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SEALING COMPOUND FOR PNEUMATIC TIRES AND METHOD OF MAKING THE SAME

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Our present invention relates to compositions or compounds to be placed in the inner tubes of pneumatic tires, to render them self-sealing when punctured.

The prior art discloses many mixtures for this purpose, but, so far as we are advised, those that are plastic contain rubber or rubber-like substances, while those that are not plastic, are suspensions of fibrous or flaky materials in water or an aqueous solution.

Of the suspensions, a few are composed of only fiber and water, but nearly all contain (*a*) finely ground fiber, (*b*) water, (*c*) a material to aid in holding the fibers in suspension, and (*d*) a material to lower the freezing point. Some also have other solids, such as whiting, clay or graphite, suspended with the fiber.

It is characteristic of these suspensions that there must be a surplus that will flow to the point where the puncture occurs. Consequently, most of these compounds are practically as fluid as water, and even those that are less fluid, as where a dextrin solution, or glycerine has been used as the suspension liquid, the compounds are specified as "flowing somewhat like syrup", or as "about the consistency of molasses".

In the case of all these liquid suspensions, the amount of fibrous or flaky material that will cling to the inner surface of the tube is not sufficient to plug an ordinary puncture, and that is why there must be a surplus to flow to the point where the puncture occurs. Consequently, considerable of the liquid and/or air must escape in order to carry enough fiber and/or other solid material into the puncture to plug it; and if the puncture is not in tread of the tire, a very large surplus is necessary in order to be sure that it will flow to and seal a puncture when it occurs in a side wall of the tube.

When such a mixture is fluid enough for the above purposes, it will flow to the bottom of the tire when it is out of use for any considerable time; and the more molasses-like it is, the longer will the collected material stick in one place and operate to unbalance the wheel when it is again driven at high speed.

As contrasted with the above, our invention depends on the discovery that finely ground fiber and hydratable material such as magnesia powder can be combined with slightly sticky water solution of non-corrosive salt, yet of such composition that a substantial part of the magnesia will become hydrated so that it has some of the qualities of milk of magnesia and so it serves as an effective filler and binder and carrier for the fiber and unhydrated part of the magnesia. Thus used, a given weight of magnesia is effective for plasticizing much more than its own weight of finely ground asbestos fiber even where a considerable excess of the water solution is used, and such mixture even when somewhat fluid, will have far more effective puncture-plugging qualities than any of those known in the prior art.

These qualities and functions of the above combination of substances have been utilized by us in the development of an entirely novel composition which is not properly describable as a suspension of fiber in a water solution but rather as a suspension of water solution in an asbestos-magnesia paste.

By way of illustration, our compound includes as a first essential, finely ground and screened asbestos fiber mixed with magnesia powder, preferably about 3 parts fiber to 2 parts magnesia, and water-salt-glucose solution combined therewith in a novel way and in novel proportions, to produce a non-liquid plastic material having novel qualities. In the preferred form this paste has two functionally important physical qualities; first, it is stiff and tenacious enough so that it appears to have no characteristics of a liquid, except of course that a large unsupported mass of it might tend to flatten out by reason of the gravity load imposed by the upper part of the mass; second, liquid is present in the mass in such relation that it will wet rubber, particularly the relatively pure rubber of an inner tube, and will creep along the surface of the rubber as a film combining the qualities of molecular affinity for adhesive contact with the rubber, and great surface tension for the exposed surfaces of the film. The net result is that even when a full charge of several pounds of the paste is inserted through the valve stem of an inner tube, it will not flow nor can it be distributed merely by whirling the tube. In fact, the most practical way for getting proper distribution is to use the tube in a tire on the road under practical working conditions for considerable time. Sufficient running will cause the liquid to creep, and the more solid parts of the paste to follow it circumferentially around the tire and also laterally around the inner surface of the tube. There is the further novel result that by this method the compound is distributed over said inner surface as a coating thick enough to locally cover and plug any puncture. This coating does not flow downward by gravity, nor does it creep downward so as to unduly thicken or thin the protecting layer,

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even when the car is out of use for long periods. This is in marked contrast to prior "suspension" compounds, all of which are fluid enough to unduly thin the seal on some parts of the tube and to depend on flow for supplying enough solid material to plug the puncture.

