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METHOD OF PRESERVING AND FIREPROOFING A STRUCTURAL
MEMBER AND RESULTANT ARTICLE
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2,804,398

FIG. 1.

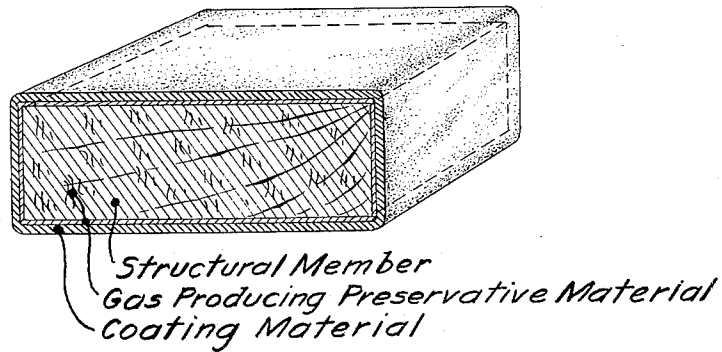
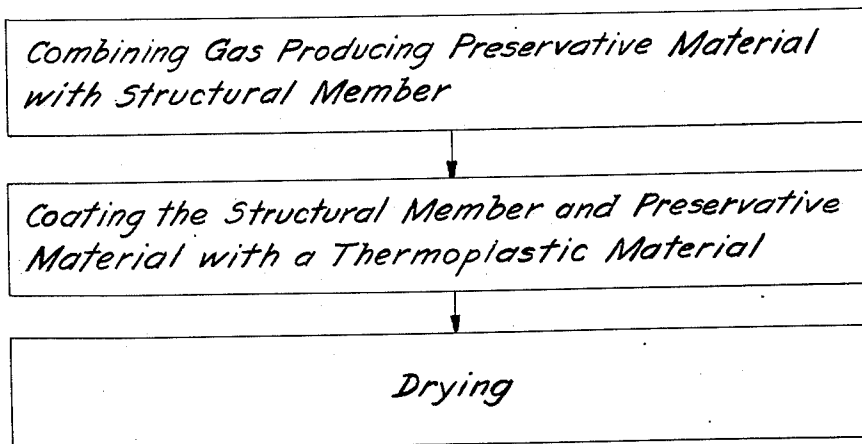


FIG. 2.



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2,804,398

**METHOD OF PRESERVING AND FIREPROOFING
A STRUCTURAL MEMBER AND RESULTANT
ARTICLE**

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Application November 22, 1954, Serial No. 470,525

4 Claims. (Cl. 117—72)

This invention relates to the proofing of structures against the hazard of fire. It has particular reference to the proofing of timbers and similar structural units of wood which have been treated with preservative. This is a continuation-in-part of my application Serial No. 320,618, filed November 14, 1952, now abandoned.

Wood structural units such as ties, piles, rails, planks, etc., used widely by railroads are customarily treated with some sort of preservative composition. One satisfactory preservative comprises a coal tar creosote-petroleum oil mixture which is impregnated into the wood under pressure to the quantum extent of about eight pounds of the preservative oil to one cubic foot of wood. Frequently the wood is subjected to the preservative treatment within a relatively short time before use must be made of it, thus preventing complete absorption into the pores of the wood and causing a residue of the preservative fluid to remain more closely adjacent the surface of the wood than is desirable.

The fire hazard to wooden structures along railroad rights of way are well known and varied. Grass fires and the like are by no means unusual and it is impossible to maintain constant watch over the long stretches which are subject to such hazard.

In the past it has been customary to use a coating of some bituminous substance, usually formulated with an asphaltum base, for coating purposes to guard against the hazard of fire. Various modifications of these asphaltum base coatings have been developed to make them more resistant to heat and prevent flow of the coating material under the influence of heat to thereby expose the wood. Such procedures have proved successful under ordinary circumstances.

But where the wood is impregnated under pressure with a large volume of coal tar creosote-petroleum oil mixture, a serious problem arises. Such a mixture is composed of approximately 50% creosote and 50% petroleum oil, or in some cases 70% petroleum oil and 30% creosote. Where such a preservative in such a large quantity is impregnated in the wood, it has been found that no known type of asphaltum base coating is completely insoluble when contacted by the preservative oils, especially on exposure to heat. The preservative oils have a flash point of approximately 235° F. and a fire point of approximately 255° F. The oils are extremely volatile and inflammable when exposed to heat and these properties enable them to remove nearly any bituminous coating from the surface of wood. The effectiveness of an ordinary bituminous base coating is eliminated as the coating material dissolves and is forced from the surface of the wood by evolution of gas.

