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PROCESS OF MAKING FRICTION FACINGS.

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To all whom it may concern:

Be it known that I, IZADOR J. NOVAK, a citizen of the United States, and a resident of the city of Bridgeport, county of Fairfield, and State of Connecticut, have invented certain new and useful Improvements in Processes of Making Friction Facings, of which the following is a specification.

This invention relates to improvements in friction facings and friction elements which are subjected to friction in connection with brake surfaces for clutches used with internal combustion engines and like friction surfaces.

Among the salient objects of the invention are to provide more particularly friction rings produced from low grade asbestos made by combining asphalt bituminous substances with the asbestos and treating them to produce a hardened ring; to provide friction elements which have a greater tensile strength and higher Brinell hardness than elements heretofore made and rings that are more uniform in character and will withstand for a longer period of time the deteriorating effect of the wear to which they are subjected.

In producing these friction elements I preferably employ low grade asbestos fibre pulp which is prepared in a beater machine such as the Dilts beater. The time of beating the asbestos stock should be limited to that the beating is sufficient only to separate the fibres and is not continued for a long enough period to shorten them to any great extent. Asbestos does not hydrate by continued beating so that there is no advantage in prolonging the operation as is the case with paper. Care should be taken to exclude paper fibre from the pulp as too much of the latter (say above 5%) is deleterious to the strength and hardness of the finished ring. To strengthen and stiffen the body of the element so that it may not be distorted or broken in handling a boiled starch size set with caustic and alum is used. This size may comprise say, 1% to 3%, of the weight of the dry stock. It has been found that unsized low grade asbestos produces a sheet that is flabby and weak in character.

The stock, when thoroughly mixed, should be run off on an ordinary wet machine such as used for binders' board and cardboard products, with an amount of water sufficient to insure easy running, the stock being allowed to build up on the make-up roll until it is the desired thickness. It is then removed in the customary way by slicing across the roll with an awl. The sheets from the wet machine are pressed with blankets positioned between the presses to remove the greater part of the water after which they are dried on flat racks at from 225–250 degrees F.

After removal from the drier the sheets are calendered down to the correct thickness, and annular rings of the desired size cut by means of a suitable die press. The waste is returned to the beater for reworking.

Stock made in this way may test from 60 to 100 pounds on a Mullen tester for .125 inches, but in certain cases may have wider variations.

In the preparation of this stock, it is desirable to keep the surfaces as nearly alike in porosity as is practical. This may be done by use of a felt or canvas covered make-up roll. The advantage of having the surfaces alike as to porosity is to diminish the tendency of the ring to dish or warp during the cure, due to the different porosities of the two sides and, hence, the different rates of curing of the smooth and rough surfaces, of board made on the ordinary wet machine with a smooth make-up roll and a felt blanket.

The ordinary dry stock as delivered for saturation contains 1 to 4% water, depending on the prevailing humidity. This water is rapidly volatilized at the temperature of saturation (300 degs. F.) and in its escape caused frothing. This frothing does not affect the actual saturation but often causes inconvenience by overflowing the tanks. It may be entirely avoided by drying the rings on a spindle for a short time before saturating and saturating soon after the removal from the drier. This drying does not affect the saturation noticeably. A saturant which has given good results consists of a residual tar from a light base Mexican crude petroleum topped at 500 to 600 degs. F. in the following specifications:

Specific gravity less than 1.00.
Flash point over 250 degs. F.
Fixed carbon in excess of 10%.
Soluble in carbon tetrachloride, 99%.

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The rings after drying are hung vertically upon spindles conforming to their inside diameter, being separated from each other not less than one-eighth an inch. These spindles are placed upon a carrier and the entire carrier immersed in the saturant which may be 300 degs. F. more or less for a predetermined saturating period, varying in length with the thickness of the wall to be saturated. It is important that the space between the rings be not less than one-eighth of an inch or thereabouts as when they are closer the air bubbles that form stick between the rings and retard saturation.

The length of saturation has an important bearing upon the reaction due to rolling. During the calendering, the sheet is lengthened from 1% to 3%, depending upon the amount of calendering necessary. This causes a strain upon the sheet which manifests itself during the saturation. After the ring has been cut from the stock which has been subjected to the calendering strain, the saturant permeating through the ring loosens the fibres relieving a part of the strain. The ring consequently shrinks in the direction in which it has been rolled or calendered and becomes slightly elliptical, which is extremely undesirable in a product which must necessarily be held so close to size as a clutch facing or friction ring. If the first saturation is permitted to go on to completion, this distortion will always be encountered. If, on the other hand, the rings are removed while there still remains a sustaining skeleton of unsaturated stock and the saturated portion is cured, the cured portion will preserve the original exactly circular shape of the rings. For this reason it is essential that the period of primary saturation be accurately fixed so that only a portion of the stock is permeated with the saturant.

