

Dec. 2, 1952

I. J. NOVAK ET AL

2,620,320

PRODUCTION OF FRICTION MATERIAL

Filed Feb. 8, 1950

Fig. 1.

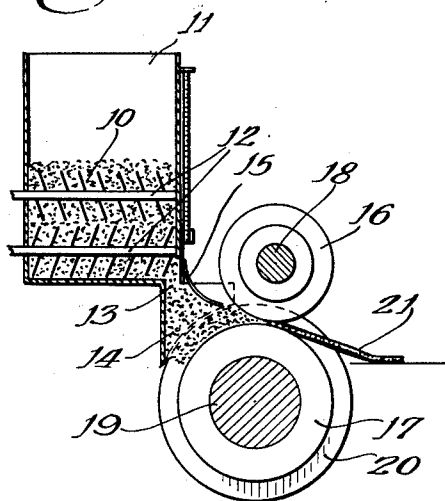


Fig. 2.

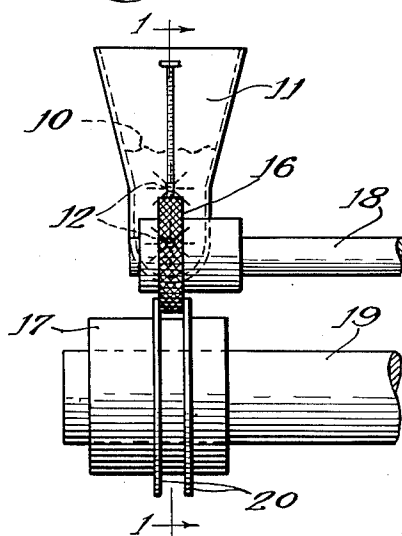


Fig. 3.

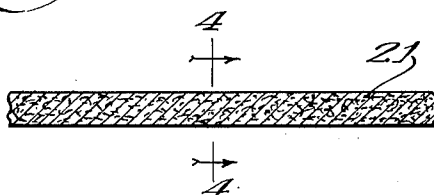


Fig. 5.

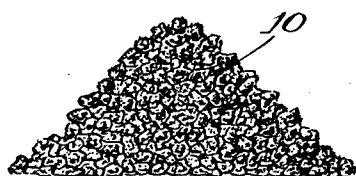
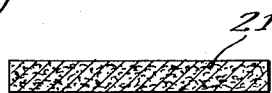


Fig. 4.



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2,620,320

PRODUCTION OF FRICTION MATERIAL

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Application February 8, 1950, Serial No. 143,124

4 Claims. (Cl. 260—23.7)

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This application is a continuation-in-part of our copending application Serial No. 22,278, filed April 21, 1948, which in turn is a continuation-in-part of our application Serial No. 598,423, filed June 18, 1945, which was co-pending therewith and is now abandoned.

This invention relates to improvements in the production of friction material suitable for use as brake linings, clutch facings and the like.

The present invention is particularly directed to a novel composition for the production of such friction material, and to the method of producing such material by compacting and shaping the composition in continuous strip form by rolling.

More specifically, our invention relates to improvements in the production of friction materials of a class which has heretofore been known as "wire-back linings," and the present invention is characterized by the ability to dispense with, and the elimination of the former requirement for reinforcement, such as by means of wire backing.

In the production of friction materials, such as brake linings of the class herein contemplated, and to which our improvements are directed, there is first formed a non-tacky mix comprising short asbestos fibers, binder comprising rubber material and which may include drying oil, together with solvent for the binder. The solvent must be adequate in amount to dissolve the binder and to permit good distribution thereof over the asbestos and fillers which may be included in the mix, but at the same time the solvent should be limited to such an amount that the mix will not be of a wet, sloppy or lumpy nature, but rather in the form of relatively dry, granular particles which can be fed by gravity to the next succeeding step, and there compacted and shaped to a dense composition, which will have a minimum of shrinkage and which will not require further compacting or condensing. The succeeding step comprises compacting and shaping the granular mass by flowing it by gravity between a pair of oppositely rotating laterally confined rotating surfaces whereby to shape the material in a continuous strip form and to simultaneously compact it to high density, the product thereafter requiring only evaporation of its relatively low amount of solvent content and binder cure, but no further compaction.