An object of this invention is to eliminate not only the fire hazard provided by the use of wood, but the extra fire hazard created by pressure impregnation in large quantities with preservative compositions having relatively low flash and fire points.

A further and more specific object resides in providing a coating for wood impregnated as heretofore described

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which, when subjected to pressure of gas evolution from within, will yield without rupture and separate from the wood surface, thereby reducing the temperature at the surface of the wood and preventing destructive distillation and charring of the wood.

A solution of the problem, such as that described above, has many benefits and is far superior to various other procedures which have been used in seeking to overcome the difficulty. Some success has been obtained by completely covering a wooden structure with a glass fabric or mat to support coatings of either a bituminous or an inorganic cement type. The cement type coatings fail when the complete covering of glass fabric or mat is omitted, since volatilization of the preservative oils actually cracks and blows the cement from the surface of the timber. Complete coverings of glass fabric are very expensive from the standpoint of initial cost and especially from the standpoint of labor cost for application.

The improved coating and method of proofing which constitute the instant invention eliminate all the difficulties heretofore outlined and a large measure of efficiency is derived from cooperation with the volatilizing characteristic of the preservative fluid which heretofore has created the primary difficulty in producing a satisfactory fireproof coating.

For a better understanding of the invention, reference may be had to the accompanying drawing, in which:

Fig. 1 is a cross section view of the article of the instant invention with legends describing the elements thereof, the preservative material and the coating material being enlarged in thickness for clarity; and

Fig. 2 is a flow diagram of the process used in producing the article of Fig. 1.

A coating which I have found eminently satisfactory for accomplishing the above described objectives is comprised primarily of a sodium silicate solution with the addition of some mineral filler such as slate dust, fibrous talc, or ground limestone, and asbestos fibers. Preferably a sodium silicate solution of 42.2° Beaumé (approximately 38% by weight) and having an alkali to silica ratio of 1:3.22 is utilized. A satisfactory formulation is as follows:

	Percent
42.2° Beaumé sodium silicate solution	60
Mineral filler (slate dust or fibrous talc)	35
7R asbestos fibers	5

The above composition is of brushing or spraying consistency. If need be, it may be thinned slightly with water, but dries to form a hard coating due to the evaporation of water from the silicate solution.

Sodium silicates are non-inflammable and their use in fire-proofing compositions may not per se be novel. However, when utilized in conjunction with timber or wood which has been treated with preservative fluid in the manner heretofore described, a most unexpected and beneficial cooperative relationship develops which results in a complete solution of the various problems heretofore outlined.

The silicate coating softens at approximately 1050° F. When the coating is exposed to fire it begins to soften slightly at about 1050° F. and continues to get softer up to approximately 1575° F., at which point it is softest. As the coating becomes soft, or just before it softens completely, the heat which causes such softening produces the formation of an excessive amount of gas from the preservative oils due to volatilization thereof. With this volatilization and evolution of gas the coating expands and swells in much the same manner as hot glass that is being blown by a glass blower.

As the silicate coating under the influence of heat expands away from the timber, in some cases as much as

two inches or more, it remains intact and the temperature at the surface of the wood drops greatly, becoming sufficiently low to prevent destructive distillation and charring of the wood.

The reduced temperature adjacent the surface of the impregnated wood slows down the volatilization of the oils considerably. Nevertheless, the heat absorbed within the timber continues to provide sufficient gas evolution to force the gas through pin-hole openings which develop in the surface of the expanding coating. These pin holes permit diffusion of the gases into the atmosphere surrounding the coated timber.

The volatilization characteristics of the impregnating composition continue so long as any fire is present at the outer surface of the coating, due to the low flash point of the said composition. This continued evolution of gas from adjacent the timber surface excludes oxygen from the void or space created by expansion of the coating from the timber. Thus there is no possibility of the timber itself burning. Even if an opening an inch or two in diameter should occur in the coating, by mechanical or accidental causes, gases from the preservative oils are sufficient to block the hole and prevent any combustion from occurring beneath the level of the expanded coating.

Under some circumstances it has been found advisable to add a small proportion of emulsified asphalt to the sodium silicate composition for the purpose of increasing the tensile strength of the coating and its stability in supporting loads where used on piles and other structural units adapted to serve that purpose.

Since sodium silicate is water soluble, it should be proofed against weather and water in some way where the timber or wooden structural unit is to be used for purposes which have heretofore been suggested. For some purposes it may be sufficient to add a waterproofing agent to the sodium silicate solution, but it is preferable to apply over the surface of the silicate base coating a regular asphaltum base coating of the type generally used for roof coatings. Such a coating, like the sodium silicate base coating itself, may be applied by brush or spray.

