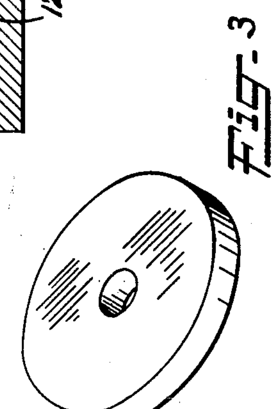
Oct. 31, 1950 C. S. FRANCIS, JR 2,527,628

PROCESS FOR PRODUCING A MATRIX CONTAINING PARTICULATE FILLERS

Filed Sept. 16, 1944 3 Sheets-Sheet 1







INVENTOR.
Carleton S. Francis, Jr.
BY
Carl A. Castellan
ATTORNEY

Oct. 31, 1950 C. S. FRANCIS, JR 2,527,628

PROCESS FOR PRODUCING A MATRIX CONTAINING PARTICULATE FILLERS

Filed Sept. 16, 1944 3 Sheets-Sheet 2

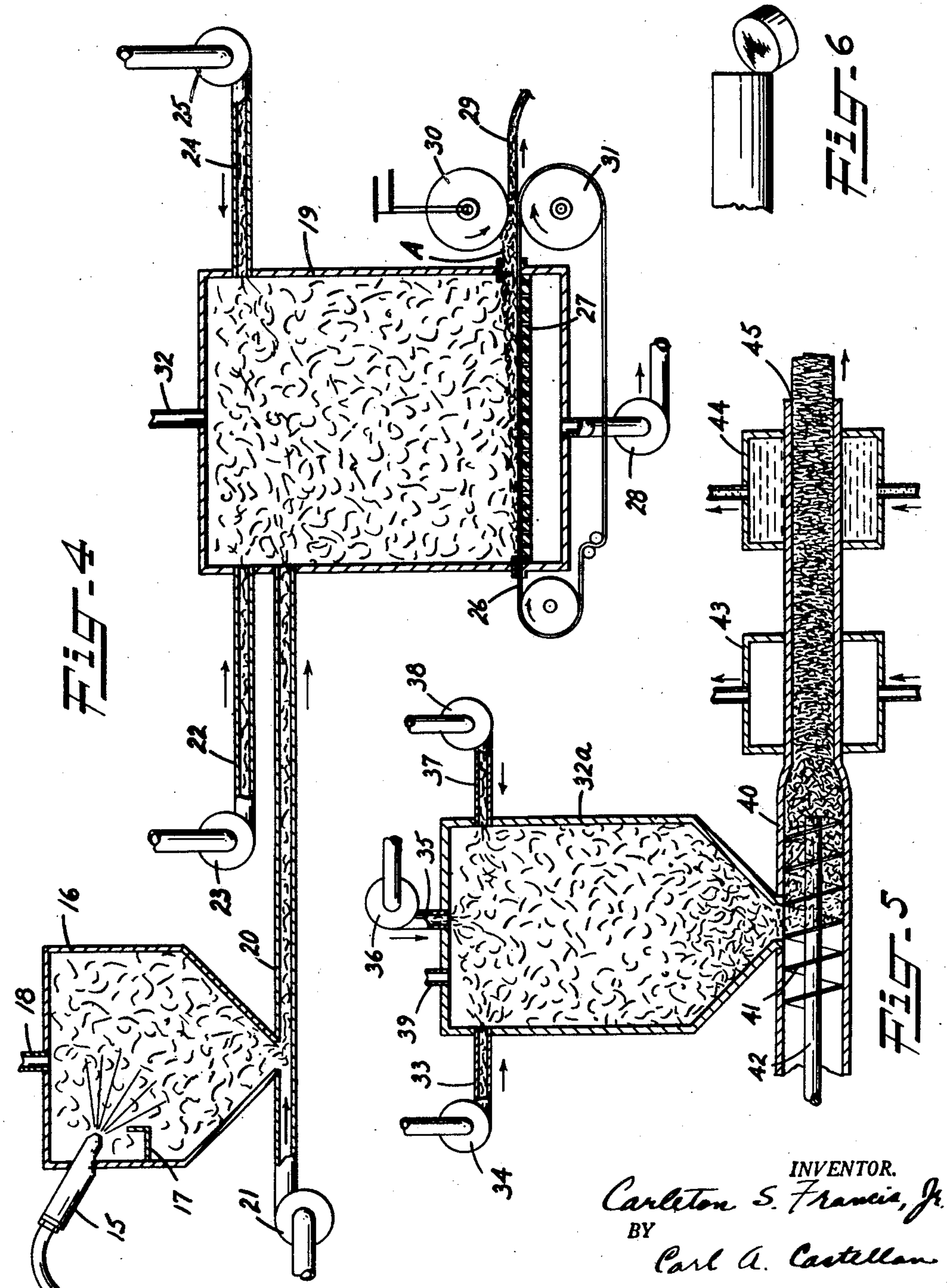


FIG-4

FIG-5

FIG-6

INVENTOR.

