United States Patent Office

2,706,936

Patented Apr. 26, 1955

2,706,936

ANTI-SKID SURFACE COVERING

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No Drawing. Application June 21, 1948, Serial No. 34,341

10 Claims. (Cl. 94—5)

This invention relates to anti-skid floor coverings of the nature of flexible and water-resistant sheet material having a roughened resinous anti-skid surface.

While the product of this invention is of general utility in providing anti-skid surfaces on floors, stairways, aircraft wing-walks, and the like, it has been found to be of particular value as anti-skid material for use on flight decks of aircraft carrier vessels, as well as for general use below decks. The requirements for such application are severe. For protection of personnel, the deck surfaces of such vessels must be made as permanently and efficiently anti-skid as possible. At the same time, the possibility of undue abrasion of the steel arresting cables commonly placed across the flight deck during landing of aircraft must be guarded against. Repeated dragging of these cables across abrasive grit-surfaced walkways has been the cause of excessive and dangerous wear and weakening of the cables in many instances. Below decks, some of the requirements of anti-skid walkway surfacings are that the surface be such as will yield no sparks when struck with steel, and that it be non-injurious to personnel. Sliding of ammunition, striking of the floor surface with nailed shoes, etc., must cause no sparking, particularly in the vicinity of gasoline or powder storage. The anti-skid surface should not abrade or cut the feet of personnel who must on occasion walk barefoot over it in carrying out their assigned duties. It should be easily cleaned, without excessive wear on mops or brushes.

Softer particulate surfacings in place of the more common mineral abrasive grid particles have found some application in providing anti-skid surfacings. Cork particles, for example, offer a degree of protection against slippage when properly bonded to the walkway surface. But under the service conditions encountered on aircraft carriers, anti-skid surfaces containing cork particles are found to be less effective in preventing slipping than those containing mineral abrasive grit. Cork and similar particulate material swells somewhat under continued exposure to water, and then is easily rolled or pulled away from the resinous binder with which it is bonded to the flooring. Furthermore, such anti-skid surfaces even under dry conditions have a somewhat shorter useful life than has the mineral type anti-skid surface.

In a popular type of anti-skid surface covering, hard abrasive mineral particles are bonded to a waterproofed fabric base with a binder material consisting largely of a thermally hardened phenolic resin. The sheet material is then attached to the sheet steel, concrete, or other floor or deck surface by means of a suitable tough and adherent adhesive cement. The anti-skid wear-resisting surface is provided by the particles of mineral, the resinous binder wearing away rapidly to expose fresh mineral surfaces as the original mineral surface is slowly abraded or broken away.

I have now found that irregularly shaped, angular grid particles of pre-cured synthetic resins or analogous bodies having properties of hardness, resilience, toughness and the like as hereinafter defined, and in particular the moulded phenolic resins, may replace the abrasive mineral particles of these prior art anti-skid walkway surfacings, with surprising results in terms not only of anti-skid efficiency but also in terms of prolonged wear-resistance.

I have found that particularly desirable and unexpected results are obtained when I employ particulate crushed fully cured phenol-aldehyde resin moulding

compositions as the grid material in my novel resinous anti-skid floor surfacing sheet material. Suitable material is available in large volume from the manufacturers of moulded phenol-aldehyde radio cabinets, telephone hand-sets, and similar objects, in the form of rejected or broken pieces, sprues, flashings, or the like. These compositions ordinarily contain a high proportion, e. g., 50–80%, of wood flour or other inert filler. They are moulded or cured at relatively high temperatures and pressures, to a fully cured, hard and dense state. As such, they are highly water-resistant.

Cast phenolic resins, which are poured into moulds and then allowed to harden for relatively long times at relatively low or moderate temperatures, have substantially equivalent properties. These and other analogous phenolic resinous products are included within the scope of the term "thermally cured phenolic resin mouldings" as employed herein.

These relatively massive moulded products may be readily reduced to desired dimensions by free crushing on rolls, followed by screening to desired size. In carrying out these operations, it has been found that materials which provide suitable grit particles for my anti-skid coverings, e. g. the phenol-aldehyde mouldings, are reducible to the specific dimensions required substantially without loss. In contrast, the abrasive minerals, whether natural or synthetic, cannot be reduced to the relatively large-size particles required for anti-skid surfacings without at the same time producing considerable quantities of much smaller particles or "fines."