It will thus be understood that the composition of the present invention is distinguished from those employing relatively high proportions of solvent to form plastic mixes and the process of shaping such mixes by extrusion through a nozzle, since such composition and process results in soft oversize strip material

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which requires further rolling or condensation after evaporation of the solvent if it is desired that the end product be of a dense nature and to bring it to desired dimension.

In the known prior relaxed, but non-equivalent practice of producing friction material in continuous strip form by simultaneous rolling and compacting, to which the improvements of the present invention are directed, the amount of rubber material which could be included as binder was limited to about 1% or less by weight of the solids of the entire mix due to the high requirement of solvent to produce a conventional rubber cement, and due to the necessary limitation or permissible proportion of solvent in the mix. That is to say, the total amount of binder solvent in a mix of the class herein contemplated should not exceed approximately 15% by weight of the solids of the mix.

Attempts to incorporate more than such small quantities of rubber required incorporation of more solvent to result in mixes which were too wet for satisfactory handling or in lumps of very soft stock which could not be properly compacted and shaped between rolls because of slippage away from the roll nip and, further, the use of excessive or high solvent proportion results in much shrinkage and subsequent distortion of the friction material when cured. Since the permissible amount of solvent which might be introduced was thus limited to result in an asbestos-binder mix of the character described, the subsequently extruded strip material was characterized by relatively poor cohesion in both the green and cured states due to necessarily low and ineffective rubber binder solids content. Thus, conventionally in the production of such brake linings, it was heretofore necessary to support and strengthen the structure by incorporating therewith during the roll shaping and compacting step, reinforcement means, such as wire mesh or the like reinforcement, to strengthen the structure during manufacture to not only permit it to be handled in the intermediate processing steps but to give strength to the final product and, further, to hold rivets when applied to prevent sliding on the rivets when in use.

In accordance with the present invention, we have been able to produce friction material of the general class, composition and method heretofore described, but of an improved character and by a more economical method, and which has such strength in both the green and cured states that it does not of necessity require wire mesh or other support for reinforcement.

We generally accomplished the objects of the

present invention by employing as the binder peptized rubber material as an effective or appreciable component of the binder or as the sole binder component together with solvent therefor. The term "rubber material" as used hereinafter in the specification and claims is intended to include both natural rubber and the synthetic rubbers which are well known in the art, examples of which will be hereinafter described. The term "peptized," as employed hereinafter in the specification and claims, is intended to include rubber materials, either natural or synthetic, which have been treated to subject them to what is sometimes referred to as "degradation," "fluidification," "degeneration," "depolymerization," "disaggregation," "oxidoplasticization," and the like, all well known in the art and being, for example, described in *Chemistry and Technology of Rubber*, Davis and Blake, 1937.

By employing such peptized rubber materials, we are able to produce cements with high solids concentration and, conversely, low solvent requirement as compared to unpeptized rubber materials. By this means, we are enabled to incorporate rubber solids in the proportions of from about 3 to about 15% by weight of the friction material composition while employing and limiting the binder solvent to from about 5 to about 15%, by weight of the total friction material composition solids. For example, by employing peptized rubber materials from about 3 to about 15% by weight of the friction material composition, the solvent requirement to reduce the rubber to cement is of such relatively small proportion as to permit the production of a granular flowable mass of friction material mix which is not too wet or lumpy to be handled, and at the same time a great advantage results in that the mix may be compacted and shaped by the conventional roll extrusion means without the requirement for reinforcement, such as wire mesh or the like means, and the shaped material is self-supporting and has strength both in the green state and in the final cured state due to the ability to incorporate an enhanced, effective amount of rubber binder. The proportion of solvent required by the peptized rubber materials to produce smooth cements therewith is such as to be equivalent to the production of cements of about 30 to 60% concentration. In order to be effective in the production of compositions of the class and by the means aforesaid, we have found that the proportion of rubber to solvent is such that cements produced therefrom have a viscosity at 60° F., five seconds, of 15 to 30 millimeters, as determined by a Humboldt Penetrometer, modified so as to have no loading on the needle, although we prefer to employ a penetration range of 20 to 25 millimeters by this method. At such viscosity the resulting cement is adequate to become uniformly distributed throughout the friction material composition and to permit production thereof in the form of a relatively dry, granular, free-flowing mass which can be effectively employed by the means hereinbefore generally described and as more specifically pointed out hereinafter.

