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CORK SUBSTITUTE AND PROCESS FOR MAKING SAME

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The invention described herein may be manufactured and used by or for the Government for governmental purposes, without payment to me of any royalty thereon.

This invention is directed to a cork substitute which may be produced in sheet form, molded or otherwise worked into any desired shape, and utilized to form liners for closures to be used with glass and tin containers, gaskets, washers, insulating materials, and/or resilient flooring material. The cork substitute produced by my improved process is made from the outer bark of the trees of the Betula family, commonly known as birch bark, this being the major constituent, and suitable bonding materials, together with plasticizers, fillers and such other ingredients as may be required to give to the compositions the desired properties. The Betula family of trees is composed of many varieties, each of which has a bark differing in its characteristics and properties from any of the others.

While the bark of several species may be utilized to produce the cork substitute under consideration, I have found that the outer bark of the paper birch (*Betula papyrifera*) is best suited for this purpose. Birch trees grow in abundance in certain parts of the north temperate zone and paper birch in particular is found in large stands of merchantable size timber in the States of Maine, New Hampshire, the Canadian Provinces adjoining and elsewhere. The outer bark of this species, due to the fact that it is often obtainable in slabs of up to two to three square feet and in thicknesses up to approximately 3/8 inch and also relatively free of inner bark and wood, lends itself readily to the production of materials suitable for use as gaskets, washers, and insulating products generally.

Trees of the birch family are used in many industries, as for example, the toy, textile, furniture and as pulp wood for paper manufacture. Where the felled trees are taken to wood-working factories to be processed into wooden objects, the stripped bark is generally burned along with the other wood waste of the mill. Where the felled trees are to be used for paper manufacture the usual practice is to strip the bark in the forest and leave it there. During certain months of the year when the sap is flowing freely, the bark of the birch is more easily removed from the trees than during other seasons and the rossering produces a fairly clean bark. Improvements in the art of rossering are possible and will give a product approaching the clean outer bark resulting from hand peeling, which is practiced to

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a considerable extent in some localities during certain seasons of the year.

In forest areas where paper birch trees have been cut, the parts of the trees not considered suitable for fabrication into wooden products, or for other purposes, display a marked difference between the wood and the outer bark as regards their ability to withstand the elements. Sections of the tree are found where the outer bark is still in a prime condition and the wood completely decayed. The decayed wood takes a more or less granular or powdered form, held in place only by the outer shell of bark. This is ample evidence that the outer bark possesses qualities and properties superior to the wood as regards its ability to resist the effects of the elements. While all the trees of the Betula family have a more or less laminated and resinous outer bark, at least during their early life, it is a characteristic of the paper birch species to develop and retain its bark in a continuous and impervious sheathing over relatively large areas. This characteristic makes it possible for the outer bark of the birch trees, left in the woods after a lumbering operation, to stand up persistently under all conditions of weathering. The bark of the yellow birch (*Betula lutea*) and the bark of the sweet birch (*Betula lente*), which are the only two other species having commercial importance, may be utilized for the production of a cork substitute when obtained during certain stages of the growth of these species.

It is therefore one of the objects of this invention to produce an industrial utility embodying the resinous and laminated outer bark of those trees of the Betula family which may be employed as a substitute for cork. The bark of the paper birch trees, after they have reached their prime of life, tends to blacken and become furrowed but with this species the practice of industry is to harvest the crop of trees at an age where the bark has not deteriorated beyond its usefulness. In accordance with this invention, the clean outer bark of the birch trees is compounded with such other materials as are required to develop in the processing, properties and characteristics suitable for such industrial utilities as discs, rods, blocks, sheets, and the like, which may be produced by molding, extrusion, hot rolling, or calendering.

This outer bark, after the necessary cleaning and preparatory work, may be prepared for manufacture by a reduction process such as, passing the bark between a pair of spirally corrugated differential rolls, by shredding, carding, and shiving, or a combination of such processes, to provide

a product of the desired degree of coarseness. For some products a coarseness of minus 8 to plus 20 mesh has been found to give satisfactory results while for others finer grades have been found to be more desirable. The divided product may be graded into any desired number of fractions from the fines or powdered stock to coarse materials. The degree of coarseness or fineness desirable for a given material depends to some extent on the "stiffness" of the desired finished product, the type and kind of binder, the processing specifications to be followed and the proportions of binder and birch bark.

