Nov. 5, 1957 H. J. COFEK 2,811,750

PRODUCTION OF FRICTION MATERIAL

Filed Nov. 5, 1954

FIG. 1.

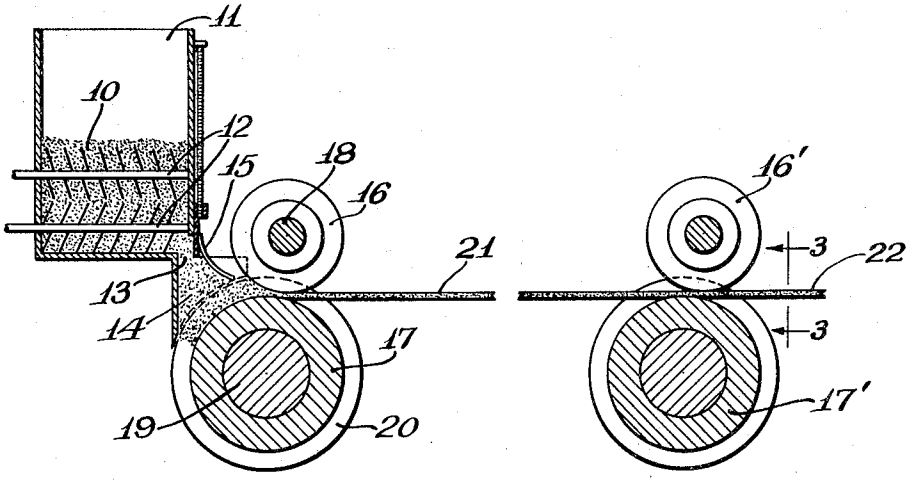

FIG. 2.

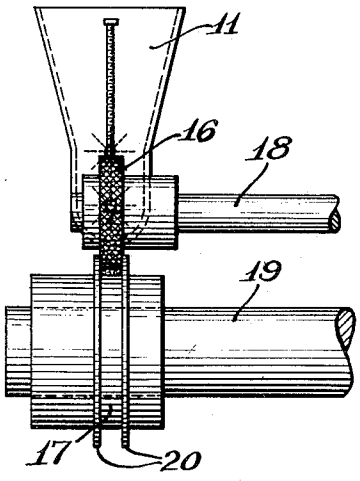

FIG. 4.

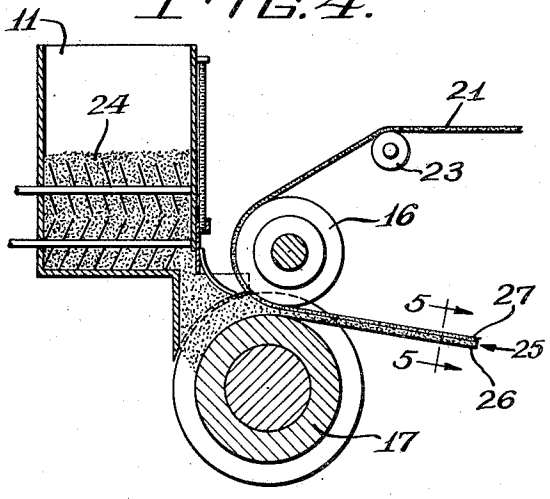

FIG. 3.

FIG. 5.

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United States Patent Office 2,811,750 Patented Nov. 5, 1957

2,811,750

PRODUCTION OF FRICTION MATERIAL

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Application November 5, 1954, Serial No. 467,054

3 Claims. (Cl. 18—55)

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

The present invention is particularly directed to improvements in the method of producing friction material by compacting and shaping particles of a preformed mixture to substantially final density and shape in continuous strip form by rolling.

For the foregoing process a mixture is made in a suitable device, such as a dough mixer, of asbestos fibers, conventional friction modifying agents and fillers, heat-hardenable organic binder material, and binder solvent, the solvent being sufficient to permit good distribution of the binder and the mix, but limited in amount so that the mix may be reduced to the form of relatively dry but somewhat tacky, granular, free-flowing particles which can be fed by gravity from a hopper to the bite between a pair of forming rollers, one of the rollers having a knurled or serrated periphery projecting into a U-shaped periphery of another roll providing a laterally confined opening between the rolls. A process and apparatus of such character is shown in the Novak and Cofek U. S. Patent No. 2,620,320.