The accompanying drawings further diagrammatically illustrate our invention.

Fig. 1 of the drawings is a diagrammatic sectional elevation of a roll apparatus employed in the production of friction materials of the class to which the present invention is directed.

Fig. 2 is a fragmentary front elevation of the roll apparatus.

Fig. 3 is a fragmentary side elevation of a strip of extruded friction material formed in accordance with the apparatus shown in Figs. 1 and 2.

Fig. 4 is a section on the line 4—4.

Fig. 5 diagrammatically illustrates a mass of granular friction composition material mix prior to introduction into the apparatus in Figs. 1 and 2.

In the practice of our invention, we may employ either natural rubber or various known, so-called synthetic rubbers, such as, for example, GR-S (butadiene-styrene copolymer), Buna N (Butadiene-acrylonitrile copolymer), neoprene (2-chloro-1,3-butadiene) and the like butalastic polymers. These are employed in peptized form, as previously indicated. As is well known in the art, peptization may be brought about by various means known to the art, such as, for example, by employment of catalysts, oxidation and other means. One effective method is to employ as the peptizing agent, phenylhydrazine (accompanied by oxidation), xylol mercaptan, or copper salts such as copper oleate. Peptization may also be accomplished by air oxidation with the aid of heat, or by oxidation of natural rubber by "dead milling," that is, breaking it down until there is no further change in its viscosity. One example of a suitable synthetic rubber is Standard GR-S, 60 Mooney, mixed with about 2% by weight of phenylhydrazine and oxidized in the atmosphere until the phenylhydrazine has exerted its maximum effect and which, upon remilling, results in a 20 Mooney plasticity.

While it will be understood that we may employ various peptized rubber materials in the practice of our invention, they are not all fully equivalent. Thus, for example, a cement of about 30% concentration within the viscosity range hereinbefore specified, may be formed by dissolving dead milled natural rubber in an aromatic solvent. Suitable cements of as high as 60% concentration may be formed when employing GR-S peptized by means of agents such as phenylhydrazine, xylol mercaptan or copper oleate and thereafter dissolving them in an aromatic solvent such as mineral spirits or gasoline. A cement of about 35% concentration may be formed by employing neoprene, peptized by means of phenylhydrazine or xylol mercaptan and dissolving it in an aromatic solvent such as toluene. A cement of about 30% concentration may be formed of Buna N, peptized by treatment with phenylhydrazine, and followed by solution in a ketone solvent.

We may employ a binder composition comprising peptized rubber material together with other binder ingredients, consisting essentially of bodied or unbodied drying oils, such as bodied, synthetic or natural drying oil such as bodied China-wood oil, linseed oil bodied by blowing and/or heat, etc.

In forming the friction composition, we may employ as solids from about 15 to about 30% by weight of the foregoing binder solids including peptized rubber material providing said composition with from about 3% to about 15% by weight of said rubber together with about 50 to about 75% by weight of predominately short asbestos fiber and from 0 to about 35% of organic or inorganic friction material agents and fillers of conventional type. Vulcanization or hardening of the peptized rubber material or peptized rubber material-oil binder may be effected by use of sulfur, accelerators, etc., or other vulcan-

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izing or hardening ingredients, in the manner necessary for the particular binder employed. The binder solvent incorporated with the foregoing is from about 5 to about 15% by weight of the total solids.