With the corrugated differential speed rolls, the reducing action is one of tearing rather than one of grinding and the pressure exerted on the bark to bring about a reduction to the desired particle size can be controlled so that the elastic limit of the bark is not reached.

Shredding and carding produce sliver-like particles which yield a product wherein the individual slivers of bark are set in interlaced relation in the processing of the compositions made from them, while shiving produces a flake-like stock which has certain advantages, among which may be mentioned the formation of more or less laminated structures which will require less binder.

I have discovered in my work with birch bark that a material excellent for bottle cap liners, gaskets, washers and insulating products generally, results only when clean outer bark is used and has been reduced to the desired particle size with as little loss of the occluded air and gases as possible. This may be accomplished by any suitable reducing apparatus as indicated above in which the bark is not compressed beyond the elastic limit which would break down the cellular structure of the bark. I have also found it desirable to have the bark in the form of scales, flakes or shredded stock rather than rounded or oval shaped particles. With flaked stock less binder is required to firmly cement the particles together. With large sized particles, more bark and less of the binder is exposed to possible corrosive action.

With the outer bark cleaned of all inner bark, wood and foreign materials and reduced to particle size desired by carding, shredding, or shiving, and screened to eliminate over and undersized particles, the bark is ready for compounding with the desired bonding materials.

The bonding materials may be dispersed uniformly throughout the mass of birch bark particles by any of the well known processes. The process and equipment to be employed are dependent on the type of binder used. With water and high boiling point solvents, open type mixers are satisfactory. Where volatile solvents are included in the binder mix, and solvent recovery is desirable, closed types of mixers are preferable. After mixing, it is desirable that the bark and binder mix shall be free flowing, and transportable by compressed air, so that the product may be readily handled in the subsequent storage and molding or other forming operations. Where the solvents retained in the mix prevent free flowing, it is necessary to either transfer the mix to aging tables where it may be spread out and the solvents allowed to evaporate or the mix desiccated. The solvents may be drawn off by placing the mix in a vacuum apparatus or air blown through the mix to carry them off. Where the value of the solvents warrant, a solvent recovery system is indicated. For some types of binder materials, the incorporation of the binder with the bark may best be carried out on heated rolls. This method has been found very satisfactory where thermoplastic materials, as for example triethanolamine-caseinate, rubber and similar compounds are to be used for bonding the birch bark particles.

In practicing my invention several formulae have been developed to meet specific commercial needs, wherein birch bark is used in combination with different binder materials. The following are examples:

Example 1

15 grams of hide or bone glue (elastomer)
25 cc. of water (solvent)
15 cc. of diethylene glycol } solvents-humectant-plasticizer
15 cc. of glycerine }
½ gram of hexamethylene tetramine (hardening or setting agent)
175 grams of birch bark
17½ grams of paraffin wax M. P. 60° C. (waterproofing agent and lubricant

In the preparation of the binder, the glue is added to an agitated mixture of water, diethylene glycol and glycerine and allowed to remain therein for several hours until it has swelled to the desired extent. When this has occurred the mixture is heated in a water bath to 180°–190° F. to effect complete dispersion of the glue in the solvents, the mixture being stirred in the meantime to hasten the results. When dispersion is complete the mixture is allowed to cool to 65° C., whereupon hexamethylene tetramine is added. The mixture is then ready for incorporation with the birch bark. This is accomplished by adding the mixture in a very fine stream to a predetermined amount of birch bark while the latter is being rapidly stirred, the stirring being continued until complete and uniform dispersion has been effected to form what will hereinafter be referred to as the batch. The batch is considered as complete when it is free of agglomerates and no longer tacky. With a batch of the size given in the above formula, from fifteen to thirty minutes under constant agitation was found to be sufficient to bring about satisfactory dispersion and render the batch non-tacky. The batch having been prepared as above the weighed amount of melted paraffin wax is then added slowly and with constant stirring. The stirring of the batch, now including birch bark, binder materials and wax is continued until the wax is completely and uniformly dispersed throughout the entire mass. Approximately fifteen minutes of stirring, after addition of the wax, was generally found to be sufficient. Upon complete dispersion of the paraffin wax, the mixture of batch ingredients is ready for pouring into the molds or for tampering into the brass tubes wherein the compositions will be processed into the forms it is desired to produce. However, in connection with the use of hexamethylene tetramine, previously referred to, it is to be noted that this ingredient is not added to the mixture of glue and solvents until the glue and solvents have been allowed to cool to a temperature of approximately 65° C. By this procedure the hexamethylene tetramine is introduced into the mixture while the latter is at a temperature affording complete dispersion but below that which would liberate sufficient formaldehyde to cause immediate hardening of the glue.