The above qualities of the compound are contributed to by having the solid fibers and filler materials (asbestos and magnesia) in much greater proportion to the liquid than any compositions employed in the prior art, but they seem more particularly dependent upon the physical and/or chemical relation of the magnesia to the water, and to the asbestos fibers. These relations and their functional results are due to the above described materials and the hereinafter described novel method of assembling them. The initially dry magnesia is in intimate association with the asbestos fiber when brought into operative hydrating relation to water containing a relatively small percentage of pure glucose dissolved in the water, so that the glucose has an intimate relation with the asbestos and the magnesia, particularly the hydrated part of the magnesia.

Preferably also, the solution contains material for ensuring plasticity at low temperatures. For this purpose, alcohol and glycerine are impractical because for cold winter weather, they would have to be so concentrated that they would inhibit hydration of the magnesia. For this and other reasons we prefer to use certain salts such as calcium chloride with a small percentage of a chromate or bichromate of an alkali, such as potassium or sodium, the percentage of the chromate compound being small in proportion to the calcium chloride, preferably somewhere between 3% and 10%. The calcium chloride is hygroscopic and its well known affinity for water seems to cause the calcium chloride in the solution to have some inhibiting effect as concerns hydration of the magnesia, but even where the paste was made with 20% $CaCl_2$ $(2H_2O)$, it was found that decrease of hydration of the magnesia was indicated only by decrease in the percentage of water required to maintain proper plasticity of the paste. On the other hand, the hygroscopic quality seems partly responsible for the maintenance of a substantial film of the calcium-chloride-glucose solution on the surface of the paste. Moreover, one of the properties of a calcium chloride solution is that of wetting and creeping along surface of a solid; and, while objectionable for most uses, this quality seems to be important in so much as the solution seems to creep along the surface of the rubber inner tube, with or in advance of the paste, thus assisting in distributing it in a relatively uniform layer protecting the entire inner surface of the tube, which remains stable even against prolonged action of gravity. Furthermore, the calcium chloride, as well as the small percentage of glucose in the solution, has the very obvious effect of preventing the asbestos magnesia from excessive setting, and keeping it relatively elastic and flexible even after long use as a sealing plug in a tire puncture. It would seem that under the conditions of such use, neither the calcium chloride nor the glucose is ever dried to a concentration where it ceases to have plasticizing or elasticity-imparting effect on the puncture-sealing plug.

The asbestos is very finely ground so that it is mostly segregated in single indivisible fibers, the fibers being very short, most of them a small fraction of an inch, and the screening being so fine that but few fibers as long as 3/8 inch, manage to get through. Too many long fibers may tend to form lumps in the paste which may tend to plug the air valve, but if in small percentage, they are not objectionable.

The magnesia is a commercial grade of pure magnesium oxide, known as "light" magnesia. This is in the form of a very fine, almost impalpable powder. While there is considerable latitude for the proportions of the magnesia to the pulverized asbestos, we prefer about two parts of magnesia to about three parts and preferably not less than two parts asbestos. Such magnesia is mixed with such asbestos fiber, as thoroughly as possible, and when so mixed, the magnesia clings to the asbestos fibers and a large part of it remains clinging during the subsequent hydration of the magnesia.

The glucose is preferably of the grade known as "confectioner's". The water is ordinary clean water, though it may carry a certain amount of natural mineral constituent. The proportions of glucose to water are such that the liquidity of the mixture is very little different from that of the pure water, the proportion of glucose being not less than 5%, and preferably not more than 10% of the water, by weight. Thus, though the mixture is a water solution of glucose, it is so dilute that the glucose can have no mechanical or other inhibiting effect on the operation of the water in hydrating the magnesia.