As far as properties of the finished anti-skid article are concerned, the abrasion and impact resistance of the particles is of the greatest importance. I have observed that the particles, obtained without formation of dusts or fines from moulded phenolic masses, provide a surprisingly high degree of wear resistance in the anti-skid surface; superior, in fact, to that obtained in an equivalent structure with conventional mineral grains. Thus, in a wear-resistance test performed under definite and reproducible conditions, a sample of the sheet material made with my novel grit material as hereinafter described resisted 500 revolutions of the test machine, whereas a sample made with mineral particles lasted only 450 revolutions. This is despite the great difference in hardness of the two materials; the moulded phenolic being about 3, the mineral particles 9.3 on the Moh scale of hardness. The relative skid resistance of my material was estimated at 95–99 on a basis which provided a value of 100–110 for the conventional mineral-granule type.

While I do not wish to be restricted by any particular theory, nevertheless I believe that the above-mentioned surprising and beneficial results may be at least partially explained in the following way. I believe that the combination of resiliency, toughness, inmpact resistance, and analogous properties of my novel grit materials, as evidenced by their peculiar reaction to crushing, is such that individual grains, while readily broken from the mass of moulded resin, are left in an unstrained and uncracked condition in which they retain maximum strength. Furthermore, the grains thus obtained with substantially no reduction to "fines" are completely clean and free from surface-adherent dust, so that the resinous binder of the sheet product forms a firm adherent bond directly to the surface of the grain.

In making sheet material suitable for application as anti-skid surfacing, I may proceed as follows: I first take a sheet of cotton drills cloth of any suitable width, and saturate the same, e. g., on squeeze rolls, with a thermoplastic resin. For this purpose, I may use thermoplastic resinous compositions such as are disclosed in Oakes Patent No. 2,357,350 or in Kugler et al. Patent No. 2,357,335. The resinous material may be applied either from solution in organic solvent or as a stable aqueous emulsion of fine particle size, and in amounts and by methods as disclosed in the afore-mentioned patents.

Both surfaces of the treated cloth are next coated with 0.15 lb. per sq. yd. of a soft, adherent phenolic resin applied as a 60% solution in a mixture of water and ethylene glycol monoethyl ether, and the coated sheet is then hung up and heated for 1½ hours at 185°

F. The phenolic resin, which is a slow-curring type, is thereby only partially cured. It acts as a priming coat, providing improved adhesion between treated cloth and resin bond.

The resin bond is next applied to one surface of the cloth base, over the last-described coating. This bond consists of 0.139 lb. per square yard of a phenolic resin made from one mol of phenol and 1.4 mols of formaldehyde, with alkaline catalyst, and which is dissolved in a mixture of water and ethylene glycol monoethyl ether. This resin rapidly sets up on heating to provide a hard, tough, and adherent bond.

As soon as the viscous resin bond coat is spead over the treated cloth, the resinous grit material is applied. This grit material consists of crushed and graded moulded phenolic resin; it has a specific gravity of about 1.4, and its surface can be scratched by calcite but not by gypsum. It is supplied as particles of from 50 to 80 grit size, the average being approximately 60. This is approximately equal to the size of grit used in making No. 1 or No. 1½ flint sandpaper. The grit is pressed into the resin bond, and excess grit is shaken off, leaving approximately .54 lb. of grit per square yard. The coated sheet is heated to remove solvent and partially cure the resin bond. It is then given a surface sizing coat of 0.46–0.48 lb. per sq. yd. (dry basis) of the same binder material but at somewhat greater dilution. The coated and sized sheet is finally cured for 12–14 hours at 175° F., then for 1–3 hours at 212° F., and finally for 4–6 hours at 248° F.

The resulting sheet product is sufficiently flexible so that it may be fitted and cemented to somewhat curved or irregular flight deck surfaces. It is of such excellent waterproofness that it does not soften, nor lose quantities of the resin particles when subjected to foot traffic, after prolonged periods of immersion in sea-water. When secured in position on flight decks or the like, it provides an effective and long-lasting anti-skid surface which does not cause noticeable wear of shoe soles or rubber tires and is completely non-abrasive toward steel cables.

A specific construction has been described which provides properties of particular desirability in connection with flight decks of aircraft carriers. This particular construction is not limited to such applications, but may be employed to advantage in many other locations. For example, the reduction in weight obtained by using my resinous grit in place of mineral type abrasive grit makes the new construction valuable for forming anti-skid walkways on aircraft. The nonabrasive quality of the resin particles is important where grit loosened or worn from an adjacent anti-skid walkway might be pressed into contact with polished surfaces or be drawn into bearings, since scratching of such polished surfaces is thereby avoided. The grit-coated surface produces no sparks when struck by steel articles. Workmen can safely walk barefooted on such surfaces without discomfort.