Carleton S. Francis, Jr.

BY

Carl A. Castellan

ATTORNEY

Oct. 31, 1950

C. S. FRANCIS, JR

2,527,628

PROCESS FOR PRODUCING A MATRIX CONTAINING PARTICULATE FILLERS

Filed Sept. 16, 1944

3 Sheets-Sheet 3

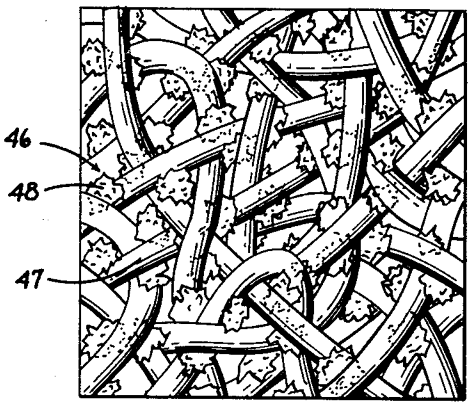


Fig. 7

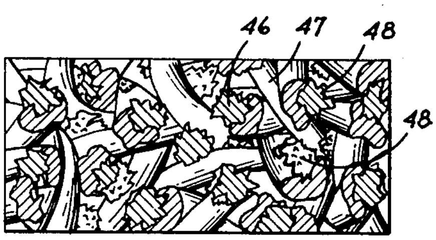


Fig. 8

INVENTOR.

CARLETON S. FRANCIS, JR.

BY

Thomas R. O'Malley

Patented Oct. 31, 1950

2,527,628

UNITED STATES PATENT OFFICE

2,527,628

PROCESS FOR PRODUCING A MATRIX CONTAINING PARTICULATE FILLERS

Carleton S. Francis, Jr., West Harwich, Mass., assignor to American Viscose Corporation, Wilmington, Del., a corporation of Delaware

Application September 16, 1944, Serial No. 554,397

6 Claims. (Cl. 51—297)

1

This invention relates to a process for producing fibrous structures formed from admixtures of non-fibrous particulate filling materials and fibers at least some of which are potentially adhesive fibers which are converted to the tacky state by heat, with or without the aid of solvents.

The present application is a continuation-in-part of my copending application Serial No. 530,953, filed April 14, 1944 and now abandoned. In the said application, I have disclosed fibrous structures formed from at least some potentially adhesive fibers and containing particles of abrasive materials, which serve as fillers. It has also been found that other particulate non-fibrous materials, in addition to abrasive materials, may be incorporated with fibers at least some of which are potentially adhesive fibers, to produce fibrous articles especially molded fibrous articles having variously modified physical properties, such as increased density, improved mechanical and impact strength, resistance to shock and chemical reagents, etc., depending upon the particular type of non-fibrous filling material utilized.

The products produced in accordance with the present invention consist of a matrix of material constituted by a compacted felt-like fibrous structure formed from at least some discontinuous potentially adhesive fibers and having particles of non-fibrous filling materials substantially uniformly distributed therethrough. The products are made by commingling fibers at least some of which are potentially adhesive fibers with particulate non-fibrous filling materials so that the fillers and fibers are thoroughly intermixed and the particles of filler are in contact with the fibers, activating the potentially adhesive fibers to bind fibers in the product, and deactivating the activated fibers to set the fibers and filler particles firmly in their new relationship, the filler particles being securely held in the matrix by the bonded fibers.

The final product may consist wholly of potentially adhesive fibers and particles of filler, but in the preferred embodiment of the invention, the products also contain some non-adhesive fibers.

By "potentially adhesive fibers" are meant fibers which are activatable by heat to a tacky or adhesive condition and which can be deactivated subsequently to the non-tacky state. By "non-adhesive fibers" are meant fibers which, although they may be rendered adhesive by some treatment, are not rendered adhesive under the conditions employed to activate the potentially adhesive fibers with which they may be associated.