The calcium chloride and the chromate salts, when dissolved in the water-glucose, seem to have no inhibiting effect, but as far as can be determined, seem to be advantageous when present in the water-glucose mixture, at the time the asbestos-magnesia mixture is stirred into it.

As a matter of convenience, the glucose may be mixed in and diluted with one part of the water and the salts thoroughly dissolved in another part of the water, and then these two parts mixed together to form a uniform water-like solution. Likewise, for convenience, the solution of the glucose and dissolving of the salt may be facilitated by having the water hot.

It is no objection, and apparently is an advantage, to have the magnesia-asbestos mixture stirred into the water-glucose-salt mixture, while the latter is still warm, although this is a matter of no particular importance.

When the water-glucose-salt and the asbestos-magnesia have been mixed to thorough uniformity, and the mixture is allowed to stand for a sufficient length of time, say 24 to 48 hours, the hydration of the magnesia progresses, in intimate relation with the asbestos, salt, etc., with the result that the mixture becomes distinctly "jellied". When the jelly formation is broken up by further mixing, the final product is a paste, in which the hydrated magnesia seems to preserve some sort of a jelly-like relation with the asbestos, but a body of the material no longer seems to have any jelly characteristic. If the original amount of water was properly proportioned with respect to the amounts and qualities of the other constituents, the product will be a smooth paste and there seems to be a tendency for a slight excess of the water-glucose-salt solution to form a surface film on the paste, giving the surface a slightly slippery quality when touched, though slight pressure will result in disclosing the sticky pasty quality of the mass.

In producing the above described product, there are certain underlying principles that are im-

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portant. The proportions of two parts magnesia to at least three parts, and preferably not more than four parts of asbestos may be further and more closely predetermined on the principle that too much magnesia tends to cause too much slip or fluidity of the paste, while too little magnesia will tend to make it too stiff or harsh. The proportioning of the amount of asbestos-magnesia mixture to the amount of water in the solution of salts and glucose, is much more critical than the proportioning of the magnesia to the asbestos. There should be at least as much solution as can be held, mechanically or capillarily, by the magnesia-asbestos, plus a slight excess. On the other hand, it will be found that as excess water is increased, the value of the magnesia in carrying the asbestos becomes less and is finally lost. That is to say, the above proportions of magnesia to asbestos, are such that there will be enough magnesia to form a proper plastic carrying medium when the consistency is that of a paste, but not enough to do so when its consistency begins to approximate that of a liquid. It may be found that a given percentage of water will not always result in exactly the paste consistency that would be most desirable. This is because there will be variations in the qualities of the magnesia and of the asbestos, from one lot to another or from one shipment to another. Also, as above explained, the required percentage of water varies with change in the percentage of calcium chloride used. Consequently, while the proportions as above will be satisfactory enough for putting through the above process for producing the jellied product and then breaking it up and mixing it to uniform consistency, it will seldom be found that the amount of the solution has been exactly correct for giving the desired plasticity of the paste. Consequently, even in quantity manufacture, the standing instructions are to mix for about one hour or until homogeneous mixture is completed; then allow the mixture to stand 24 to 48 hours to cool and set in jelly form; then remix and adjust consistency, as may be required in each particular case.

While the proportions of the constituents may be somewhat varied within the above limits, and the salt may be omitted where the compound is to be used in hot countries or in hot weather, a preferred proportion for the constituents, by weight, is as follows:

	Per cent
Water, about 30 parts, or say	62
Glucose, about 2 parts, or say	4
Asbestos, about 9 parts, or say	18
Magnesium oxide, about 5 parts, or say	10
Calcium chloride, about 3 parts, or say	6
Chromate, about ¼ part, or say	½

The 6% calcium chloride referred to in the formula is $CaCl_2.(2H_2O)$, and this is the equivalent of about 4½% of $CaCl_2$. It will be understood, however, that this percentage is not critical and 15% to 20% may be employed if necessary for preserving the plasticity of the paste in very cold climates.