A preferred sodium silicate coating has been discovered; its properties have been proved superior through extensive tests. This preferred coating, when protected by a vinyl aluminum weatherproof coating, has gone a period of 2,000 hours in the weatherometer and when tested by fire still shows good expansion properties. The formulation is as follows:

	Percent
42.2° Beaumé sodium silicate solution	42.0
Slate dust or other suitable mineral pigment	22.0
7R asbestos fibers	6.0
Emulsified asphalt, 53% solids as asphalt	30.0

This formulation must be mixed in a special manner; the sodium silicate, slate dust, and asbestos must be mixed first and then the emulsified asphalt is added.

The vinyl aluminum weatherproof coating used to protect the preferred sodium silicate coating has the following formulation:

	Percent
High molecular weight vinyl chloride-vinyl-acetate copolymer resin	10.85
Medium molecular weight vinyl chloride-vinyl acetate copolymer resin	7.23
Tricresyl phosphate	7.23
Toluene	11.81
Isophorone	18.89
Methylisobutylketone	36.77
Aluminum powder	7.23

The aluminum powder used in this coating has a maximum retention of 15% on a 325 mesh screen. It has a bulking value of 0.047 gallon per pound and a weight of 21.24 pounds per solid gallon. The vinyl chloride-vinyl acetate copolymer resins have sufficient chlorine in them

to prevent the coating from supporting combustion except when it is in the presence of fire.

A sodium silicate coating may be applied directly to a freshly treated wood structure since the sodium silicate is not affected by the preservative material in the structure such as creosote and petroleum oils.

In certain structures it is not commercially feasible and sometimes not possible to cover completely the sodium silicate coating with a weatherproof coating. It has been discovered in practice that, where the sodium silicate fireproof coating is not completely covered, water will deleteriously affect not only the uncovered fireproof coating but also a portion of the covered fireproof coating by a leaching action from under the weatherproof coating. Fire retardant materials for coatings which do not require the protection of a weatherproof coating and which have the quality of binding mineral pigments together when properly formulated to give the desired expansive coating are as follows:

- Vinyl resins
- Vinyl-vinylidene chloride resin
- Silicone resins
- Polyvinyl acetate resin
- Chlorinated rubber
- Chlorinated rubber-alkyd resin type coating
- Synthetic rubbers containing large percentages of chlorine such as neoprene
- Chlorinated coal tar
- Chlorinated biphenyl
- Chlorinated polyphenyl
- Chlorinated asphalt
- Chlorinated paraffin

A preferred material for the formulation of a fire retardant weatherproof coating which, like sodium silicate, may be applied directly to a freshly treated wood structure is the polyvinyl acetate resin since it is not affected by the creosote and petroleum oil preservative. Polyvinyl acetate resins, as well as the vinyl-vinylidene resins, are presently commercially available as water emulsions and therefore offer the added advantage of non-inflammability.

A very effective expansive coating is prepared by the addition to a polyvinyl acetate resin of suitable amounts of a plasticizer, solvents, thickeners, mineral pigments and water as a diluent. The carboxyl group contained in the chemical structure of the polyvinyl acetate resins forms carbon dioxide when burned, and this gas formation greatly retards the rate of burning of the resins. Thus this material, when plasticized with a fire-retardant plasticizer such as tricresyl phosphate, functions most satisfactorily as a binding resin in an expansive coating. A suitable and preferred polyvinyl acetate type coating is as follows:

9.21% polyvinyl acetate.....	Resin.
1.57% tricresyl phosphate.....	Plasticizer.
2.32% ethylene glycol monoethyl ether.....	Film forming solvent.
0.26% dioctyl sodium sulfosuccinate.....	Wetting agent.
0.21% polyoxyethylated vegetable oil.....	Pigment dispersion aid.
0.33% 400 centipoise methyl cellulose.....	Thickener.
0.41% sodium pentachlorophenate.....	Preservative.
28.72% talc.....	Mineral pigment.
2.74% carbon black.....	Pigment.
0.27% oleic acid:0.22% 26° ammonia (ammonium oleate)...	Buffering agent to give pH of 8-9.
0.22% polypropylene glycol...	Anti-foam agent.
5.10% 7R asbestos.....	Mineral pigment.
48.38% water.....	Thinner.

The polyvinyl acetate used in this coating comes in the form of an emulsion and the percentage shown is the actual solids content of the emulsion used in the coating and the water used in making the emulsion is shown in the total percentage of water. Since this coating is an emulsion it can be brushed or sprayed right over the oily surface of timber containing preservative oils, and it is not affected, i. e., is not softened by the preservative oils, and dries to a firm, hard coating by the evaporation of the water. This coating may also be thinned with water, which is advantageous.