Many variations in the construction of my novel resinous anti-skid sheet material will become apparent, particularly in view of the following discussion. Thus, any strong and flexible fabric or fibrous sheet may be protected with any suitably flexible, strong, adherent and water-resistant thermoplastic resinous impregnating agent to provide a flexible base for the anti-skid surfacing. Depending on the type of surface to be given anti-skid properties, it may also be possible to form and cure the anti-skid surface on a relatively rigid pre-formed shaped body, or even to form and cure it directly on the base surface, as in the case of wood floors, for example. However, it is ordinarily more convenient, and makes for a much more uniform and superior product, to provide a flexible pre-cured surfacing material such as hereinabove described, and subsequently to cement such product to the walkway surface.

The resinous binder composition described in connection with the above example is typical of phenolic binders employed in the coated abrasive art, and forms no part of the present invention. Any analogous binder composition providing equivalent adhesion, toughness, water resistance, and other required properties may be used, and many such materials are known to the art.

While heavily loaded phenolic or other resinous compositions are not ordinarily suitable as binders and surface sizes due to their greatly increased viscosity, nevertheless some loading of these materials is possible and often is advantageous. Wood flour, mineral pigments and fillers, and other inert powders may be used for this purpose. Coloring agents are particularly desirable, in improving the appearance of the final product. Resinous grit such as is here used for the anti-skid layer, but reduced to a much finer particle size, may be added as filler.

With regard to the resinous grit material itself, all things considered, the sized particles obtained on crushing relatively massive thermally cured phenol-aldheyde mouldings containing a high percentage of inert filler and having a Moh hardness value of about 3 are generally to be preferred. Particles of the approximate size identified in the example have been most useful, but a considerable range of particle size, for example from 24 mesh to 150 mesh, is permissible. As hereinbefore noted, a preferred phenolic raw material is available as a waste product from the plastics industry. For special purposes, and where the added expense is of no particular consequence, phenolic mouldings containing a much lower proportion of inert filler, or mouldings containing special types of filler, such as specific colored pigments or fibrous material, or even unfilled moulded phenolic resin products, may replace the moulded radio cabinets, telephone hand sets and the like specifically mentioned herein as source material for my resinous particles. Many examples of such compositions have been found to possess toughness, resiliency, impact resistance, etc. to a desirable degree, particularly as evidenced by their ability to be reduced to desired grit size without excessive formation of fines.

Resins or equivalent materials other than phenolic resins, and having the desired hardness value and crushability factors, may be used in many instances, but are found to be in general less desirable. Thus, aminoaldehyde resin masses having a Moh scale hardness value of about 3 have been reduced to the proper particle size and bonded, by means of phenolic resin binding and sizing compositions, to impregnated fabric, as in the above example. The resulting product was effective as an anti-skid surfacing under dry conditions, but the grit broke up and lost its effectiveness under use conditions involving the continued presence of water. Furthermore, the sheet material curled when dampened prior to application, and was then difficult to apply smoothly to flat surfaces.

The relative weights, or more significantly the relative volumes, of binding and sizing composition and of resinous grit material may be varied widely in making my improved type of surfacing. Minimum amounts, both of binder and of surface size, which are required to provide effective anchoring of a desired quantity of resinous particles of any specific diameter or particle size may readily be determined. The product is somewhat more flexible than more heavily bonded sheets, and is also somewhat less costly to produce. Increasing the amount of binder increases the number of particles which may be retained per unit area, and also increases the life of the sheet in use. The amount of surface sizing is ordinarily controlled so as to provide complete covering and effective anchoring of each particle without completely filling the valleys between particles. However, where a particularly long-wearing surface is desired at the expense of a somewhat reduced effectiveness as an anti-skid material, the amount of sizing coat may be increased so as to form a continuous smooth outer surface. Such a product has merit as a long-wearing and fire-resistant floor covering, and has been suggested as a replacement for linoleum. In this type of product, the addition of finely divided resinous filler to the resinous binder and surface size, as hereinbefore mentioned, is particularly appropriate.

My flexible resinous anti-skid surfacing sheet may be affixed to flight decks or other surfaces in a number of ways, but I prefer at the present time to employ solvent-type adhesive cements for this purpose. One such cement, which has given excellent results for the specific purpose here emphasized, consists of a solution in a volatile organic solvent of a blend of pigmented polymerized chloroprene and a compatible, oil-soluble, heat-advancing phenol-aldehyde resin. The liquid adhesive cement is ordinarily applied to both surfaces, i. e. the deck surface and the back of the anti-skid sheet, and is allowed to dry; one or both of these coatings is then re-

activated, either by heating or by the application of a thin surface coating of dilute adhesive cement or of solvent, and the strip is pressed in place and held until the bond is completed. The surfacing sheet may be furnished to the user as a pre-coated sheet, requiring only activation of the adhesive coating by heat or solvent.