2

Among the non-adhesive fibers which may be employed are natural fibres such, for example, as wood fibres, cotton, flax, jute, kapok, wool, hair and silk; and synthetic fibres, such, for example as cellulosic fibres, such as cellulose hydrate, cellulose derivatives, as cellulose esters, mixed cellulose esters, cellulose ethers, mixed cellulose ester-ethers, mixed cellulose ethers, cellulose hydroxy-alkyl ethers, cellulose carboxy-alkyl ethers, cellulose ether-xanthates, cellulose xantho-fatty acids, cellulose thiourethanes; natural and synthetic rubber and derivatives thereof; fibres made of alginic acid, gelatine, casein; and mineral fibres such, for example, as spun glass, asbestos, mineral wool, and the like; and fibres made of natural and synthetic resins which are not rendered tacky; also fibres and filaments made by slitting, cutting or shredding non-fibrous films, such as cellophane.

The potentially adhesive fibers may be composed of a wide variety of materials and may comprise any material capable of being formed into fibers which have an inherent tackiness under conditions such that the non-adhesive fibers are not damaged or rendered tacky, and which are not tacky at room temperature. Examples of the potentially adhesive fibers are thermoplastic fibers, such as those of cellulose acetate or other cellulose esters and ethers, or mixed cellulose esters such as cellulose acetate-propionate, or cellulose acetate-butyrate, in plasticized condition; also resins as, for example, cheap natural resins such as shellac, dammar, copal and the like, and synthetic resins either permanently thermoplastic or thermosetting, but in the thermoplastic state formed by the polymerization or condensation of various organic compounds such as coumarone, indene or related hydrocarbons, vinyl compounds, styrene, sterols, aldehydes, furfural, ketones, urea, thiourea, phenol-aldehyde resins either unmodified or modified with oils, urea-aldehyde resins, sulfonamide-aldehyde resins, polyhydric alcohol-polybasic acid resins, drying oil-modified alkyd resins, resins formed from acrylic acid, its homologues and their derivatives, sulfur-olefine resins, resins formed from dicarboxylic acids and diamines (nylon type); synthetic rubbers and rubber substitute herein called "resins," such for example as polymerized butadiene, olefine poly-sulfides, isobutylene polymers, chloroprene polymers; polyethylene; and fibers formed from a resin comprising the product of copolymerizing two or more resin-forming monomers, such as copolymers of vinyl halide and vinyl acetate, copolymers of vinyl halide and an acrylic acid derivative, copolymers of vinyl compound and styrol compound; and also a mixture of resins, such as a mixture of vinyl resins and acrylic acid resins or methacrylic acid resins, a mixture of polyolefine resins and phenol-aldehyde resins, or a mixture of two or more resins from the different classes just named. There may be employed also fibers made from rubber latex, crepe rubber, gutta percha, balata, and the like. Further, the potentially adhesive fibers may be mixtures of the cellulose derivatives with resin or rubber, such as, for example, a mixture of cellulose nitrate and an acrylic acid resin, a mixture of benzoyl cellulose and a vinyl resin, or a mixture of ethyl cellulose and shellac.

A preferred class of vinyl resin from which the fibers may be formed are the copolymers of vinyl chloride with vinyl acetate or vinyl cyanide, and after-chlorinated copolymers of vinyl chloride and vinyl acetate.

The resins above mentioned may be classified as:

(a) Heat non-convertible resins such for example as glycol polybasic acid resins, vinyl resins (particularly those of the preferred class above) and the acid type phenolaldehyde resins, and the like.

(b) Heat-convertible or thermosetting resins such for example as glycerol-polybasic acid resins, polyolefine resins, phenol-aldehyde resins and the like.

(c) An element-convertible resin (which becomes infusible through the action of certain elements, such as oxygen and sulfur) such for example as glycerol-polybasic acid-drying oils, resins, and olefine-sulfur resins.

The choice of non-fibrous filler for incorporation with the fibers will be determined entirely by the purpose to which the final product is to be put, as the filler will, of course, have a determinable effect on the physical properties of the final article. Thus, the filler may serve simply to fill in the interstitial spaces between fibers in the product, thereby increasing the density of the product and also increasing its mechanical and impact strength; or it may also improve the product in other respects, for instance, as regards the conductivity of the product for heat or electricity; its resistance to shock or chemical reagents; its abrasiveness etc. The fillers may consist of such substances as asbestos powder, mica, sand, rotten stone, clay, brick dust, diatomaceous earth, talcum, slate powder, etc. Pigments may also be used such as chromium oxide, titanium oxide, iron oxide pigments, barium sulfate, carbon black, graphite, zinc oxide, etc. Further, the filler may be a special absorbent substance such as activated magnesium silicate, active carbon, silica gel, activated alumina, fuller's earth, activated bleaching clay, activated bauxite, French chalk, or the like.