A preferred coating having the desired expansible properties coupled with sufficient chlorine in its make-up to render it very fire retardant includes a chlorinated rubber and a 70% chlorinated paraffin, a 40% chlorinated paraffin being included also primarily as a plasticizer. A preferred formulation is as follows:

	Percent
Chlorinated rubber—viscosity of 125 centipoises—	5.70
70% chlorinated paraffin—	5.70
40% chlorinated paraffin—	5.70
Toluene—	14.40
Methylethylketone—	12.05
Xylene—	4.00
7R asbestos fibers—	6.26
Slate dust—	41.96
Carbon black—	3.72
Stabilizer—	0.51

The above solvent coating material may be changed to an emulsion coating material by the replacement of most of the solvents with water. The product is made by dissolving the chlorinated rubber and the two types of chlorinated paraffin in the solvents shown and stirring into this solution the asbestos and slate dust. The resultant coating is a viscous semi-fluid material suitable for applying with brush or spray equipment.

A coating employing chlorinated rubber and chlorinated paraffin when used on freshly treated oily wood structures does not give the superior results of the previously discussed sodium silicate type or the polyvinyl acetate type. The preservative oils are quite readily soluble in the solvent used for the chlorinated rubber and chlorinated paraffin; therefore any residue oil on the surface or any oil which might bleed to the surface due to heat from the sun will be absorbed into the coating. A coating employing chlorinated rubber and chlorinated paraffin is well suited for oil-free surfaces of structures having impregnated oils in an amount sufficient to cause expansion of the coating when heated by fire but insufficient to cause bleeding when heated by the sun.

A combination chlorinated material-alkyd resin type coating has been discovered which provides the solution to this problem; it has the property of a much greater resistance to the preservative oils in the woods since the dried alkyd resin can stand the absorption of a reasonable amount of preservative oil without allowing softening of the coating. A preferred chlorinated rubber-alkyd resin coating material is as follows:

	Percent
Chlorinated rubber—	7.00
Alkyd resin—	5.00
Slate dust—	41.25
7R asbestos—	7.00
Lead naphthenate—	0.33
Cobalt naphthenate—	0.08
Manganese naphthenate—	0.04
Stabilizer—	0.50
Solvent (toluene or xylene)—	35.05
Carbon black—	3.75

Alkyd resins which are unmodified by drying oils are composed of glycerol and phthalic anhydride. When these two products are heated together, they react to form a long chain molecule which has available hydroxyl groups on it. These hydroxyl groups may be reacted

with unsaturated monoacids such as linoleic acid which is one of the main constituents of linseed oil. Linseed, tung, perilla, fish, oiticica, and soybean oils can be used as modifying oils for the alkyd resins. The oil used in modifying alkyd resins must be one which will make the finished alkyd resin compatible with chlorinated rubber. A suitable alkyd resin for this use generally contains approximately 23% to 29% phthalic anhydride, the remaining portion being glycerol and drying oil.

In coatings employing chlorinated rubber and chlorinated paraffins, stabilizers are required for the chlorinated materials. These stabilizers are primarily for the purpose of preventing dehydrochlorination when exposed to ultra-violet light. The addition of carbon black pigments or other suitable pigments to filter out the ultra-violet light is helpful and, in addition, gives color to the coating. Other suitable stabilizers are monohydrous tribasic lead sulfate, basic lead silicate sulfate, dibasic lead phosphite, dibasic lead phthalate, and the alkaline earth metal salts of such acids as stearic, oleic and ricinoleic acids.

In all coatings numerous types of mineral pigments may be used either singly or in combination, examples being asbestos fibers, talc, slate dust, ground limestone, finely ground mica, and finely ground perlite, either in expanded or unexpanded form.

Materials which function as plasticizers and are exceptionally fire-retardant are (1) tricresyl phosphate, (2) liquid chlorinated biphenyl and polyphenyl and (3) 40% chlorinated paraffin. It will be understood that other plasticizers might well be used and that in some situations any resin which is not fire-retardant might be substituted in small percentages for the fire-retardant resin, especially when the plasticizer is an exceptionally good fire retardant.

As has previously been stated, the desired expansive property may be obtained by the proper application of the coating materials. Coating materials of the sodium silicate type have exceptionally good expansive and fire-retardant qualities; a weatherproofing outer coat is required to prevent deterioration by water. The polyvinyl acetate type coating and the chlorinated rubber type coating have good expansive qualities and may be used without an outer weatherproofing coat.