While the above formula, in which the weight of the binder is approximately forty per cent of the weight of the birch bark, may be used with satisfactory results, in the production of rod and block stocks, I prefer to make a stock prep-

aration of the glue and solvents and then add thereto hexamethylene tetramine in the proportion noted in the formula, hexamethylene tetramine being added to a weighed amount of the stock preparation, after the latter has been brought to a temperature of approximately 65° C. This prepared mix is then added to the required amount of birch bark. To this batch paraffin wax is added in the proportion of ten per cent based on the weight of the birch bark. While forty per cent is the percentage of glue and solvents to birch bark, indicated in the above formula, other percentages may be resorted to when the requisite properties of the desired product so require.

In the manufacture of rods, the batch, as noted above, is tampered into brass tubes, the inner walls of which have been swabbed with a heavy paraffin oil or other lubricant. Where crown seal liners are to be made the inside diameter of the tubes is $1\frac{1}{16}$'' and the amount of batch tampered into said tubes is sufficient to give a product ranging from 2½ to 3 ounces per linear foot. This indicates a compression ratio of about 4 to 1. After being filled, the tubes are placed in a fixture which provides for sealing the open ends, and then baked in an oven at a temperature range of 240° F. to 265° F. for a period of thirty to forty-five minutes. I prefer to use the longer time interval with the lower temperature and the shorter time interval with the higher temperature. After the tubes containing the batch have been baked, they are removed from the oven and allowed to cool to about 125° F. to 130° F. Approximately one-half hour will be required for the cooling operation. When the rods are thus cooled, they are readily extruded with a ram without much pressure being required. Where the extrusion takes place before the rods are allowed to cool sufficiently, and the contents of the tubes have become set, there is a tendency for the extruded rods to expand both laterally and lengthwise. If the rods are left in the tube until excessively cooled, the pressure required to effect their extrusion becomes excessive and results in their permanent deformation.

When the blocks are manufactured, the weighed amount of the batch is poured into the mold, the sides of which have previously been lubricated, and the mass of material compressed to the thickness which will provide the desired density in the molded block.

After appropriately sealing the molds, they are placed in an oven and the contents thereof baked. The larger the mold the longer the baking time required to insure that the heat has penetrated to the center of the mass. For a 2'' diameter block 1½'' thick approximately one hour baking time was found to be sufficient.

When the rods are to be used for the production of crown seal liners, or other disc shapes, they are cut into discs of suitable thickness with smooth surfaces, having the proper diameter, which is the same as the molded rods. Sheets preferably are made by slicing layers from molded blocks with a band saw, and from them different shapes may be cut or blanked out.

Products made in accordance with the above procedure will withstand the action of actively boiling water for at least fifteen minutes and after such boiling treatment the products retain a satisfactory degree of flexibility. In the experimental work it was found that the molded blocks and rods lost weight quite rapidly immediately after they were removed from the molds and that the rate of loss in weight decreased with time. After a time interval of about one month, there was found to be no further substantial loss in weight, although there may be a slight variation from day to day. When this stage has been reached, it is considered that the shapes have aged sufficiently and any fluctuations in weight subsequently noted are natural differences due to the property of the humectants of giving up and taking on water as required to keep a moisture content in the shapes in equilibrium with the moisture content of the air, thereby maintaining the desired plasticity in the shapes. As a result of these observations, I prefer to permit the shapes prepared with the glue binder as noted above, to age for approximately one month before utilizing them for the production of articles for commercial use. In place of the glycerine, I may use sorbitol in conjunction with diethylene glycol. The ratio of glycerine to diethylene glycol may be varied as desired, and other similar compounds, as for example, sorbitol, may be substituted for any part of each. Glycerine and sorbitol may be used alone, if desired, although it is preferred to use diethylene glycol in conjunction therewith. In any event I prefer to have approximately two parts of humectant to one part of the glue in the final composition as this ratio gives to the glue the desired plasticity and hence imparts the desired flexibility to the final products.