A particular feature of the invention is that it permits the production of abrasive and polishing devices which have special attributes. For this purpose, as described in the aforementioned copending application, any of the abrasive materials in common use may be employed as fillers, such as silicon carbide, diamonds, boron carbide, fused aluminum oxide, flint, pumice, corundum, emery, rouge, and similar substances. The size of the abrasive particles may vary from the finest polishing or buffing powder to the coarser grit sizes used in grinding.

One method of commingling the fibers and particulate filling material is to impel the fibers and particles of filler by blowing them with air or any other gaseous or vaporous, but preferably gaseous medium, into a common mixing and depositing chamber. The fibers and particles in suspension in the aeriform current are thus agitated and whirled about in a confined space, so that they freely mix and intermingle, after which they are permitted to settle out on a collecting device. The thus freely intermixed fibers and particles fall upon the collecting device in such a manner that the filler is substantially uniformly distributed throughout the fibers. When the mixed product is compacted, as by molding it to the shape required, at appropriate temperatures, the particles of filling material are firmly held uniformly throughout all parts of the product by the bonded fibers.

The discontinuous fibers may be formed in any manner, as by cutting previously formed continuous filaments to the desired lengths. Also, in the case of the potentially adhesive fibers, they may be formed by dispersing a potentially adhesive fiber-forming material, while in a flowable condition, that is, in solution, plastic, or molten condition, into a setting fluid, e. g. a liquid or a gaseous atmosphere under sufficient pressure to form a multiplicity of fibers, as taught in my copending application Serial No. 381,292, filed March 1, 1941 (now Patent No. 2,357,392). In such case, the association of the non-adhesive fibers and the particles of filler with the potentially adhesive fibers may take place concurrently with the formation of the latter, that is, the potentially adhesive fibers may be formed and associated with the particles and non-adhesive fibers in immediate sequence, without permitting the potentially adhesive fibers to settle before association. The association of the fibers and filler may take place either in the chamber or confined space in which the potentially adhesive fibers are formed, or in a chamber which is separate from but connected with the chamber in which such formation is effected.

If the potentially adhesive fibers are produced as taught in my copending application Serial No. 381,292, the fibers produced may be independent and separable one from another or they may adhere to one another at spaced points to form a more or less reticulated fiber structure or web, depending on whether the fibers are tacky due to their temperature or the presence of residual solvent when the fibers contact each other in settling out from the fluid dispersion. Furthermore, the particulate filling materials may adhere to such tacky fibers and when non-adhesive fibers are also employed, the tacky potentially adhesive fibers may adhere to such other fibers as well as to themselves.

The fiber-forming material from which the fibers are produced may contain added agents for obtaining special effects. For example, the fiber-forming material for the potentially adhesive fibers may contain hardening agents in the case of resins; while the fiber-forming material for either the potentially adhesive or the non-adhesive fibers may contain latent activating agents, dyes, pigments, plasticizers, etc.

After association of the fibers and non-fibrous filler particles, and collection thereof, the product is compacted and the potentially adhesive fibers are activated by heat or solvent to effect a firm binding of the fibers and filler particles, the filler particles being held together by the compacted bonded fibers. After activation and compaction, which operations may be carried out simultaneously, the product is deactivated to render the adhesive fibers non-tacky, so as to fix the fibers and non-fibrous filler particles in the new relationship. If activation has been accomplished by heat, deactivation may be accomplished by heating for a prolonged period, or to a higher temperature in the case of thermosetting resins, or by cooling; and if activation is by means of a solvent, deactivation may involve extraction of the solvent as by washing, evaporation, or decomposition.

The mixed fibers and non-fibrous filler particles may be shaped to the desired form in any suitable manner, concomitantly with activation of the potentially adhesive fibers. Thus the mixture may be collected directly in a mold and subjected to a molding step under heat and pressure, or it may be continuously forced through a heated extrusion device to produce rods and tubes having any desired cross-section, for example, circular or oval. Further, the mixed fibers and non-fibrous filler particles may be collected in the shape of a mat or bat and after activation, compaction, and deactivation may be cut to any convenient size, or if only subjected to a low degree of activation merely to facilitate handling, the mat or bat or segments thereof may be subjected to further activation in an appropriate molding or forming apparatus.

