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## TREATED FABRIC AND PROCESS OF MAKING THE SAME

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This invention relates to a treated fabric and process of making the same. It relates more particularly to a woven or felted product of asbestos or other fibers containing insoluble, inorganic material precipitated in situ and adapted to increase the hardness, stiffness, durability, and/or heat and water resistance of the product. The product containing the inorganic precipitate may be impregnated with a plastic material adapted for use in friction brake lining.

In the manufacture of friction materials for use on automotive brake shoes it is common practice to use asbestos fiber spun into yarn around metal wires and then woven into the form of tape or listing of one or multiple plies. In this form, however, the material is not adapted for use. The material is soft, has insufficient structural strength to prevent its being loosened or torn from the rivets used to attach it to the brake shoes, and is in loose fibrous condition that gives unsatisfactory resistance to wear in service. To overcome these objections it is customary to treat the woven listing with some form of impregnation or bonding agent such as oxidizable oils, resins, and/or bituminous materials which, upon solidification, by heat, pressure, or evaporation of the solvents used, becomes hard and embeds the fibers and yarns, thus acting as a bond and stiffening agent. These impregnating materials, however, being usually of an organic nature, lose to a greater or less extent their normal characteristics of toughness and strength when subjected to the high temperature conditions which accompany severe service as brake lining and become more or less unsatisfactory as to tensile strength and resistance to wear. Their softening under heat seriously affects the frictional characteristics of the material.

To remedy these undesirable characteristics, fibrous yarns made from either organic or inorganic fibres, but suitably from asbestos, are treated, either before or after weaving, with a water suspension of hydrated lime, whereby the fine particles of lime are deposited on and within the loose fibrous structure of the yarn. This treated yarn, in one embodiment of the invention, is then subjected to a weaving process, to form the desired weave structure, and the woven fabric immersed in or treated with a water solution of sodium silicate, subsequently washed, and dried. This treatment produces a marked change in the physical characteristics of the structure. From a soft, loosely fibrous structure unsuitable for use as a brake lining, the fabric treated by the above process becomes firm and acquires desirable characteristics of strength and resistance to abrasion. The product as a friction material has high resistance to wear and desirable friction characteristics. Furthermore, since the material retained in the fibrous structure is entirely inorganic, the product has great resistance to the action of heat and does not tend to change rapidly its frictional characteristics in use. The product is suitable as a brake lining for severe service.

As one example of this invention, asbestos yarn containing approximately 80% of actual asbestos and 20% cotton fiber is spun about one or more fine brass wires of about .008 inch diameter, to produce reenforced yarn. This yarn wound on spools is mounted on a frame or creel and the individual strands passed over a roller revolving partially immersed in a bath consisting of a water slurry or suspension of fine hydrated lime 25 parts and water 75 parts, by weight. This slurry wets the surface of the roller to the extent that the yarns, while being drawn in tangent position over the top of the revolving roll, absorb the required quantity of suspended hydrated lime within and around the fibers of the yarn. These yarns are then interfabricated, as by being woven either dry or wet into the desired form, preferably listing. Preferably the yarns are interfabricated without being dried and the resultant product is then dried, suitably at approximately 200° F., for several hours, or may be treated without previous drying with a water solution of sodium silicate for a definite length of time, preferably two hours, washed to remove excess sodium silicate and other soluble material, dried and calendered to size desired.

The resulting silicated fabric may now be applied directly to the shoe members of a given brake assembly without any further treatment, or the material may be further impregnated with a conventional friction material, as with a drying oil, pitch, bituminous substances, resins, and/or gums, in a manner that is usual in the impregnation of fabric for brake lining. Thus there may be used as the impregnating composition a solu-

tion of hard pitch in gasoline, say 1 part by weight of the pitch to four parts of gasoline.

A 2-ply double-selvaged fabric of asbestos yarn with inner reenforcing wires of brass, silicated as described above, and then impregnated with a bituminous friction material gave a brake lining of the following properties:

| | |
|---|---|
| Size of test piece | 2" x ¼" |
| Coefficient of friction—minimum | 0.36 |
| Coefficient of friction—maximum | 0.69 |
| Coefficient of friction—average, 10 hours | 0.62 |
| Coefficient of friction—average, 15 hours | 0.63 |
| Wear per hour—average for 10 hours | 0.00250" |
| Wear per hour—average for 15 hours | 0.00173" |
| Loss in weight in 15 hours | 14.0% |

The above data was obtained on a brake testing machine having a freely spported frame for holding the friction material under test in contact with a small steel wheel which is continuously rotated, and having an indicator for showing the pressure and torque. It is understood that the data obtained in testing friction materials will vary somewhat with the type of machine used for the test.