One of the functions of the paraffin wax in the composition is to serve as a waterproofing material. In this capacity, the presence of the wax enhances retention of the moisture content in both the intermediate shapes and final products, thus maintaining uniform flexibility of the products regardless of atmospheric conditions.

Example 2

32 parts of a solution containing 45 to 50% of phenol-formaldehyde solids (Bakelite resin solution #XC11488)
15 parts of diethylene glycol
7½ parts of formalin
109 parts of birch bark (flake stock)

The binder ingredients as shown in the formula are stirred into the birch bark and the stirring continued until the agglomerates have all been broken up and the mix is a uniformly granular mass. After the mixing is complete, the binder and birch bark batch is spread on a table and the solvents allowed to evaporate. To hasten evaporation the material is stirred from time to time. On a larger scale operation the solvents would be recovered to do this the mixing operation should be carried on in a closed vessel with agitation. Upon release of the great bulk of the solvents (those contained in the Bakelite solution) the batch becomes dry to the touch and is free flowing. This composition is put in the mold and after being compressed to the desired compactness is baked at a temperature of 260° F. for thirty minutes to bring about the polymerization of the phenol. The above curing specification gives satisfactory results with a rod two feet long and $1\frac{1}{16}$ inches in diameter. For larger molded pieces additional time is required to permit the heat to penetrate to the center of the object.

Example 3

31 parts of a 60% solution of urea-formaldehyde in butanol
36 parts of #2600 Paramet resin solution (60% modified alkyd resin in toluol). The phthalic alkyd resin consists of 50% phthalic glyceride and 50% castor oil
105 parts of birch bark (flake stock)
5 parts of paraffin wax, M. P. 55° to 60° C.

The binder ingredients as shown in the formula above are stirred into the birch bark with the stirring continued until all the agglomerates have been broken up and a uniform batch results. The wax is then melted and poured into the batch while same is stirred. Stirring is continued until the wax is completely and uniformly dispersed throughout the batch and the latter becomes dry and free-flowing. A batch prepared as above when tampered into 1⅛" diameter brass tubes of 24" length, gives a satisfactory cure when baked at 260° F. for thirty minutes. On large scale operations the butanol and toluol can be recovered in any suitable solvent recovery system connected with the mixer. Samples of discs cut from the rods were satisfactory in the boiling water test and also for formaldehyde content.

Example 4

85 parts of casein
6 parts of commercial triethanolamine
85 parts of sorbitol
15 parts of bentonite (powdered)
100 parts of water
30 parts of birch bark (100 mesh or finer)

A binder made of triethanolamine-caseinate, a humectant and a filler insoluble in organic solvents when mixed with the outer bark of trees of the paper birch species, produces a composition suitable for certain commercial needs. The above formula gives satisfactory results.

In the preparation of this composition I prefer to steep the casein in the triethanolamine and sorbitol, with stirring to effect uniform dispersion and hasten results. When this has taken place, the bentonite, which has been swelled in the formula weight of water, is stirred in and the whole mass ground and kneaded until uniformity is obtained. The birch bark is then added and the mixing continued until the birch bark is uniformly dispersed. The mass resulting from the above treatments is then transferred to heated rolls where it is softened and finally calendered. The tannin in the birch bark reacts with the casein during the softening and working on the heated rolls to bring about a cure and impart to the composition the commercial properties desired. The sorbitol or other humectant which may be used in place of it absorbs enough water to replace that which is lost on the hot rolls to give to the composition the desired flexibility. The ratio of casein to triethanolamine is so taken as to produce an approximately neutral mix. In determining the amount of casein and triethanolamine required, the casein is assumed to be a divalent acid of approximately 2,100 equivalent weight and the triethanolamine a trivalent alkali of approximately 100 equivalent weight. The combining weights therefore are in the order of fourteen parts by weight of casein to one part by weight of triethanolamine. With the amount of triethanolamine in an amount sufficient to combine with all of the casein and a humectant present to the amount indicated in the above formula, the composition will remain sufficiently plastic to meet commercial specifications for bottle cap liners.