In order to provide granules of a character which can flow freely and uniformly by gravity, and in order to permit the formation of strip material of uniform compactness and in the density and shape substantially that finally desired in a single pass through the described rollers, it has heretofore been necessary that the asbestos fibers be of the very short fiber grades, and without long fiber content, since the longer grades of fiber do not lend themselves to uniform gravity feed because they tend to tangle and clump in the hopper, resulting in nonuniform compactness in the formed continuous strip. On the other hand, it is desirable that the asbestos should contain fibers of the longer grades, since the longer fibers provide better reinforcement and hence impart greater strength to the finished product. Heretofore the longer grades of asbestos fibers have essentially been restricted to use in weaving processes, dry molding techniques, paper machines, sheeters or die-casting techniques.

In accordance with the present invention is has been found that asbestos fibers of the longer grades may be employed in the mixture if the strip material as first formed is passed at least once more between the forming rollers at which time a uniformly compacted strip results having improved strength in both the green and cured states. Further, products of substantially equal strength may be formed with a smaller proportion of fibers of the longer grades as compared with the requirements when using the short fiber grades.

Although the strip material of the present invention does not require other reinforcement, if desired a wire mesh or other reinforcement may be incorporated on either the first forming pass or second compacting pass through the rollers.

The second pass of the strip material through the rollers need not be of the preformed long-fiber-content

strip alone, but on this second pass there may be formed another layer, by supplying additional material from the supply hopper containing the shorter grades of fibrous asbestos without long fiber content. This second layer may be of the same or different thickness than the first, and may serve various functions, such as reinforcing backing or a backing to provide acoustical properties to overcome noise conditions in use.

As a further alternative, when forming multi-ply material, the initially formed long-fiber-containing strip may comprise the reinforcing backing for the composite. As another alternative, multi-ply strip material may be formed of two layers of long asbestos fiber content which may otherwise vary as to proportons and character of constituents. In such case, after the second layer is deposited in the second run, a third run is made through the rollers, without added material, to evenly compact the second layer.

The second pass may also be employed to imbed a wire mesh or other reinforcement between the two layers of material so as to position the reinforcement closer to the neutral axis of the strip and to minimize problems of machining and warpage in cure and use which otherwise occur when wire mesh is merely imbedded in the surface of the strip, as is provided by a single pass, and as more fully described and claimed in my copending application Serial No. 467,055, filed of even date herewith.

As indicated previously, the present invention is characterized by the employment of fibrous asbestos having a content of long grade fibers, and it will be understood that as commercially provided in the standard designated grades in accordance with Canadian Chrysotile Asbestos Classification, a grade of asbestos will have fibers of different lengths and that even the highest spinning grades will contain some very short material or fines passing a 10-mesh screen, but will still be classified as long fiber, and therefore, as employed in the following specification and claims, it will be understood that the term "asbestos of long fiber content" is intended to include the grades of groups 3, 4 and 5 of the aforesaid classification where the majority of the fibers are retained on a 10-mesh screen having a screen opening of 0.053 inch, and mixtures of said grades. Group 3 contains fibers retained on a ½-inch screen opening, and group 4 contains fibers retained on a 4-mesh screen. In group 5, a majority of the fibers are retained on the 10-mesh screen and only a minor amount pass said screen. As distinguished from this, asbestos of groups 6 and 7 are characterized by a content of fibrous material, the majority of which passes a 10-mesh screen, and minor amounts are retained on the 10-mesh screen, and are thus designated as short asbestos fibers.

The accompanying drawings diagrammatically illustrate the process of the invention and the apparatus employed for forming the products thereof.

Fig. 1 of the drawings is a diagrammatic sectional elevation of a rolling 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 rolling apparatus.

Fig. 3 is a section on the line 3—3 of Fig. 1.

Fig. 4 is a diagrammatic illustration similar to that of Fig. 1 illustrating a modified process step.

Fig. 5 is a section on the line 5—5 of Fig. 4.

In the production of strip material from an asbestos-binder composition wherein the asbestos is characterized by a long fiber content as hereinbefore defined, a mix is prepared wherein the solids are composed of from about 25% to about 75% by weight of asbestos of long fiber content; from about 15% to about 30% by weight of heat hardenable organic binder material; and from about 0

to about 60% conventional friction material fillers, which term is inclusive of accelerators, lubricants, and relatively inert organic and inorganic friction augmenting and modifying agents, all well known in the friction-material art.