The temperature at which the molding or shaping operation is effected will depend upon the type of fibers utilized and the properties desired in the final article. Preferably, the molding or shaping operation is effected at a temperature which is sufficient to convert the potentially adhesive fibers to a tacky condition, but insufficient to cause them to flow, so that in the final article the particles of filling material are held together by a binder which is essentially in fiber form.

The present invention may be adapted to the production of compacted fibrous structures comprising particles of non-fibrous filling material and fibers of any suitable length, but is of special advantage when either or both the potentially adhesive and non-adhesive fibers are of shorter than average length, that is, fibers which are less than normal cardable or feltable length and which cannot be combined and consolidated together by conventional methods. The fibrous material may be such as is generally considered waste, including "wool flock," "shear flock," cotton linters, the short fluffy waste thrown out of carding and/or combing machines, the waste from reeling, warping, winding, weaving, and cop bottoms, the waste from slubbing, roving and wool tops, and in fact all short fibers and fibrils which do not usually find use in the manufacture of commercial products. Thus, molded devices of very great density and strength may be produced most economically since they may comprise such waste materials, and due to the admixture of the fibers with the non-fibrous filler particles prior to activation of the potentially adhesive fibers, do not require activation of the potentially adhesive fibers to a flowing condition.

The invention is particularly adapted for the production of various types of abrasive and polishing devices suitable for abrading purposes, as for grinding, polishing, buffing, or like operations. Abrasive devices heretofore available have had the disadvantage that the abrasive particles are deposited on or through a fabric or other support by binding agents consisting of resin or other plastic materials in liquid form, the binder being cured or hardened after application thereof to the support, with the result that the abrasive particles are completely covered by the hardened binder which forms a coating or surface glaze on the particles and fills up the crevices and irregularities in the surfaces of the particles upon which dependence is placed for the abrading and polishing effect. In such previously known devices, the coating or film of binder material which obscures the abrasive particles is first brought into contact with the work and must be worn down by rubbing before the abrasive material is made available. This causes both the polishing device and the work to heat up above normal, resulting in smearing of the binder and a "hot cutting" or burning action which is deleterious to the finish being produced. Also, such heating up makes the binder in the device messy and gummy, necessitating frequent steaming of the device in order to clean it. Further, when liquid binding agents are used, a very uneven deposition of the abrasive particles on or through the support results, and as the hardened binder is worn down, surfaces of varying degrees of abrasiveness are continually presented to the work.

The abrasive and polishing devices of the present invention consist of abrasive particles substantially uniformly distributed throughout and securely held in a matrix of material constituted by a compacted felt-like fibrous structure comprising at least some discontinuous potentially adhesive fibers, which fibers have been activated to a condition in which they are tacky but do not flow to form a film. The abrasive particles are partially imbedded in or studded on the fibers and are adhered thereto and firmly held in the product due to the bonding of the potentially adhesive fibers.

Abrasive devices produced in accordance with this invention distinguish over similar devices in which liquid or powdered adhesives or binding agents are utilized, in that the new devices of the invention are characterized by the fact that a surface of each abrasive particle is free and uncoated and protrudes from the bonded fibers so that when the device is in use a keen abrading or polishing edge is directly and continuously presented to the work. The new devices have the added advantage that they have a cool, free, grinding or buffing action and do not heat up above normal in use, and do not unduly heat the work, and consequently do not smear or deposit difficultly removable fragments of softened binding material on the work. As the abrasive device is worn down, new abrasive particles are exposed, and due to the uniformity of their occurrence in the device, the surface presented to the work has the same degree of abrasiveness throughout the entire polishing or finishing operation. The devices are easily cleaned by means of an emery stick, for instance, or in some cases, by simply wiping them with a suitable solvent.

Abrasive devices of all types may be produced by means of the invention, including grinding and polishing wheels, flexible or non-flexible abrasive disks, sanding and polishing belts, blocks, pads, and other shapes. Mats or bats comprising potentially adhesive fibers and abrasive particles, which have been activated, compacted, and deactivated, may be cut into squares or sections of any other shape to be used in a manner similar to sand-paper or emery cloth, or they may be cut into narrow strips for various purposes. For example, such mats or bats, or segments thereof, may be glued or otherwise attached to a hand block or the like. Short lengths or pieces of the abrasive products may be placed in a tumbling barrel with articles which are to be finished, in order to cut down edges or to otherwise polish or finish the exterior of the articles.