Example 5

80 parts of boiled linseed oil
10 parts of rosin
10 parts of gum copal
40 parts of birch bark (100 mesh or finer)

The binder mix as noted above which is commonly known as linoleum cement is after preparation a solid rubber-like mass. To use, I prefer to soften it on heated rolls and then add to the softened stock the formula weight of birch bark and such an amount of inert filler as may be required to produce an article required by consumers' specifications. When the composition is to be used as a flooring material, the mixture on the hot rolls is spread on a burlap backing and rolled out to the desired thickness. After spreading on the burlap the composition is transferred to a heated chamber wherein the oxidization of the linseed oil is allowed to proceed to the desired point. I have found in my tests that infusorial earth when added in the proportion of one part of same to approximately five parts of the above formula weights of materials produces a satisfactory flooring composition.

Compositions such as those described above will be recognized as having insulation properties. I have also found in my experimental work that a piece of birch bark (the outer bark of the *Betual papyrifera* species) may be compressed as much as 50% and on release of the pressure, the bark will regain a considerable percentage of its original thickness.

Assuming that proper care has been exercised in reducing the outer bark of the birch to the desired form, so as not to impair its cellular structure, this invention provides a cork substitute affording properties of compressibility, impermeability to gases, resiliency, insulation and resistance to fatigue which are equal and in some respects superior to those of cork. Moreover, the inherent resiliency of outer birch bark of the species indicated, due to its physical structure and entrapped air, is such that the introduction of additional air through the instrumentality of foaming agents for the purpose of regulating resiliency becomes unnecessary.

While I have described a preferred embodiment of my invention and indicated certain uses for the cork substitute resulting therefrom, it will be understood that the uses given are by way of illustrations only and that various details may be modified without departing from the spirit or scope of my invention and I do not desire to be limited to the specific modifications except as recited in the appended claims.

This application is a continuation-in-part of my application Serial No. 402,566, filed July 15, 1941 now abandoned.

Having thus described my invention, what I claim as new and wish to secure by Letters Patent is:

1. The process of producing a cork substitute which comprises reducing outer bark of paper birch trees while preserving the cellular structure of the bark, incorporating a binder in the reduced bark while maintaining the bark in excess over the binder, and baking the resulting mixture of bark and binder at a temperature below destruc-

tive distillation of the binder until the mixture attains a physical structure similar to cork compositions.

2. The process of producing a cork substitute which comprises reducing outer bark of paper birch trees to particles of predetermined shapes and sizes while preserving the cellular structure of the bark, preparing an adhesive resilient binder by dissolving a resilient adhesive in an organic solvent, incorporating the reduced bark in the resulting binding solution while maintaining the bark in excess over the binder, and curing the resulting mixture by baking it at a conversion temperature below destructive distillation of the binder until the mixture attains a physical structure similar to cork compositions.

3. The process of producing a cork substitute which comprises reducing outer birch bark of the species *Betula papyrifera* to particles of predetermined shape while preserving the cellular structure of the bark, preparing a binder for the bark by dissolving glue in a solvent mixture consisting of water, diethylene glycol and glycerine, adding hexamethylene tetramine to the resulting solution at a temperature of approximately 65° C., incorporating the reduced bark in the resulting liquid binder while maintaining the bark in excess of said binder, agitating the resulting mixture until it is free from agglomerate and becomes non-tacky, incorporating and uniformly dispersing melted paraffin wax in said resulting mixture, and curing the resulting composition by baking it at a conversion temperature below destructive distillation of the binding composition until the composition attains a physical structure similar to cork compositions.

4. The process of producing a cork substitute which comprises reducing the outer birch bark of the species *Betula papyrifera* to predetermined shaped particles, while maintaining the cellular structure of the bark, dispersing glue in a liquid mixture of water, diethylene glycol and glycerine at a temperature of about from 180° F. to 190° F. to produce a fluid binder, cooling the binder to approximately 65° C., adding thereto hexamethylene tetramine, mixing with the resulting liquid the reduced bark while maintaining the bark in excess of liquid, uniformly commingling the bark and liquid to form a batch, agitating the batch until it is free of agglomerates and non-tacky, uniformly commingling melted paraffin into the resulting batch, and hardening the resulting composition by baking it at a temperature of from approximately 240° F. to approximately 265° F. until it acquires a physical structure similar to cork compositions.