When a slightly softer product or different properties are desired, other additional materials may be introduced within the asbestos fibers. Thus there may be introduced a lubricant, or softening agent, such as a highly emulsified and suitably non-polymerizable mineral or vegetable oil. We have used, satisfactorily, powdered graphite added in amount equal approximately to 40% of the weight of hydrated lime. As used, the graphite and lime were intimately mixed in the dry form and then suspended in water, to produce the bath through which the yarns were drawn previous to weaving.

In the application of this invention to the manufacture of paper products, hydrated lime is added in finely divided state directly to a beater containing asbestos paper stock (such as short fiber asbestos gently beaten in water containing a small proportion of starch binder). The resulting mixture is then collected as a felt and finished in conventional manner. The formed sheets are then treated, either after being dried or in a damp condition, with a solution, of a soluble inorganic salt adapted to precipitate an insoluble lime compound, preferably an aqueous solution of sodium silicate, in such a manner that penetration of the mass is effected, with the consequent production of a hard structure with the precipitate substantially uniformly distributed throughout. Material thus produced may be used for a variety of purposes such as brake lining and as sheets in building construction. A feature of this product is its high resistance to pulping and weakening when used in paper form in damp locations, as well as its tenacity. This resistance is due in large part to the bonding of the fibers together by the precipitated silicate, for example.

Another type of asbestos product which may be made with the use of my invention is a hardened mill board. To make this improved mill board, approximately 15 parts of lime are mixed into the furnish to the mill board machine, suitably with about 10 parts of mineral wool, and 100 parts, by weight, of asbestos. The mixture is then collected on the continuous belt for forming the felt. The felt is then collected on a cylinder to form a laminated, thick sheet, removed therefrom, and dried in a usual manner, as at 170–270° F. The resulting mill board, containing particles of lime intimately associated with and approximately uniformly distributed throughout the units or fibers of asbestos, is immersed in a solution of water glass, washed, dried, and finished after the manner described above. The product is a very hard mill board which may be used as a substitute for Portland cement and asbestos compositions.

Another example of this invention is the formation of a molded article of refractory nature. In this embodiment, loose masses of asbestos fiber are mixed with finely ground hydrated lime and dry silicate of soda, the mixture is dampened with a dilute solution of sodium silicate, and formed into the desired shape in a mold under pressure. On removal from the mold the pressed mass is further treated by immersion in a dilute solution of sodium silicate and dried. If desired, the mass may be washed to remove soluble products of chemical reacton before drying. In carrying out the above process, materials in the following proportions may be used:

| | Parts by weight |
|---|---|
| Asbestos fiber | 70 |
| Hydrated lime | 10 |
| Dry silicate of soda | 20 |
| Dampened with 18° Bé. silicate of soda before pressing | |

Many variations may be made from the details of the examples given to illustrate my invention, without departing from the scope of the invention. For example, there may be used in place of the asbestos yarn or fiber described, other asbestos products, or other equivalent fibrous material. For products of special characteristics cotton yarn with or without reenforcing wires, or products of wool or wood pulp may be silicated as described above. However, particularly desirable results have been obtained when the base to which the silicating treatment is given is asbestos cloth or yarn that is later woven into cloth. In being woven into the fabric, the yarn may be interwoven with wires, as for example, those of lead or other soft and/or fusible metals. Or pieces of such metals may be embedded in or inserted between the yarns. Also, the yarn may contain a certain proportion, say 20%, of fibers other than asbestos, as, for example, cotton.

Instead of the precipitate of calcium silicate, there may be provided another compound of the same type, that is, an insoluble, inorganic substance, such, for example, as a silicate of a metal other than calcium, as for example, a silicate of lead, zinc, barium, and/or aluminum. In precipitating these silicates within the fibers or around the yarns, the procedure may be that outlined above, with the substitution of the lime by the hydroxide or other slightly soluble compound of the metal whose silicate it is desired to have in the finished product. The amount of lime or substituting material used is suitably 15 to 50, say 25, per cent of the weight of asbestos fibers.

It will be understood that the proportions of materials may be varied in accordance with the properties desired in the finished product. For example, the use of an increased quantity of lime, within limits, will increase the hardness of the product. The proportion of graphite or other lubricating agent affects the smoothness of the product. While the sodium silicate is used in the immersion bath preferably in excess, that is, in excess of the quantity absorbed by the fibre, I have made most satisfactory products when

the finished material, after the final washing and drying, contains no substantial excess of free sodium silicate, and the silicate that is present is insoluble in water, as in the case of calcium silicate. For many purposes, it is desirable that the amount of silicate in the fabric should be less than 50 parts, suitably approximately 25 parts, for 100 parts of asbestos.