We prefer glucose because it is a liquid which though very viscous will speedily go into very dilute solution, as contrasted with other materials such as dextrin, which is a solid requiring much more time and effort for its solution. Moreover, glucose remains elastic and flexible even after drying for a long time, and this quality is even more marked when it is present in a calcium chloride solution having the above described hygroscopic and plasticizing qualities; whereas dextrin is in the nature of a glue which easily dries to a hard, brittle substance; and though possibly usable in the small percentage required to make a paste comprising our above described proportions of asbestos-magnesia mixture, calcium chloride, water, etc., we much prefer the glucose.

It is to be understood that while the above theories are probably correct and may serve to account for the remarkable novel qualities of our composition, the existence, and the novelty of said qualities are entirely independent of theory and would exist even if the theory were shown to be inaccurate or even incorrect in certain particulars.

Important qualities of our compound not heretofore noted include the following: Although the paste clings to and has a molecular adhesive quality with respect to the rubber, it does not cling to metal parts, such as the air inlet tube through which the mixture is introduced into the tire. Moreover, it has no corrosive action on the tube. It has no harmful effect on the rubber such as is characteristic of glycerine or the like. The use of glucose renders it entirely different from a compound in which dextrin is employed, dextrin being in the nature of a glue, whereas glucose in the quantities used imparts merely a slight tacky quality, which is quite different from a glue quality.

The composition will not work its way through the rubber, and when blown through a puncture will not stick the inner tube to the casing, as is the case with many compositions employed for such purposes. The non-liquid, paste-like quality of the composition makes it easy to patch and vulcanize the tube in case of blow-outs such as sometimes result from pinching of the inner tube, this being in marked contrast to the fluid fillers which flow through holes that are too large to be plugged by the fiber and other solid constituents of the compound. There is no danger of plugging the air valve when the tube is deflated therethrough.

As to the range of plasticity of the compound, it will be understood that the term "paste" as used in the claims is intended to be descriptive of a compound which will not be sufficiently fluid to flow like molasses and will not be stiff enough to fail of spreading completely over the inner wall of the tube so as to cover the entire inner surface with a layer of viscous substance of quality and consistency such that in all parts of the tube there will be enough of it present to immediately fill any opening, except possibly large ones such as result from pinching and blow-out. In this connection, it is to be noted that by reason of the paste quality of the compound, much larger openings may be automatically and satisfactorily plugged, than is possible with any of the compositions of the prior art.

As a specified illustration of a quantity of the compound desirable for properly protecting an inner tube, we may note that in a particular case where the inner tube had an inner or tire circumference of, say, 64 inches, and a tube circumference of, say, 16 inches, about 3½ pounds of a composition, made exactly according to the illustrative formula given above, proved entirely satisfactory throughout two years of rough use, during which several punctures, one of them of substantial size, was automatically healed, and one of them large enough to require it, was success-

fully patched and vulcanized, without removing the composition.

This application is a continuation-in-part of our prior copending application Serial No. 526,116, filed March 28, 1931.

We claim:

1. A tire sealing composition, including finely comminuted asbestos intimately associated with a substantially less amount of powdered magnesia and mixed with a dilute solution of water containing glucose, a substantial percentage of calcium chloride, and a much smaller percentage of an alkali; all combined in proportion insuring hydration of a substantial part of the magnesia and a paste-like consistency for the composition.

2. A tire sealing composition, including finely comminuted asbestos intimately associated with a substantially less amount of powdered magnesia and mixed with a dilute solution of water containing a small percentage of sticky material and a substantial percentage of salts in non-corrosive proportions; all combined in proportion insuring a paste-like consistency for the composition.

3. A tire sealing composition, including finely comminuted asbestos intimately associated with powdered magnesia and mixed with a dilute solution of water and glucose, the water being 10 to 20 times the weight of the glucose, the amount of asbestos being approximately 20% but not exceeding 100% greater than the magnesia, and the whole combined in proportions insuring a paste-like consistency for the composition.