There is, on the other hand, an under limit to this saturation which must be carefully avoided. If the amount absorbed in the first saturation is less than 18% of the original weight, upon reaching the temperature of cure, the asphalt is very liable to ignite and burn. There is no danger of this if the concentration of the saturant is kept higher than two parts saturant to ten parts asbestos. The upper limit of saturation is not important with this manipulation. There is a compensating action of the second saturation on the first, that is, the weight of the saturant absorbed during the second saturation varies inversely as the weight of the saturant already in the ring after the first cure. The weight of the saturant absorbed during the first saturation should be normally between 30% and 40% of the normal weight. To maintain the saturant at a proper density for continuous use, it may be thinned from time to time by the addition of gas oil such as oil having been relieved of its more volatile fractions and having a gravity of from 27° to 30° B. After removal from the saturant by lifting the carrier therefrom, the rings are allowed to drain and cool. Immediately the asphalt "strikes in" and permeates the stock, leaving a clean dull brown surface. This indicates, first, that the saturation has not been excessive for the cure to be given it and, second, that no asphalt will remain on the surface to form an impenetratable skin during the cure and so hinder the oxidation of the interior of the ring.

During the first five hours of the cure the smoke should be removed from the oven by means of blowers, and if desired, may be burnt under the boilers. The temperature of curing should be accurately regulated. The temperature of the oven is raised gradually during a space of four hours from 200 to 500 degs. F., this interval being sufficient to provide for the safe distillation of the low boiling point liquids in the saturant. If the heat is raised too rapidly, the distillation is violent and blisters form on the rings from the expansion of the vapors imprisoned in their interior.

Also, the saturant expanding rapidly before its volume is diminished by volatilization appears on the surface in small drops. This asphalt that remains on the surface dries and forms a skin which effectually diminishes the rate of cure of the central or interior portion of the rings.

After the preliminary cure at 200 to 500 degs. F., the temperature is held at approximately 500 degs. for a period in the neighborhood of eight hours. The change from a softy, flabby, moist material to a hard, dry substance takes place rather sharply between the first and second hour of cure at 500 degs. F. At this time the greatest fire risk is present. At the end of this first cure, the solubility in chloroform, ether, alcohol, aniline or amylacetate is very slight.

After the cure the rings are rapidly removed from the racks and subjected to great pressure while cooling. This high pressure straightens any slight distortions or defects in the rings, the rings being slightly amenable to high pressure at 500 degs. It is very difficult to straighten a ring that becomes dished or warped, and for this reason, it is essential to prevent as far as possible distortions of this sort.

It has been found that stock made on a smooth make-up roll forms rings that are more susceptible to dishing or distortion due to the fact that the rough or more porous side cures more rapidly than the smooth side. The method used for preventing this variance in the porosity in the two sides of the stock is to cover a smooth make-up roll with canvas or felt of a texture and com-

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pressibility similar to that of the blanket. This method produces two sides of uniform character.

When the rings have cooled and the pressure has been removed, they are replaced upon the racks and resaturated in the same saturant as was used for the first saturation. There will, of course, be less foaming and the saturation as a whole proceeds more easily and smoothly as there is less moisture to be driven from the stock. There is no danger of over-saturation during the second immersion as the rings are not subject to distortion as after the initial bath. After removal from the first cure, the rings average from 2000–2500 lbs. per square inch in tensile strength and from 15 to 18 in Brinell hardness, containing from 12% to 17% residual asphaltic binder.

The second saturation is necessary in order to increase the strength, hardness and, therefore, resistivity of the rings to wear in actual service. Enough supplementary saturant is absorbed in the second immersion to bring the total amount absorbed during both saturations to about 50% of the original weight. The saturant does not, however, permeate or strike in as cleanly after the second as after the first immersion.

The second cure is accomplished in the same oven and in the same manner as the first cure except that the rings may be introduced to the oven directly at 500 degs. F. without any preliminary graduated heating. This is possible due to the small weight of saturant absorbed and the lower susceptibility of the material itself. This cure may be continued at 500 degs. for a desired period, four hours being the usual period of treatment. By this time the rings are completely dry of the saturant absorbed during the second immersion. There is, however, a dense skin of cured asphalt on the surface which should be removed in order to facilitate oxidation of the asphalt in the secondary or interior portion of the rings. The rings are removed from the oven and permitted to cool and the surfaces on both sides removed of five to ten thousandths of an inch of material to the exact final size desired. This operation is preferably effected upon a sander or wood finishing machine.

The rings, after being sanded on both sides, are returned to the oven and the remainder of the cure accomplished in an eight hour curing period at 525 degs. F. The rings are again pressed while hot in order to straighten any that have become warped during the latter cure. The rings are then ground to the proper diameter size for attachment to plates for use in friction clutches.