5. The process of producing a cork substitute which comprises reducing the outer birch bark of the species *Betula papyrifera* to particles of predetermined shape while maintaining the cellular structure of the bark, preparing a binder for the reduced bark by comminging animal glue with water, diethylene glycol and glycerine in the approximate ratios of fifteen grams of glue, twenty-five cc. of water, fifteen cc. of diethylene glycol and fifteen cc. of glycerine, heating this mixture to a temperature of from approximately 180° F. to approximately 190° F. until the glue is completely dispersed, cooling the resulting solution to approximately 65° C., adding hexamethylene tetramine to the resulting solution at the said 65° C. in the ratio of approximately 0.5 gram of hexamethylene tetramine, incorporating the reduced bark in the resulting liquid in the ratio of approximately 175 grams of the bark, thereby producing a mixture containing approximately sixty per cent by weight of the bark, agitating the resulting batch until it becomes free of agglomerates and is non-tacky, adding melted paraffin wax to the batch in the ratio of approximately 17½ grams of wax, uniformly dispersing the wax in the batch, and curing the resulting composition by baking it at approximately from 240° F. to approximately 265° F. until the composition acquires a physical structure similar to cork compositions.

6. The process of producing a cork substitute which comprises producing a dry, free-flowing batch by commingling a solution containing from approximately forty-five percent to approximately fifty per cent of phenol-formaldehyde resin, diethylene glycol and formalin, into an excess of outer bark of paper birch trees reduced to flakes, evaporating solvents from the resulting batch, and heating the resulting dry composition to approximately 260° F. until polymerization of the phenol in the composition is effected.

7. The process of producing a cork substitute which comprises reducing outer birch bark of the species *Betula papyrifera* to granular, flaked and sliver particles dependent upon the final product to be produced, while maintaining the cellular structure of the bark, preparing a binder composition for the bark particles by dissolving glue in a solvent comprising water and sorbitol, adding hexamethylene tetramine to the resulting solution at a temperature of approximately 65° C., incorporating the bark particles into the resulting liquid binder to form a batch, agitating the batch until it is free from agglomerates and becomes non-tacky, incorporating and uniformly dispersing melted paraffin wax into the resulting product until the particles are coated with the wax, and baking the resulting composition at a temperature of approximately 240° F. to approximately 265° F. until the composition attains a physical structure similar to cork compositions.

8. A cork substitute comprising a compressible and elastic composition having a physical structure similar to cork and composed essentially of comminuted cellular outer bark of paper birch trees and a resilient binder therefor.

9. The process of producing a cork substitute which comprises reducing outer bark of paper birch trees to a particle size ranging from minus 8-mesh to plus 20-mesh while preserving the cellular structure of the bark, preparing a liquid binder for the particles, incorporating and uniformly distributing the binder into the bark particles to form a batch while maintaining the bark in excess over the binder, and baking the batch in the presence of formaldehyde at a temperature of approximately 240° F. to approximately 265° F. until the resulting material attains a physical structure similar to cork compositions.

10. A process of forming a cork substitute comprising adding glue to a solvent solution consisting of water, diethylene glycol and glycerine, heating this mixture to a temperature of 180° to 190° F until complete dispersion of the glue has been effected to form a uniform binder, lowering the temperature of the binder to approximately 65° C., adding thereto hexamethylene tetramine, reducing outer birch bark of the species *Betula papyrifera* to a desired particle form while preserving the cellular structure of the particles, dispersing the binder and hexamethylene tetramine in the bark particles to form a batch of material, agitating this material until it is free of agglomerates and non-tacky, adding paraffin wax to the batch while stirring the latter until complete dis-

persion of the wax has been effected, baking this mixture under a predetermined temperature and pressure until the mixture attains a physical structure possessing properties of compression, permeability to gases, resiliency and resistance to fatigue substantially equal to those of cork compositions.

11. A process of forming a cork substitute comprising adding glue to a solvent solution consisting of water, diethylene glycol and glycerine, heating this mixture to a temperature of 180° to 190° F. until complete dispersion of the glue has been effected to form a uniform binder, lowering the temperature of the binder to approximately 65° C., adding thereto hexamethylene tetramine, reducing outer birch bark of the species *Betula papyrifera* to a desired particle form while preserving the cellular structure of the particles, dispersing the binder and hexamethylene tetramine in the bark particles to form a batch of material, agitating this material until it is free of agglomerates and non-tacky, adding paraffin wax to the batch while stirring the latter until complete dispersion of the wax has been effected, baking this mixture under a predetermined pressure and at a temperature range of 240° to 265° F. for a period of thirty to forty-five minutes to produce a product having properties of compression, permeability to gases, resiliency and resistance to fatigue substantially equal to those of cork compositions.

ROBERT STUART OWENS.

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