Whether the abrasive device will possess a hard abrading action, or a softer action, will be determined by whether or not the fibers utilized are exclusively potentially adhesive fibers. Thus, if the matrix consists wholly of potentially adhesive fibers, the device has a relatively hard abrading action and is suitable for coarse cutting, polishing, or finishing, whereas, if non-adhesive fibers, such as wool flock, for example, are also present, the device has a softer abrading action and is suitable for use when a very fine polish or finish is desired. It is also possible, by appropriate selection of the fibers utilized, and the molding or activating temperature, to control the porosity of the abrasive device so as to provide clearances for the object being abraded or buffed.

Although the invention is of special merit in the manufacture of novel abrasive and polishing devices, it is not limited thereto, and instead of abrasive particles other filling or pigmenting materials, in subdivided form, may be admixed with the potentially adhesive fibers, and with non-adhesive fibers if desired, to obtain products having special characteristics. Thus, devices such as washers, caster wheels, wheels for vacuum cleaners, carpet sweepers or the like, which are extremely dense and well-compacted, and which exhibit a high degree of mechanical and impact strength, may be obtained very inexpensively, without requiring the use of large amounts of the relatively expensive fibers. The quantity of fibrous material utilized, and the relative proportion of potentially adhesive fibers to non-adhesive fibers may be varied within wide limits, of course, but generally speaking, it is possible, by means of the invention, to obtain the desired results by the use of only comparatively small amounts of fibrous material in combination with non-fibrous filler particles. The use of graphite or similar lubricious type of particle yields products which can be used as "oil-less" bearings, washers, packings, etc. For this purpose, the potentially adhesive fibers are preferably of thermosetting character to prevent softening of the bearing because of heat developed during use.

For a more detailed description reference should be made to the accompanying drawing. The potentially adhesive fibers may be produced by spraying the fiber-forming material by means of spray gun 2 into chamber 3 (Figure 1) from which the fibers are blown by blower 4 through pipe 5 into the common mixing chamber 6, the volatile solvent being exhausted from chamber 3 through screened-vent *3a* by means of a suction device (not shown). The filling material in the subdivided state, may be simultaneously blown into chamber 6 through pipe 7 by blower 8. At the same time non-adhesive fibers may be blown into chamber 6 through pipe 9 by blower 10. The fibers and filler particles are intimately commingled in chamber 6, air being exhausted from the chamber through screened-vent *6a*. The base of chamber 6 is preferably tapered as shown and the bottom closed by a removable mold 11 having a suitable cavity 12 which may or may not be provided with a centrally disposed hollow passage. After the commingled fibers and filler particles are deposited in cavity 12, the mold is removed from chamber 6 and a male mold 13 (see Figure 2) which may or may not have a centrally disposed projection, is pressed upon the assembled fibers and particles, both molds being heated in a convenient manner. The mass of fibers is pressed into a permanent form of the shape of the mold. Heat sufficient to cause softening of the potentially adhesive fibers without flowing thereof may be supplied to molds 11 and 13 by means of flame, a hot water jacket (not shown), or by means of electric heating coils 14 embedded in the molds. As a result of the heat and pressure, the potentially adhesive fibers are converted to the tacky state and all of the fibers are firmly compacted to hold the particles of filler together. After the product has been molded by heat and pressure, it may be deactivated to convert the activated fibers to the non-tacky condition. The apparatus shown in Figure 1 results in the production of wheels or disks such as shown in Fig. 3, and which may have any desired diameter and thickness. By substituting molds of appropriate configuration for the circular mold shown in Figures 1 and 2, the device may be obtained in any desired form.

When using the apparatus shown in Figure 4, the composition suitable for forming potentially adhesive fibers is dispersed by means of spray gun 15 into a gaseous atmosphere contained in chamber 16. Any material which is not formed into fibers is caught on shelf 17 and may be removed at intervals. Solvent is removed from chamber 16 through screened vent 18, by means of a suction device (not shown). The potentially adhesive fibers thus formed are withdrawn from chamber 16 and blown into chamber 19 through pipe 20 by blower 21. Simultaneously, particles of filler material are blown into chamber 19 through pipe 22 by blower 23 and, at the same time, a multiplicity of non-adhesive fibers are blown into chamber 19 through pipe 24 by blower 25. The fibers and particles are thoroughly intermixed before settling out. The mixed fibers and particles then come to rest on the surface of an endless belt 26 made of a flexible material such as textile, metal, leather, or the like, which belt is preferably positioned in a horizontal plane at the base of chamber 19 and serves as a collecting surface.