The asbestos may be composed of any of the grades of long fiber content or mixtures thereof, as previously described. The heat-hardenable organic binders may be bodied or unbodied drying oils, such as bodied synthetic or natural drying oil, as for example China-wood oil or linseed oil bodied by blowing and/or heat; thermosetting resins such as phenol-aldehyde resins, preferably aqueous, partial-condensation phenol-formaldehyde resin solutions, such as those described in Cofek Patent 2,586,150; natural or synthetic rubbers such as styrene or acrylonitrile copolymers with butadiene, polychloroprene, and the like; or mixtures of the aforesaid binders, together with vulcanizing or hardening agents for the aforesaid rubber materials.

A typical example of the solids content of a suitable mixture for the practice of the present invention is 40% by weight of asbestos of long fiber content composed of a mixture of 4T and 3R grades; 17% by weight of heat-hardenable organic binder; 18% by weight of metal chips; and 25% by weight of other inert fillers, accelerators, lubricants, and friction augmenting agents. These materials are mixed in a dough mixer together with solvent for the binder adequate to dissolve and distribute the binder over the remaining solids in the mix, the solvent being just sufficient to permit good distribution but limited in amount so that the mix may be reduced to the form of relatively dry granular particles which can subsequently be fed by gravity from a hopper to the bite of the forming rolls subsequently to be described, and compacted and shaped thereby to a dense composition which will have a minimum shrinkage.

The solvent for the oil and rubber binders may be the conventional hydrocarbon solvents, and when employing aqueous solutions of phenol-formaldehyde resin as previously indicated, the aqueous phase of the resin solution provides the binder solvent. The mixing is continued until the mix has a comminuted texture and is in the form of loose pellets or nodules. These are permitted to age at room temperature for about one or two days and then pulverized in a hammer mill to produce particles, which are generally termed "granules" of irregular shape, roughly 1/16" to 1/8" in diameter. These particles are highly compressible, and although they are normally dry, they have strong tack on being pressed together. Further, although these granules can be and are employed in the process herein described, by reason of the long asbestos fiber content, there is a tendency for these particles to tangle and clump in the hopper, with the result that they do not flow in a uniform manner, but rather as nonuniform granule aggregates.

Thus referring to the drawing, for the purpose of compacting and shaping, the described granular particle material **10** is placed in the hopper **11** 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 passed therefrom 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** and 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**.

However, as previously indicated, this strip material **21**, as a result of inherent nonuniformity and uneven flow of feed stock is initially of nonuniform compactness. In order to overcome this, the strip **21** is then passed a second time between the rolls **16** and **17** without any added stock; or, in the alternative, it is passed in a continuous operation between a successive pair of rolls **16'** and **17'**, which is similar to the rolls **16** and **17**, to thereupon result in a strip **22** of substantially uniform compactness and cross-sectional dimension substantially conforming to that of the ultimately desired friction material, such as brake lining, with a density of from about 85% to about 95% of theoretical upon evaporation of the solvent content and binder cure. This strip has high strength and is self-sustaining in both the green and the cured state, and does not require any wire or open mesh reinforcement, although such reinforcement may be provided if desired. Although not illustrated, it will be understood that not only may this strip material be produced in a width suitable for brake linings, but also in wider widths suitable for the production of clutch facings; the latter, however, requiring added blanking.

The issuing strip material **22** may be rolled up on a mandrel into coils of desired length, dried free of solvent, and then subjected to heat to cure and harden the binder content. The material may thereafter be finished in a suitable manner, as by grinding to remove roughness. It may be alternatively cut into single brake segment lengths, and these lengths cured to segments having fixed curvature.

Alternatively, a multi-ply product may be formed as illustrated in Fig. 4. In this case the preformed strip **21** is passed through a rolling apparatus as previously described, by passing the strip over the guide roll **23** and around roll **16** so that it is caused to pass a second time between the pair of rolls **16** and **17** to thereby reduce it to a condition of substantially uniform compactness. In this instance there is simultaneously supplied from the hopper **11** granules of an asbestos-containing composition wherein the asbestos is all of short fiber content and the granules are of a free-flowing nature. This composition **24** may be of an asbestos heat-hardenable organic binder friction material composition, such as that described in the two patents hereinbefore mentioned, having an asbestos content from about 50% to about 75% by weight of all short fiber when this second layer is to form a friction face.

