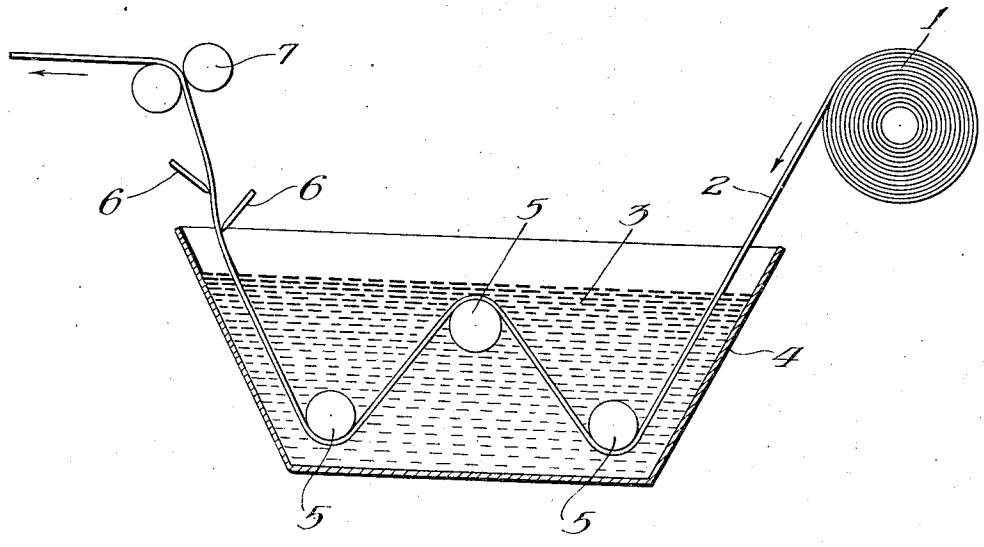
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MANUFACTURE OF WOVEN FRICTION MATERIAL

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MANUFACTURE OF WOVEN FRICTION MATERIAL

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This invention relates to the manufacture of woven friction material for use as brake linings, clutch facings, and the like, in automotive vehicles; and in a more specific aspect to a woven friction material in which the voids of the woven structure are filled with pulverulent filling materials.

It has been well known to weave a tight multiply structure consisting of asbestos-wire or asbestos-cotton thread yarns, to a width approximately that of the finished desired width of a friction material, and approximately the thickness thereof; saturating the tape so formed with a suitable binding material, such as drying oil, asphalt, phenol resin, resin-oil combinations and the like, then to cure or harden the binder and compact it to approximately the finished size, either by rolling or hot pressing. However, due to the structure of such a woven tape and the disposition of the warp and filler yarns, there always remain voids (which may result from the shrinkage of the impregnating fluid) which are undesirable in that they lower the ultimate compactness of the friction material, and thereby its durability in use. It is, therefore, desirable to produce a structure wherein these voids are reduced to a minimum and it is an object of this invention to provide a method of making such a structure.

The product of this invention is a structure comprising a tightly compacted mass of primarily well separated yarns, saturated with a binder and lying in a matrix of filler material bonded with the same binder, the finished product having a high degree of compactness and satisfactory friction quality. The yarns may also contain either no additional binder or a binder different from that in the filler matrix.

In the single figure of the drawing, a diagrammatic arrangement of the apparatus for soaking or saturating the tape is shown.

One method of carrying out the invention is to proceed as follows: the number of ends used in the manufacture of white asbestos tape, suitable for say 2" x $\frac{3}{16}$" finished brake lining, which may be, for example, 40 warp ends, is woven into an open weave tape say 3" wide by ½" thick, in a sufficient number of plies, say 5 plies, and in a wide enough thread and reed spacing to provide the width and thickness mentioned. This tape has approximately 4 picks per inch. It is extremely open, the yarns being well separated to provide well defined spaces between them. It has an apparent density of 0.16 oz. per cubic inch on a no wire basis.