Preferably belt 26 is provided with a multiplicity of small uniformly distributed perforations and runs over a similarly perforated false bottom or screen 27. A suction pump 28 is connected to the region below the belt in chamber 19, to create a down draft through belt 26 as it passes through the chamber. The mat 29 is carried on the belt from the chamber and through pinch rolls 30 and 31 which compress or compact the mat and enable it to be removed from the belt for completing compaction of the mat and for activating the potentially adhesive fibers to a tacky state. If the potentially adhesive fibers are thermoplastic, the rolls 30 and 31 may be heated to effect the desired activation of the thermoplastic fibers, the activated fibers being deactivated when mat 29 passes from the rolls and becomes cool. Air may be permitted to escape from chamber 19 through a screened exhaust pipe 32 if the suction pump is not used. When potentially adhesive fibers which are activatable by means of an organic solvent are used, the solvent may be sprayed on the mat 29 as it is carried on the belt, as at point A, so that the fibers are in the desired adhesive condition when passing through the pressure rolls 30 and 31.

Articles in accordance with the invention may also be obtained in the form of rods, tubes, etc., by continuously extruding the mass comprising the fibers and filler particles through a suitable extrusion device, means being provided along the path of travel of the mixture through the device to heat the mass and effect activation of the potentially adhesive fibers. When the fibers are thermoplastic, means may also be provided along the path of travel of the mass through the extrusion device to deactivate the activated fibers. For example, when using the apparatus shown in Figure 5, thermoplastic potentially adhesive fibers are blown into chamber **32a** through pipe **33** by blower **34**; non-adhesive fibers are blown into the chamber through pipe **35** by blower **36**, and particles of filling material are simultaneously blown in through pipe **37** by blower **38**, air being exhausted from chamber **32a** through screened vent **39**. The mixed fibers and other filler particles drop into a tube or compression chamber **40**, provided with a worm-type feed **41** having a driving shaft **42**. The mixture is forced through chamber **40**. As it travels along the path defined by the chamber, the mass passes through a heating zone **43** which is supplied with heat in any suitable manner, as by means of steam, or circulating hot air, or the device may be heated by means of high frequency electric current, the temperature in any case being adjusted with respect to the time required for the mass to pass the heating zone so as to insure that the potentially adhesive fibers are activated to a tacky nonflowing condition. After it passes the heating zone and travels along the tube **40**, the mass passes through a cooling zone **44** which is supplied with cold water, cooled air, etc. to deactivate the activated fibers and bind fibers and filler particles in the product. After emerging from the cooling zone, the product passes continuously through extrusion orifice **45** in the form of a compacted rod-like structure, which may be cut to convenient sizes as desired.

It has not been recognized, previously, that fibrous masses comprising at least some potentially adhesive fibers can be molded by extrusion molding methods. Within the purview of my invention, I have discovered that such molding methods may be employed and are peculiarly advantageous for the production of articles having a cylindrical or tubular configuration.

In many instances it may be desirable to mold fibrous masses comprising potentially adhesive fibers by extruding the same through a molding device of the type shown in Figure 5, since in this manner it is possible to obtain devices in which fibers are firmly bonded to hold the filler particles in place therein, while at the same time the product is characterized by more uniform density, the product being subjected to a readily controllable amount of compacting due to the uniform configuration of the extrusion device throughout. An abrasive device having a circular cross-section and obtained by extruding a mass of fibers containing abrasive particles in accordance with my invention is shown in Figures 6, 7, and 8. Figure 7 is a face view of an abrasive article, greatly enlarged, and Figure 8 is a view of the article in cross-section.

When the potentially adhesive fibers in the dense felt-like mass are activated to a softened condition, as by heating the mass to the softening temperature for the potentially adhesive fibers, and the mass is compacted, the fibers are bonded together at their points of crossing. As shown in Figures 7 and 8, the abrasive granules

46 are held between the autogenously bonded fibers **47**, the particles being imbedded in the fibers with a free uncoated surface of each particle, designated by the numeral **48**, projecting from between the bonded fibers. The particles thus imbedded in the bonded fibers remain firmly fixed in position until they are presented to the work, as the article is worn down in use.

The following example is given to illustrate a specific embodiment of the invention.

Example

33⅓% of wool flock and 33⅓% of fibers formed from a copolymer of vinyl acetate and vinyl chloride were intermingled with about 33⅓% of finely powdered pumice, by blowing the fibers and pumice together. The resulting mixture was collected in a mold and pressed for six minutes at a temperature of 260° F., with a pressure of 4,000 lbs./sq. inch. An abrasive wheel was obtained in which the abrasive particles were uniformly distributed throughout and firmly held together in a matrix constituted by the wool flock and copolymer fibers.