In all of the coatings based upon the chlorinated rubber, chlorinated paraffin and polyvinyl acetate, it will be noticed that there is a very large percentage of mineral pigment which when bound by a small percentage of the resin forms the desired expansible wall to provide a chamber between the fire and the wood. The resin may or may not decompose, depending upon the intensity of the fire. If it does decompose, the resulting partially decomposed resin and carbon formed from the decomposition of the resin, act as the binding material, after expansion has occurred.

In certain locations it has been found advisable to restrict the degree of expansion of the fire-retardant coating; this has been found of value when using coatings of the chlorinated rubber type and the polyvinyl acetate type. In tests, glass fabric strips which are three inches wide have been stapled to timbers to reduce the expansion of the coating and to increase the mechanical bond strength of the coating to the wood, this being of prime advantage on freshly treated timbers. For round timbers, such as piles or posts, the three inch glass fabric strip is spirally wound on the timber at 12 inch centers. At no point does the coating extend more than 9 inches, thereby reducing expansion. For large flat surfaces the glass fabric may be spaced at 12 inch centers. On small rectangular timbers, stripping of the corners has proved a satisfactory expedient.

On rather dry, weathered timbers stripping is not required, except on the corners, since the volatilization of the remaining preservative oils is usually not sufficient to excessively expand the coating.

In some situations it may be desirable to insure the production of gases under the coating. Old weatherbeaten

timbers, unpreserved wood structures, plastic structures and metal structures, the thin sheet metal type, for example, can be coated with the fireproof coatings of my invention. The desired expansion property of the coating may be obtained by applying an undercoat capable of producing the required amount of gas. A suitable undercoat can be formulated by dispersing 10% to 15% of pentaerythritol into a 3% solution of 400 centipoise methyl cellulose. The resulting coating would dry by evaporation of the water, leaving the pentaerythritol bound to the water soluble methyl cellulose resin. The fireproof coating may then be applied. Upon the application of heat the pentaerythritol volatilizes, causing the fireproof coating to expand and creating the desired void between the structure and the fire. It will be appreciated that the degree of expansion can be controlled within reasonable limits by applying a predetermined amount of the gas-producing undercoat.

While I have described for illustrative purposes a preferred form of the invention, various modifications within its scope may be apparent to those skilled in the art and for that reason I wish to limit myself only within the scope of the appended claims.

I claim:

1. A structural unit comprising a structural member, preservative material including a petroleum oil combined with said structural member, and a coating covering said structural member and said preservative material for inhibiting deterioration and destruction by fire of said structural member, said coating comprising a thermoplastic material selected from the group consisting of sodium silicate, polyvinyl acetate resin, chlorinated rubber-chlorinated paraffin, and chlorinated rubber-alkyd resin, said coating having the property of becoming soft and elastic under heat, said preservative material including a petroleum oil having the property of producing an excessive amount of gas as the coating softens due to heat to cause expansion of said coating by the formed gas away from said structural member to form an insulating chamber over said structural member.

2. A structural unit comprising a wood member, a preservative material including a preservative oil impregnated into said wood member, and a coating covering said wood member and said preservative material for inhibiting deterioration and destruction by fire of said wood member, said coating comprising a thermoplastic material including polyvinyl acetate resin, said coating having the property of becoming soft and elastic under heat, said preserva-

tive material including a petroleum oil having the property of producing an excessive amount of gas as the coating softens due to heat to cause expansion of said coating by the formed gas away from said wood member to form an insulating chamber over said wood member.

3. A method of preserving and fireproofing a structural member which comprises the steps of combining a preservative material including a petroleum oil with the structural member, said preservative material having the property of producing an excessive amount of gas when heated, coating the structural member and preservative material with a coating comprising a thermoplastic material selected from the group consisting of sodium silicate, polyvinyl acetate resin, chlorinated rubber-chlorinated paraffin, and chlorinated rubber-alkyd resin, and drying the coating to form a hard coating having the property of becoming soft and elastic under heat whereby said coating is caused to expand away from said structural member by the formed gas of said preservative material, the expansion of said coating forming an insulating chamber over the structural member.

4. A method of preserving and fireproofing a wood member which comprises the steps of combining a preservative material including a petroleum oil with the wood member, said preservative material having the property of producing an excessive amount of gas when heated, coating the wood member and preservative material with a coating comprising a thermoplastic material including polyvinyl acetate resin, and drying the coating to form a hard coating having the property of becoming soft and elastic under heat whereby said coating is caused to expand away from said wood member by the formed gas of said preservative material, the expansion of said coating forming an insulating chamber over the wood member.

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