This method will produce rings which average above 3500 pounds, in tensile strength and above 19 Brinell hardness. In some cases rings of a tensile strength of over 4700 pounds have been obtained. They are straight and flat and the inside diameter of the ring is uniform and does not deviate from a true circle materially.

It has been found that there is a certain ratio of asphalt retained after the final cure to asphalt absorbed on both saturations which gives the optimum strength in the shortest time. Further curing lowers this ratio slightly but does not change the tensile strength materially. The ratio for the method explained is approximately .50. The percentage of saturant based on the weight of the finished ring averages between 17 to 20%. It has been found that if the percentages of saturant are much lower than 17%, weak rings will result, and much higher than 20% of residual saturant will increase the time of cure to an extent beyond that by which the aforementioned optimum ratio is obtained.

An excess of paper is highly undesirable in the stock from which the rings are cut, for during the curing at 500 degs. F., it will tend to completely carbonize, leaving five-sixths of the space previously occupied entirely empty. Such voids are obviously undesirable because of their weakening effect on the rings. The denser the ring, the greater the tensile strength and hardness.

The above-described process is a series of steps chosen as an example, but it is understood that numerous variations may be introduced both as to temperature, character of materials and time of treatment without departing materially from the scope of the invention. Thus, a heavy base topped Mexican crude petroleum or a blown mid-continent oil of the correct specifications will give rings with the above manipulation that will average above 3000 pounds in tensile strength and over 19 in Brinell hardness. Also there are many combinations or particular asphalts that will produce rings of the same excellent properties. Further the character of the saturant as well as numerous other operating conditions may vary somewhat the time of treatment and the particular methods involved.

I claim as my invention:

1. A process of making friction elements, consisting in cutting friction elements from a sheet of felted incombustible stock, subjecting the elements to a primary saturation with an asphaltic binder substance, and curing the saturated element for a period of time sufficient to attain a suitable binding strength and hardening, and effecting a final saturation and cure.

2. A process of making friction elements, consisting in separating asbestos fibre in a beater, agglomerating the fibres with a size, passing the mixture over a paper machine with water to form a sheet, calendering the

sheet to a predetermined thickness, forming friction elements therefrom, subjecting the elements to initial and final saturating and curing operation, said saturant comprising a topped Mexican crude.

3. A process of making friction facings, consisting in separating asbestos fibre in a beater, agglomerating the fibres with a size, passing the mixture over a paper machine with water to form a sheet, calendering the sheet to a predetermined thickness, forming friction elements therefrom, saturating the elements with an asphaltic base topped Mexican crude oil at a temperature in excess of 200° F. and subjecting the saturated elements to a curing operation.

4. A process of making friction elements, consisting in separating asbestos fibre, mixing the fibres with a sizing substance, passing the mixture over a paper machine and calendering the sheet produced therefrom to a predetermined thickness, forming the friction elements from the sheet, saturating the elements with an asphaltic base topped Mexican crude oil and subsequently subjecting them to a curing operation until the remaining saturant bears a ratio of substantially 50% of the absorbed saturant.

5. A process of making friction facings, consisting in cutting friction elements from a sheet of felted incombustible stock, subjecting the elements to a primary saturation with an asphaltic binder substance, and curing the saturated element for a period of time sufficient to attain a suitable binding strength and hardening, and effecting a final saturation and cure, the asphaltic binder in the cured ring having the characteristics of being insoluble in asphaltic solvents.

6. A process of making friction elements consisting in sheeting asbestos fibre on a paper machine, calendering the sheet to predetermined thickness, forming friction elements therefrom, saturating the formed friction elements with a topped crude having an asphaltic base, and heat treating the saturated element to harden the binder.

7. A process of making friction elements consisting in separating asbestos fibres in a beater, agglomerating the fibres with a size, passing the mixture over a paper machine with water to form a sheet, calendering the sheet to a predetermined thickness, forming friction elements therefrom, subjecting the elements to initial and final saturation, and a curing operation, said saturant comprising a topped asphaltic base crude.

8. A process of making friction elements consisting in separating asbestos fibre in a beater, agglomerating the fibres with a size, passing the mixture over a paper machine with water to form a sheet, calendering the sheet to a predetermined thickness, forming friction elements therefrom, saturating the elements with an asphaltic base topped crude and curing the saturated elements.

9. A process of making friction elements consisting in separating asbestos fibre, mixing the separated fibres with a sizing substance, passing the mixture over a paper machine and calendering the sheet produced therefrom to a predetermined thickness, forming friction elements from the sheet, saturating the formed elements with an asphaltic base topped crude, and subsequently subjecting the saturated elements to curing until the remaining saturant is substantially one-half of the originally absorbed saturant on the basis of weight.

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