The sheet material may also be adherently attached to various surfaces by means of normally tacky and pressure-sensitive adhesives. Thus, one type of my anti-skid sheet material is first lightly coated or primed on the back surface with a dilute solution of the polychloroprene-phenolic resin adhesive cement, and is subsequently coated with a heavier layer of a high-strength normally tacky and pressure-sensitive adhesive, which is then protected with a temporary liner such as Holland cloth.

By means of the invention described hereinabove, I provide a new product of widespread utility, and having particular advantages as a component of anti-skid deck surfaces on aircraft carriers. One embodiment of my invention is in the form of a flexible pre-formed sheet material suitable for adhesively bonding to deck surfaces or the like, and having an anti-skid surface layer comprising firmly bonded sized particles of water-resistant thermally cured phenolic resin mouldings. The anti-skid surface thus produced is substantially equivalent in anti-skid properties to similar surfaces made with mineral abrasive grit particles, yet has no abrasive action on steel cables. Surprisingly, in spite of the vastly lower hardness or abrasive factor, the new all-resin product is also superior in wear-resistance to the mineral-granule type.

I claim:

1. Flexible unitary sheet material having a rough anti-skid surface layer of improved wear-resistance and which is non-abrasive and non-sparking toward steel, said sheet material comprising, in order, a flexible water-resistant fibrous supporting base, a water-resistant non-thermoplastic grit bond, and a layer of firmly bonded, tough and resilient angular resinous grit particles having a Moh scale hardness value of about 3 and a particle size in the range of about 24–150 mesh.

2. Sheet material according to claim 1 and having, on the surface opposite the anti-skid surface, a firmly bonded non-tacky coating of a solvent-activatible water-resistant adhesive cement.

3. Sheet material according to claim 1 and having, on the surface opposite the anti-skid surface, a firmly bonded coating of a normally tacky and pressure-sensitive adhesive.

4. A structure comprising a walkway having a surface and, adhesively bonded thereto to form an anti-skid surface covering, sheet material according to claim 3.

5. Flexible unitary sheet material having a rough anti-skid surface layer of improved wear-resistance and which is non-abrasive and non-sparking toward steel, said sheet material comprising, in order, a flexible, water-resistant, impregnated fibrous supporting base, a water-resistant resinous grit bond, and a layer of firmly bonded, tough and resilient angular grit particles of water-resistant, thermally cured phenolic resin having a Moh scale hardness value of about 3 and a particle size in the range of about 24–150 mesh.

6. Flexible sheet material having a rough anti-skid surface layer of improved wear-resistance and which is non-sparking and non-abrasive toward steel, said sheet material comprising, firmly bonded together in the order indicated, a flexible, water-resistant, impregnated fibrous supporting base, a water-resistant phenolic resin grit bond, and a layer of firmly bonded, tough and resilient angular resinous grit particles having a Moh scale hardness value of about 3 and a particle size in the range of about 24–150 mesh.

7. Flexible unitary sheet material having a rough anti-skid surface layer of improved wear-resistance and which is non-sparking and non-abrasive toward steel, said sheet material comprising, in order, a flexible, water-resistant, impregnated fabric supporting base, a water-resistant phenolic resin grit bond, and a layer of firmly bonded, tough and resilient angular resinous grit particles having a Moh scale hardness value of about 3 and a particle size in the range of about 50–80 mesh.

8. Flexible unitary sheet material having a rough anti-skid surface layer of improved wear-resistance and which is non-sparking and non-abrasive toward steel, said sheet material comprising, in order, a flexible, water-resistant, impregnated fabric supporting base, a water-resistant phenolic resin grit bond, and a layer of firmly bonded, tough and resilient angular grit particles of water-resistant, thermally cured phenolic resin containing about 50–80% of inert filler and having a Moh scale hardness value of about 3 and a particle size in the range of about 50–80 mesh.

9. Sheet material according to claim 8 and having, on the surface opposite the anti-skid surface, a firmly bonded coating of a normally tacky and pressure-sensitive adhesive.

10. Flexible sheet material having a rough anti-skid surface layer of improved wear-resistance and which is non-sparking and non-abrasive toward steel, said sheet material comprising, firmly bonded together in the order indicated, a flexible, water-resistant, thermoplastic-resin-impregnated fabric supporting base, a water-resistant phenolic resin grit bond, a layer of firmly bonded, tough and resilient fully cured phenolic resin angular grit particles having a Moh scale hardness value of about 3 and a particle size in the range of about 24–150 mesh, and a surface sizing layer of phenolic resin.

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