4. A tire sealing composition, including finely comminuted asbestos intimately associated with powdered magnesia and mixed with a dilute non-corrosive solution of water, glucose and a hygroscopic salt, the amount of asbestos being approximately 20% but not exceeding 100% greater than the magnesia, and the water being 10 to 20 times the weight of the glucose.

5. A tire sealing composition, including finely comminuted asbestos intimately associated with powdered magnesia and mixed with a dilute solution of water and glucose, combined in proportions which, by weight are approximately as follows: asbestos, about 9 parts; magnesia, about 4 to 6 parts; water, about 30 parts; and glucose, about one-tenth to one-twentieth the weight of the water.

6. A composition as specified in claim 5, containing also about 1 to 4 parts calcium chloride, together with an alkali chromate about one-twelfth to one twenty-fifth the weight of the calcium chloride.

7. A method of making a tire sealing composition which includes dry-mixing finely-comminuted asbestos and a substantially less amount of magnesia powder, dissolving glucose in 15 to 20 times its weight of water, intimately mixing the asbestos-magnesia mixture with the glucose solution, the amount of solution being in such proportion to the amount of asbestos-magnesia as to insure hydration of most of the magnesia; allowing the mixture to set until the hydrating action of the solution on the magnesia is completed and a jelly-like mass is formed; breaking up the jelly-like mass, mixing it to uniform consistency and adjusting the proportions of solution to the solids to insure a paste-like consistency for the product.

8. The method of making a tire sealing composition which includes dry mixing finely comminuted asbestos and with a substantially less amount of magnesia powder, and intimately mixing it with a dilute solution containing a sticky material with 15 to 20 times its weight of water; said solution being prepared by dissolving the sticky material in part of the water, dissolving calcium chloride separately in another part of the water and then mixing said solutions together before mixing in the asbestos-magnesia, allowing said intimately mixed mixture to set until the hydrating action of the solution on the magnesia has been completed and a jelly-like mass has been formed; breaking up the jelly-like mass, mixing it to uniform consistency, and adjusting the proportions of the solution to the solid to ensure a paste-like consistency for the product.

9. A tire sealing composition including finely comminuted asbestos fibers intimately associated with powdered magnesia mixed with a water-like solution of water and water soluble substances including a substantial percentage of deliquescent salt and a small percentage of sticky material; the asbestos being by weight approximately 20% but not exceeding 100% more than the magnesia, and the solution being of amount, dilution and quality operating to hydrate a substantial part of the magnesia and to form a paste-like mass.

10. A tire sealing composition including finely comminuted asbestos fibers intimately associated with powdered magnesia mixed with a water-like solution of water and water soluble substances including a substantial percentage of calcium chloride, with a smaller percentage of a chromate of an alkali and a small percentage of sticky material; the amount of magnesia being by weight substantially less than the asbestos and the solution being of amount, dilution and quality operating to hydrate a substantial part of the magnesia and to form a paste-like mass.

11. A tire sealing composition in the form of a paste-like mass including finely comminuted asbestos fibers intimately associated with and carried by magnesia which is less by weight than the asbestos and a substantial part of which is hydrated by and intimately associated with a slightly adhesive water solution of such amount as can be mechanically or capillarily carried by the magnesia-asbestos in the said plastic mass plus a slight excess adapted to form a liquid film on the surface thereof.

12. A tire sealing composition in the form of a paste-like mass including finely comminuted asbestos fibers intimately associated with and carried by magnesia which is less by weight than the asbestos and a substantial part of which is hydrated by and intimately associated with a water solution of such amount as can be mechanically or capillarily carried by the magnesia-asbestos in the said plastic mass plus a slight excess adapted to form a liquid film on the surface thereof, said solution containing water soluble materials not substantially decreasing the water-like fluidity of the solution, said solution including small percentages of sticky material, and of salts suitable for maintaining the plasticity of the paste at a desired low temperature.

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