This tape may be then saturated or filled with a paint having the following composition: 30 parts litharge, 20 parts barytes, 12½ parts oil-soluble, heat-setting resin, 12½ parts China-wood oil and 25 parts of a solvent such as xylol. To saturate or soak the tape a quantity of said tape may be arranged in the form of a roll 1. The tape 2 carried from the roll 1 may be immersed in a bath 3 comprising a relatively viscous saturant or paint, said bath being carried by vat 4. The tape 2 in passing through the bath 3 is carried around guide rolls 5 disposed beneath the surface of the saturant. Upon emerging from the bath 3 doctor blades 6 may serve to remove excess surface saturant. After saturation sufficient of the paint is squeezed out between suitable rolls 7 to leave approximately twice the weight of paint in the tape with respect to the original weight of the tape. For example, assuming the tape weighed 17 pounds per 100 feet, its impregnated weight is approximately 51 pounds per 100 feet.

The solvent is dried off at a low temperature and the tape is then rolled in a four roll calender so as to decrease its width from 3" to 2", which is the desired finished width. It is then hot pressed in a follower type mould of the same width at 2,000 pounds per square inch and at a temperature of approximately 300° to 320° F. to partially set the resin.

It is then cut into strips of the desired length. These strips are finished to width and thickness in suitable sanding machines, followed by curving while hot to the desired radius of the finished segment, and are cured to infusibility of the binder in curved forms. The finished product of the above procedure is a friction material having high durability in use, because of its density; low scoring properties, because of the presence of a large proportion of fine filler; and uniformity of friction co-efficient for the same reason. It contains approximately 40% asbestos-wire or asbestos-cotton thread yarn, 40% of filler, and 20% of binder on a weight basis.

The advantages of this method of manufacture are several, the weaving of a loose tape of the type described is a simple, relatively quick operation, permitting the use of light, fast looms, as against the weaving of the previous type of brake lining tape, wherein density and compactness in the original tape are required, necessitating heavy, slow, powerful, weaving equipment.

Furthermore, it is ordinarily impossible to introduce fillers into a tightly woven tape by saturation with a paint, and even simple liquid saturants for this tightly woven type must be specially

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designed so as to have low viscosity and good penetrating properties. This ideal is not always obtained in practice because asbestos is well known to be an excellent filtering material. By the method described above it is possible and practicable to use paints of high viscosity, and containing large proportions of loading or filler materials, as the spaces between the threads are large in comparison to the size of the particles which are to enter. Also, it is an advantage that the tape may be flexed and worked while in the impregnating paint so as to provide good distribution of the paint, and also that an excess of binder and filler material may be introduced and then reduced to the desired quantity by a mechanical operation.

Ordinary woven tape ready for saturation is of the order of .55 to .90 oz. per cubic inch on a no wire basis (that is, omitting from calculations both the weight and volume of any metallic wire contained), but for the purposes of this invention I prefer to use tape in a much lower density range to permit the type of impregnation specified. My tape may range from .1 oz. per cubic inch to .5 oz. per cubic inch (on a no wire basis), to provide the macro pores necessary for the entrance of viscous saturants.

I have described the process wherein a brake lining take is formed and finished into hard, rigid, segments; but by selection of more flexible or more plastic binding materials, or by reducing the proportion of the binder, or by reducing the degree of cure of the binder, I may operate to produce flexible brake lining which may be handled in the conventional rolls.

In forming a clutch facing from such a tape I may weave a tape sufficiently wide so that full rings may be die cut therefrom before the hot pressing and curing stage, and these rings then pressed in suitable moulds and thereafter cured. This method, of course, results in wastage. On the other hand, where the endless type is not required, I may take the dry impregnated tape rolled to the desired width of face, and form it into a spiral on a mandrel in a lathe, by the conventional method of forming woven clutch facings. After filling the mandrel with the tape on edge, the tape may be cured, resulting in a hardened spiral and rings may be cut therefrom and laced by staples, rivets, or interlocking the abutting edges and sanding to finish them to size, or they may be removed in partially cured condition and hydraulic pressed hot.