Since changes may be made in practicing the above invention without departing from the spirit and scope thereof, it is to be understood that the foregoing description and specific example are illustrative only, and the invention is not to be limited except as defined by the appended claims.

I claim:

1. A method of producing a felt-like compacted fibrous structure which comprises the steps of associating particles of filler material and discontinuous fibers at least some of which are potentially adhesive fibers, activating the potentially adhesive fibers to a softened non-flowing condition, and compacting the product while the fibers are in activated condition to produce a product in which the fibers are autogenously bonded together at their points of crossing, and each filler particle throughout the product is partially imbedded in and held by the potentially adhesive fibers, the portion of each filler particle not imbedded in said fibers having a free, uncoated surface.

2. A method of producing a felt-like compacted fibrous structure which comprises blowing particles of filler, discontinuous potentially adhesive fibers, and discontinuous non-adhesive fibers together in a confined space, collecting the mixed fibers and non-fibrous particles, and molding the mixture to a pre-determined shape at the softening temperature for the potentially adhesive fibers, to produce a product in which the fibers are bonded together at their points of crossing, and each filler particle throughout the product is partially imbedded in and held by the potentially adhesive fibers, the portion of each filler particle not imbedded in said fibers having a free, uncoated surface.

3. A method of producing a felt-like compacted fibrous structure which comprises dispersing into a fluid medium a potentially adhesive fiber-forming material to form a multiplicity of discontinuous adhesive fibers, associating said fibers, concurrently with their formation, with particles of a non-fibrous filler, heating the mixed fibers and particles to the softening temperatures for the potentially adhesive fibers, and compacting the product while the fibers are in the softened condition, to produce a product in which the fibers are autogenously bonded together at their points of crossing, and each filler particle throughout the product is partially imbedded in and held by

the potentially adhesive fibers, the portion of each filler particle not imbedded in said fibers having a free, uncoated surface.

4. A method of producing a felt-like compacted fibrous structure which comprises blowing particles of filler and fibers at least some of which are potentially adhesive fibers together in a confined space, and heating the mixture to the softening temperature for the potentially adhesive fibers while continuously forcing the mixture through an extrusion molding device, to produce a product in which the fibers are autogenously bonded together at their points of crossing, and each filler particle throughout the product is partially imbedded in and held by the potentially adhesive fibers, the portion of each filler particle not imbedded in said fibers having a free, uncoated surface.

5. A method of producing a felt-like compacted abrasive device which comprises blowing abrasive particles, discontinuous potentially adhesive fibers, and discontinuous non-adhesive fibers together in a confined space, collecting the mixed particles and fibers, and molding the product at the softening temperature for the potentially adhesive fibers, to produce a product in which the fibers are autogenously bonded together at their points of crossing, and each filler particle throughout the product is partially imbedded in and held by the potentially adhesive fibers, the portion of each filler particle not imbedded in said fibers having a free, uncoated surface.

6. A method of producing a felt-like compacted abrasive device comprising the steps of blowing abrasive particles, wool flock, and fibers formed from a copolymer of vinyl chloride and vinyl acetate together in a confined space, collecting the mixed abrasive and fibers, and molding the product at a temperature to activate the potentially adhesive fibers to a softened non-flowing condition, to produce a product in which the fibers are autogenously bonded together at their points of crossing, and each filler particle throughout the product is partially imbedded in and held by the potentially adhesive fibers, the portion of each filler particle not imbedded in said fibers having a free, uncoated surface.

CARLETON S. FRANCIS, Jr.

REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
Re. 10,794	Randolph	Jan. 4, 1887
Re. 17,372	Morris	July 9, 1929
292,452	Wallace	Jan. 22, 1884
299,109	Brigham	May 27, 1884
942,699	Baekeland	Dec. 7, 1909
942,700	Baekeland	Dec. 7, 1909
2,154,185	Robie	Apr. 11, 1939
2,168,288	Fischer	Aug. 1, 1939
2,306,781	Francis, Jr.	Dec. 29, 1942
2,369,583	Lucid	Feb. 13, 1945
2,375,585	Rimer	May 8, 1945
2,379,166	Lucid	June 26, 1945
2,411,660	Manning	Nov. 26, 1946
2,413,551	Englund	Dec. 31, 1946