The following examples are given for the purpose of illustration but not limitation of general formulations suitable for preparation of brake linings in accordance with the present invention, the proportions being in percentage by weight:

	1	2	3	4
Short Asbestos Fiber.....	60.75	60.45	60.20	55.50
Drying Oil.....	0.08	11.78	14.96	17.52
Peptized Rubber Binder.....	10.68	6.31	6.27	3.41
Solvent for Binder.....	7.43	8.51	5.67	6.42
Sulfur.....	5.20	4.92	4.90	1.48
Fillers and Friction Agents.....	9.86	8.03	7.00	17.67
	100.00	100.00	100.00	100.00

In preparing mixtures as exemplified by the foregoing compositions, peptized rubber material and solvent may be pre-mixed to form a cement after which there is mixed therewith the oil, fillers and the like to form a batter or heavy slurry and then combined with the asbestos fibers by thorough mixing in suitable means to thoroughly distribute the binder and other components with the asbestos to provide a mix of desired comminuted texture and particle size. More conveniently, the peptized rubber material may be introduced in solid pieces, together with the requisite solvent and the filler materials into a dough mixer such as a Werner-Pfleiderer mixer, the peptized rubber material not requiring milling because of its already plastic and of a softened nature. After the rubber has been thoroughly dissolved and mixed by aid of the incorporated filler materials to form a smooth batter or slurry, the asbestos fibers are combined therewith and mixed until even distribution of the binder has been obtained, the mix resulting having a comminuted texture. This resultant mix is a loose mass of small pellets or nodules of fiber and is aged or tempered at room temperature for 1 or 2 days and then pulverized in a hammer mill to produce relatively uniform particles, which are termed generally as "granules," of irregular shape and roughly of $\frac{1}{16}$ " to $\frac{1}{8}$ " diameter. This mass is loose, flows by gravity, is highly compressible and the particles have strong tack on being pressed together.

Referring to the drawings, for the purpose of compacting and shaping this granular material 10, as is illustrated in Fig. 5, it is placed in the hopper 11 of the apparatus illustrated in Figs. 1 and 2 wherein it is agitated by means of the spike agitators 12 and flowed therefrom by gravity through the hopper opening 13 into the reservoir 14 and passes therefrom in controlled amount by means of the adjustable feed gate 15, to and between the nip of the rolls 16 and 17. Roll 16 has a knurled surface and is suitably mounted for rotation on the shaft 18. Roll 17 suitably mounted for rotation on the shaft 19 is provided with a pair of flanges or confining walls 20, the roll 16 being spaced from the roll 17 by projecting within the flanges or confining walls of the latter. In operation, the feed gate 15 is adjusted to a spacing from the periphery of the roll 17 somewhat greater than the desired thickness of the issuing strip material 21 to be produced. The granular mix is compacted between the rolls 16 and 17 and shaped and densified to a compactness or density of about 92% of

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theoretical, and as it issues from between the rolls the strip material is of a self-sustaining nature so that it can be rolled up and handled prior to curing without reinforcement or support as was heretofore necessary. In the prior practice, as the strip material issued between the rolls 16 and 17, there was simultaneously fed between the rolls reinforcement, such as wire mesh, which continuously became embedded in the friction material as formed. This, however, in accordance with our invention and by reason of the employment of effective amounts of the peptized rubber material binder, is no longer necessary. The strip material 21 may be of desired thickness by proper spacing of the rolls 16 and 17. Although not illustrated, it will be apparent that not only may we form this strip material in a width suitable for the brake linings but in wider widths suitable for use in the production of clutch facings, the latter, however, requiring added blanking.