In this case, the pressing operation usually follows the lacing, and precedes the final hardening cure and finishing operations.

It is obvious that the size of the yarn and the construction of the weave may be varied within large limits to produce structures of different frictional characteristics, and the paint or emulsion may comprise any combination of binder and filler or fibrous materials to which the particular woven fabric is adapted. Thus, when a very liquid saturant containing very little filler material is employed, I may tighten the weave, still obtaining good saturation. If the binder-filler combination is very viscous or contains a large amount of filler or fiber, I may open out the weave to allow an easy penetration of this viscous mass to the interior. For example: a structure of the latter type may be saturated with a rubber or chloroprene cement-filler mixture, which of course, could not possibly be introduced into the ordinary tightly woven multi-plied brake lining tape.

The saturant may also comprise relatively fine fibers such as asbestos fibers, or leather fibers, or it may carry relatively coarse pieces of solid material such as cork, sawdust, coal, or granulated rubber; or I may use any of the well known types of binders used in the manufacture of frictional material, including natural or artificial asphalts, drying oils, resins, resin-oil combinations, synthetic and natural gums, including rubber substitutes, and certain types of hydrocarbon and coal tar pitches.

The proportion of filler material to asbestos yarn may vary widely and may range from approximately 5% to 200% filler relative to asbestos yarn, on a weight basis. Similarly, I do not wish to be limited to any specific proportions of saturant, since the amount used will vary with the type and binding properties desired.

By the use of the term "asbestos yarn" I intend to include asbestos, asbestos-wire and asbestos-cotton thread, roving and yarn.

By the use of the term "woven" I intend to embrace braided structures as well as woven structures.

I am aware that it has been a known practice to incorporate fillers as a means of closing the voids in textile cloth of woven or braided structure for the purpose of loading said textile fabrics or producing smooth texture. This common practice is not to be confused with the concept of the present invention wherein the purpose is to introduce filler material and binder uniformly between the threads of a woven structure and then compact the structure to a high density. In the loading of textile fabrics the spacing between the threads is maintained, whereas in the manufacture of this invention, the original widely spaced threads are finally brought as close together as possible by condensation and pressure. Furthermore, this method provides a means of producing a unitary, non-laminated structure of woven friction material wherein the asbestos content may be varied within wide limits to obtain frictional properties concomitant with this variation.

It will also be appreciated that I may similarly employ saturants comprising no filler material which ordinarily do not impregnate ordinary woven asbestos tape of customary density, such as rubber cement, highly viscous phenolic resins, heavy asphalt solutions, and like liquids of such colloidality or concentrations that prevent their entrance into ordinary woven asbestos tape.

Instead of using a paint, that is, a combination of binder, binder solvent and filler, I may use a water emulsion of the binder to which fillers may be added in suitable proportions or I may combine the binder with the filler prior to emulsification. I have found that rubber compounds of the compositions used in folded cloth friction materials can be effectively introduced in emulsion form into the open weave tape described above. After saturation with the emulsion, the filled tape is dried, calendered (cold or warm) to width and may then be vulcanized in molds in a belt press similar to those used in vulcanizing the folded cloth linings; also, the tape before vulcanizing may be formed into a spiral on a suitable mandrel, individual rings cut therefrom and vulcanized in suitable molds for clutch facings.

I find that the process of emulsification and subsequent drying does not detract from the quality of the rubber compounds, and the friction materials filled, as described, with the rubber compounds possess all the qualities of similar

combinations of yarn and rubber compounds made previously. Since the rubber emulsions do not saturate the yarns themselves, the tape may be, if desired, presaturated with a suitable binder such as a China-wood oil varnish and this binder dried. This does not interfere with the subsequent rubber compound emulsion saturation.