On the other hand, the composition **24** applied as the second layer need not comprise the friction face but rather may act as a backing. Thus, for example, a typical reinforcing back composition is composed of 19% by weight of short fibers of 7D grade; 16% by weight of heat-hardenable organic binder material; 28% by weight of metal chips; and 37% by weight of other fillers, accelerators, lubricants, friction augmenting and modifying agents. In the alternative, the composition **24** may provide a backing of acoustical properties to overcome a noise condition of an otherwise satisfactory brake lining, and for this purpose the asbestos fibers may be replaced in part with, for example, about 50% of comminuted or granular cork particles of from about 10 to about 40 mesh size.

It will thus be understood that although the composition of the granular particle material **24** may have frictional properties adapted for use as the operative friction surface, so as to form a composite strip generally indicated as **25** composed of the layers **26** and **27**, with the layer **27** being the reinforcing layer resulting from the rerolling of the preformed strip **21** in Fig. 4, these may be reversed so that the strip **21**, rerolled as strip **27**, may be of greater thickness and form the friction surface, and the layer **26** resulting from the mix **24** may be relatively thinner and provide a backing which may be of reinforcing character or have acoustical properties as described. In any event, the preformed strip **21**, by having passed the second time between the rollers **16** and **17**, has as a result been reduced to a composition of desired uniform compactness and high strength.

Although not illustrated, it will be understood that the composition **24** may be characterized by a content of asbestos of long fibers, such as in composition **10**, although

the proportions of components between the two successive applied layers, and the nature of the fillers, when employed, may be different. In such event, however, it is necessary to again pass this dual-ply composite strip a third time through the pair of rolls **16—17** or **16'—17'** so that the last applied layer of long asbestos fiber content will have passed between the compacting rollers at least twice whereby the last applied layer may be reduced to a condition of substantially uniform compactness.

It will also be understood, as more particularly described and claimed in my aforementioned copending application filed of even date herewith, that a strip of reinforcing wire or other open-mesh fabric may be imbedded between the plies of the hereinbefore described multi-ply strip material, by passing same, for example, over the strip **21** in Fig. 2 so that it becomes imbedded between the ultimate layers **26** and **27**.

It will thus be seen that in accordance with the hereinbefore described invention I have been able to form friction materials with asbestos of long fiber content by means of the rolling process wherein the use of such asbestos was heretofore thought unfeasible, with the result that friction material of novel properties and strength characteristic of long asbestos fibers is now obtainable in this economical procedure for use either as friction material per se or as reinforcing backing for friction material. It will be further evident that I have been able to produce friction material of unitary character composed of a plurality of blended layers wherein each layer may be of different character and perform a different function, one of the layers being characterized by asbestos of long fiber content with the attendant advantages of such asbestos material.

I claim:

1. The method of making friction material which comprises, rolling granular friction composition particle material comprised of a mixture of asbestos of long fiber content wherein a majority of the fibers are retained on a 10-mesh screen having a screen opening of .053 inch, heat hardenable organic binder material and binder solvent, between spaced oppositely rotating surfaces while laterally confining the material, to compact and shape the particles into the form of a dense continuous strip, subjecting said strip, prior to cure of its binder, to a successive like rolling to reduce it to a condition of substantially uniform compactness and simultaneously adding granular composition particle material comprised of a mixture of asbestos of all short fiber content wherein a majority of the fibers pass said screen, heat hardenable organic binder material and binder solvent, to form a consolidated multi-ply strip.

2. The method of making friction material which comprises, rolling granular friction composition particle material comprised of a mixture of asbestos of long fiber content, heat-hardenable organic binder material and binder solvent, between spaced oppositely rotating surfaces while laterally confining the material, to compact and shape the particles into the form of a dense continuous strip, subjecting said strip, prior to cure of its binder content, to a successive like rolling to reduce it to a condition of substantially uniform compactness and simultaneously adding granular composition particle material comprised of a mixture of asbestos of all short fiber content, comminuted cork particles, heat-hardenable organic binder material and binder solvent, to form a consolidated multi-ply strip having a backing of acoustical property.

3. The method of making friction material which comprises, rolling granular friction composition particle material comprised of a mixture of asbestos of long fiber content, heat-hardenable organic binder material and binder solvent, between spaced oppositely rotating surfaces while laterally confining the material, to compact and shape the particles into the form of a dense continuous strip, subjecting said strip, prior to cure of its binder content, to a successive like rolling while simultaneously adding similar granular composition particle material of long asbestos fiber content to form a consolidated multi-ply strip, and subjecting the latter strip, prior to cure of its binder content, to a successive like rolling, in the absence of added material of long asbestos fiber content, to reduce it to a condition of substantially uniform compactness.

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