In connection with the drying of the lime-impregnated asbestos product, as at an elevated temperature, before immersion in the solution of silicate, and with other steps in the process, it is to be understood that all of the effects upon the asbestos are made use of in my invention. Thus, the lime may produce swelling of or chemical combination with the asbestos. The invention is not limited to any theory or explanation of the results obtained.

In cases where the inner precipitation of a silicate gives a product not entirely suitable for the purposes for which the finished article is to be used, a different inner precipitate may be formed. Thus, units of asbestos, by which is meant fibers or yarn, may be treated in such a manner as to give a softer product than the silicated material. In making such a product, the asbestos may be impregnated with a slightly soluble compound of a metal, as, for example, lead chloride, and then treated with a solution of an electrolyte, such as soda ash or caustic soda, adapted to convert the said metal compound to a less soluble material.

There should be understood the distinction between the present invention in which an originally insoluble or slightly soluble inorganic material is first lodged and retained in intimate association with individual units of asbestos collectively composing an asbestos fabric and then converted in situ to a less soluble precipitate and processes in which impregnation is made with a water-soluble substance or in which one water-soluble substance reacts with another that is also soluble in water. A water-soluble substance migrates to the surface or "effloresces" on drying of a fabric containing it.

What we claim is:

1. A friction element adapted for use as automotive brake lining and the like comprising asbestos fibers, a water-insoluble, heat-resistant, dried inorganic compound, and an impregnating friction material bonding the fibers into a unitary product, the said compound being distributed substantially uniformly throughout the fibers and being in the condition of having been precipitated therewithin, by the interaction of a water-soluble silicate upon a compound of a metal associated with the said fibers previous to the application of the water-soluble silicate, and the said compound of the metal being only slightly soluble in water and adapted to form a precipitate with the water-soluble silicate.

2. A friction element adapted for use as a brake lining comprising interfabricated strands of asbestos yarn, a water-insoluble, heat-resistant inorganic compound of the type of calcium silicate precipitated and retained in situ, in intimate association with the individual strands and distributed substantially uniformly therethroughout, and an impregnating friction material.

3. A friction element adapted for use as a brake lining comprising interfabricated strands of asbestos yarn, a water-insoluble, heat-resistant inorganic compound of the type of calcium silicate precipitated and retained in situ, in intimate association with the individual strands and distributed substantially uniformly therethroughout, and a lubricant.

4. A friction element adapted for use as a brake lining comprising a woven asbestos product including reenforced strands of asbestos yarn, a water-insoluble, heat-resistant inorganic compound of the type of calcium silicate precipitated and retained in situ, in intimate association with the individual strands, and a soft metal.

5. In making a woven asbestos product comprising strands of asbestos yarn associated individually with calcium silicate, the method which includes treating the strands with a suspension of lime in water, weaving the treated strands into a fabric, drying the fabric at an elevated temperature, and then treating the fabric with a solution of sodium silicate, whereby insoluble calcium silicate is precipitated in intimate association with the individual strands.

6. In making a woven asbestos product, the method which includes treating strands of asbestos yarn with a compound of a metal that is only slightly soluble in water and is adapted to form an insoluble silicate, weaving the treated strands into a fabric, treating the fabric with a solution of sodium silicate, whereby an insoluble silicate is precipitated in intimate association with the individual strands, washing the silicate-containing fabric with water to remove soluble substances, and then drying the washed fabric.

7. A heat-resistant and durable product comprising a mixture of asbestos and mineral wool fibers and a water-insoluble, heat-resistant, inorganic substance precipitated in intimate association with the said fibers and bonding them together.

8. A friction element adapted for use as automotive brake lining and the like comprising asbestos fibers, a water-insoluble, heat-resistant, dried inorganic compound, a lubricant, and an impregnating friction material bonding the fibers into a unitary product, the said compound being distributed uniformly throughout the fibers and being in the condition of having been precipitated therewithin, by the interaction of a water-soluble silicate upon a compound of a metal associated with the said fibers previous to the application of the water-soluble silicate, and the said compound of the metal being only slightly soluble in water and adapted to form a precipitate with the water-soluble silicate.

9. An article of manufacture comprising asbestos fibers and a water-insoluble silicate distributed uniformly therethroughout, the article being identical with the product resulting from forming a mixture including asbestos fibers and a compound of a metal that is only slightly soluble in water and is adapted to react with a soluble silicate, to form an insoluble silicate, forming a felt from the said mixture, and causing the said compound in the felt to react with a solution of a soluble silicate, to precipitate an insoluble silicate throughout the said felt, with preservation of the fibrous nature of the asbestos.

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