The advantages of this method for making rubber compound-filled brake linings and clutch facings are:

(1) The product is non-delaminating as opposed to folded cloth types.

(2) Because of the relative irregularity of the yarns on the wearing surface and the elimination of hard nodes of asbestos yarn present in cloth woven for folded vulcanized products, the tendency to score and ridge metal cooperating surfaces is decreased.

(3) The cost of producing an equivalent structure by this method is appreciably lower.

As an example of a rubber compound which has been satisfactorily made into brake lining of high frictional quality, the following compound was mixed in a Banbury mixer:

	Parts
Rubber	19
Rosin	4
Sulfur	9
Lead litharge	54
Mica	14

This was emulsified as follows: The warmed and sheeted compound was added to a steam and water jacketed internal type mixer containing a water solution of about 1% sodium or ammonium caseinate and approximately ¾% sodium hydroxide, both by weight on the rubber compound. The mix was allowed to work until free from lumps, at which time the temperature of the paste was modified to suit the conditions of the batch and additions of ammoniacal water were cautiously made as fast as absorbed. Final dilution was made at a faster rate to the desired concentration, which, dependent on the specific gravity of the compound, may vary from 70 to 75% solids, at which time the dispersion is screened, cooled and ready for use.

An asbestos covered brass wire yarn tape of the following characteristics: 1¾'' wide x 100 ft. long x .270/290'' thick, 15.3 pounds per 100 ft. weight, corresponding to .5 oz. per cu. in. density (.35 oz. per cu. in. and a no wire basis) was saturated to 170% increase in the above emulsion at 72% solids and was dried to 225° F. for 3 hours. After drying, is was calendered while warm to $\frac{1}{32}$'' under the finished width and to .240/.250'' thick and was then vulcanized in a mold at 320° F. for 10 minutes at 1500 lbs. per sq. in. pressure. After removal from the mold, one surface was ground to bring the tape to the final thickness desired, and it was then repressed without molds for 20 minutes at 320° F. at 300 lbs. per sq. in. The resulting product, after marking and inspection, was then ready for use at a density of approximately 1.3 to 1.4 oz. per cu. in.

While I have specified emulsions of rubber and rubber compounds, it is to be understood that I may utilize in the form of emulsions or dispersions any of the binders or saturants hereinbefore mentioned or which have been used as binders for friction materials.

This application is a continuation-in-part of my co-pending application Serial No. 15,926, filed April 11, 1935.

I claim as my invention:

1. In the manufacture of friction material for use as brake linings, clutch facings, and the like, wherein asbestos yarns are woven into a tape, the tape impregnated with a saturant and cured to convert the saturant to a hardened binder, the improvement which comprises weaving asbestos yarns into a tape having well defined openings between the yarns of such size as to freely pass filler material carried in a liquid saturant, and having a width substantially greater than the width of the friction material desired, soaking said tape with a filler material carried in a liquid saturant in an amount greater by weight than the original weight of the tape, decreasing the width of the tape to approximately the desired finished width, and curing the filled tape to set the saturant and bond the asbestos yarns and filler material.

2. In the manufacture of friction material for use as brake linings, clutch facings, and the like, wherein asbestos yarns are woven into a tape, the tape impregnated with a saturant and cured to convert the saturant to a hardened binder, the improvement which comprises weaving asbestos yarns into a tape having all parallel strands so spaced from each other as to provide macro pores of such size as to freely pass filler material carrierd in a liquid saturant, soaking said tape with a filler material in a liquid saturant carrier, in an amount greater by weight than the original weight of the tape, and curing the filled tape to set the saturant and bond the absestos yarns and filler material.