To facilitate an even, smooth shaping and compacting by the foregoing apparatus, the knurled roll 16 may be, if necessary, lubricated slightly with a graphite-castor oil mixture in an amount just sufficient to prevent sticking. The issuing strip material may be rolled up on a mandrel into coils of 15 to 25 ft. lengths and then dried free of solvent at progressively rising temperatures of 180 to 280° F. for suitable periods, such as for 30 hours, followed by hardening and curing of the binder by, for example, heating at 280° F. for 2 to 6 hours. The surface of the material may be ground to remove roughness and inequality and the product is then in the form of flexible brake lining. It may be alternatively cut into lengths equivalent to one brake segment, and these lengths further cured to form brake segments having fixed curvature and being of a relatively non-flexible nature.

Not only is our resultant product of a self-sustaining nature throughout both the cured and uncured states, but it has a strong bond resulting from the incorporation of effective percentages of rubber material and its toughness and resistance to friction is considerably enhanced. Further, whatever shrinkage occurs in curing is now evenly distributed over the whole surface without the restraining effect on the wire mesh or like reinforcement and, therefore, without serious distortion which is characteristic of high solvent mixtures applied to a wire mesh backing. An allied advantage in the elimination of the wire mesh back is the elimination of the curl or bulging of the lining in the path of brake travel during use, producing squeak and rough action resulting from resistance to dimensional change offered by the wire mesh back, that is, in accordance with our present invention, omission of the wire mesh allows the brake lining to expand or contract uniformly with frictional heat without permanent distortion, thereby improving brake action. Lining produced in accordance with our present invention has high durability, characteristic of the structure of high compactness (85-95% of theoretical maximum) produced by close packing of adhesive fibrous granules and frictional qualities entirely adequate for the service intended.

As previously indicated, it is preferred to employ the peptized rubber material in the proportion of at least about 15% by weight or more of the total binder employed and that it be at least about 3% by weight of the total solids of the frictional material composition, since such

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proportions have an increasing effect on strength. Below this, the effect is lesser or minor. However, even using smaller quantities of peptized rubber materials but in excess of that previously possible when employing rubber materials in an unpeptized condition, an improvement in durability, toughness and flexibility may be obtained and in such or other of our compositions the wire-back may be used as previously if reinforcement or extraordinary strength is required.

We claim as our invention:

1. A friction material composition comprising from about 50% to about 75% by weight of short-fiber asbestos, from about 15% to about 30% by weight of binder solids including peptized rubber material providing said composition with from about 3% to about 15% by weight of said rubber, binder vulcanizing agent, up to about 35% by weight friction material fillers, and solvent for said binder in the proportion of from about 5% to about 15% by weight of the composition solids.

2. A friction material composition comprising from about 50% to about 75% by weight of fibrous asbestos, from about 15% to about 30% by weight of binder solids including drying oil and peptized rubber material providing said composition with from about 3% to about 15% by weight of said rubber, binder vulcanizing agent, up to about 35% by weight of friction material fillers and solvent for said binder in the proportion of from about 5% to about 15% by weight of the composition solids.

3. A friction material composition comprising from about 50% to about 75% by weight of short-fiber asbestos, from about 15% to about

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30% by weight of binder solids including peptized rubber material providing said composition with from about 3% to about 15% by weight of said rubber, binder vulcanizing agent, up to about 35% by weight friction material fillers, and solvent for said binder in the proportion of from about 5% to about 15% by weight of the composition solids, said composition being in the form of a mass of non-coherent granules.

4. A friction material composition comprising from about 50% to about 75% by weight of short-fiber asbestos, from about 15% to about 30% by weight of binder solids including peptized rubber material providing said composition with from about 3% to about 15% by weight of said rubber, binder vulcanizing agent, up to about 35% by weight friction material fillers, and solvent for said binder in the proportion of from about 5% to about 15% by weight of said solids, said composition being in the form of a dense, compact, self-sustaining, elongated, shaped strip.

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