3. In the manufacture of friction material for use as brake linings, clutch facings, and the like, wherein asbestos yarns are woven into a tape, the tape impregnated with a saturant and cured to convert the saturant to a hardened binder, the improvement which comprises weaving asbestos yarns into a tape having openings between substantially all of the yarns of such size as to pass filler material carried by a liquid saturant, soaking said tape with an aqueous emulsion of a rubber compound comprising essentially rubber and filler material whereby said tape is saturated, and curing the saturated tape to produce a structure comprising a tightly compacted mass of woven yarns lying in a matrix of filler material bonded with rubber.

4. In the manufacture of friction material for use as brake linings, clutch facings, and the like, wherein asbestos yarns are woven into a tape of greater width than thickness, the tape impregnated with a saturant and cured to convert the saturant to a hardened binder, the improvement which comprises weaving asbestos yarns into a tape having well defined openings between the yarns in the plane of the face of the tape, soaking said tape with a fluid paint in an amount comprising at least 35% of the original weight of the tape, and curing the saturated tape to produce a structure comprising a tightly compacted mass of woven yarns saturated with a binder and lying in a matrix of filler material bonded with the same binder.

5. A process of manufacturing friction material for use as brake linings, clutch facings and the like, which comprises weaving asbestos yarns into the form of a tape having substantially all adjacent warp and weft strands spaced respectively from each other so as to provide well defined openings between the yarns of sufficient size to freely pass a paint comprising a filler material carried by a potentially hardenable liquid binder, soaking said tape with a liquid paint comprising

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filler material carried by a potentially hardenable liquid binder, whereby said tape is saturated with the paint to the amount of at least 35% of the original weight of the tape, and curing and compressing the impregnated tape to produce a structure comprising a tightly compacted mass of woven asbestos yarns saturated with a binder and lying in a matrix of filler material bonded with the same binder.

6. In the process of manufacture of friction material for use as brake linings, clutch facings and the like, wherein asbestos yarns are woven into a tape and the tape is impregnated with a saturant and cured to convert the saturant to a hardened binder, the improvement which comprises weaving asbestos yarns into a tape having well defined openings between substantially all the adjacent yarns of such size as to freely pass filler material carried by a liquid saturant, soaking said tape with a filler material carried by a liquid saturant whereby said tape is saturated in excess of the amount to be retained in the final product, compacting said saturated tape to remove excess saturant and/or filler, and curing the tape to set the saturant and bond the asbestos yarns and filler material.

7. In the manufacture of friction material for use as brake linings, clutch facings and the like, wherein asbestos yarns are woven into a tape, the tape impregnated with a saturant and cured to convert the saturant to a hardened binder, the improvement which comprises weaving asbestos yarns into a tape having well defined openings between the yarn of such size as to pass a relatively viscous fluid saturant, soaking said tape with a relatively viscous saturant in the fluid state whereby said tape is saturated, and curing the saturated tape to produce a structure comprising a tightly compacted mass.

8. In the manufacture of friction material for use as brake linings, clutch facings and the like, wherein asbestos yarns are woven into a tape, the tape impregnated with a saturant and cured to convert the saturant to a hardened binder, the improvement which comprises weaving asbestos yarns into a tape having well defined openings between the yarns of such size as to pass a filler material carried by a liquid vehicle including a saturant, soaking said tape with a filler material carried by a liquid vehicle including a saturant, whereby said tape is substantially uniformly saturated, and curing the saturated tape to produce a structure comprising a tightly compacted mass.

9. In the manufacture of friction material for use as brake linings, clutch facings, and the like, wherein asbestos yarns are woven into a tape, the tape impregnated with a saturant and cured to convert the saturant to a hardened binder, the improvement which comprises weaving asbestos yarns into a tape having well defined openings between substantially all the adjacent yarns of such size as to freely pass a relatively viscous saturant, said tape having an apparent density of .1 to .4 ounces per cubic inch, soaking said tape with a relatively viscous liquid saturant whereby said tape is saturated, densifying said saturated tape by pressure to bring the originally widely spaced yarns closely together, and curing the tape to convert the saturant to a hardened binder bonding the yarns into a homogeneous structure.

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