

[54] **METHOD FOR MARKING PAVED SURFACES**
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3,264,131	8/1966	Nagel.....	117/33
3,296,010	1/1967	Craig et al.	117/33
3,393,615	7/1968	Micheln.....	117/46
3,410,185	11/1968	Harrington.....	404/77
3,664,242	5/1972	Harrington et al.	404/77

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[58] **Field of Search** **117/26, 33, 72; 1/72; 94/1.5, 22; 404/77; 427/137, 202, 376, 422**

[56] **References Cited**
UNITED STATES PATENTS

2,716,075	8/1955	Wiese	117/72
2,897,733	8/1959	Shuger.....	117/33

[57] **ABSTRACT**
 An improved method for marking paved surfaces by methods as taught in Harrington, U.S. Pat. No. 3,410,185, using solid particulate thermosoftening marking material. A bonding layer is first formed by coating onto the paved surface a liquid, low-viscosity coating composition that comprises a film-forming organic binder material. After formation of the bonding layer the particulate marking material is projected onto the bonding layer in the presence of heat.

4 Claims, No Drawings

METHOD FOR MARKING PAVED SURFACES

BACKGROUND OF THE INVENTION

Harrington, U.S. Pat. No. 3,410,185, and Harrington and Jorgensen, U.S. Pat. No. 3,664,242, teach methods by which solid particulate thermosoftening marking materials are applied to paved surfaces in the presence of heat to form continuous markings. These methods made possible for the first time the formation of markings on paved surfaces that were ready to bear traffic within seconds after application. This rapid traffic-bearing ability meant that traffic-control markings could be applied to roadways with almost no interruption of traffic. The methods and materials described in U.S. Pat. Nos. 3,410,185 and 3,664,242 have found good acceptance in the pavement-marking industry, especially for forming markings at roadway intersections.

Another long-standing goal in the pavement-marking industry is to find marking methods and marking materials that will form markings capable of a long useful life on the roadway. Many traffic-control markings last only a few months or less, especially at the heavily traveled intersections for which the methods described above are especially used. Early failure of markings is particularly prevalent in geographic areas that experience severe winters, which subject roadways and applied markings to internal stresses such as freeze-thaw cycles that tend to weaken the marking or separate it from the roadway, and which require roadway cleaning operations involving application of sand and salt to the roadway and plowing of the roadway. Early failure of the traffic-control markings means that roadway-marking costs are greatly increased; and for portions of the year there may be no traffic-control markings on the roadway.

Achieving longer life in traffic-control markings formed from solid particulate marking materials is a special challenge because of the difficult conditions under which the marking operation is performed. The roadway surface is an unclean surface covered with a film of accumulated road oils as well as particles of dirt or sand. Yet it is impractical to subject such a surface to anything more than a superficial cleaning, such as sweeping the surface, during a roadway-marking operation. Further, a paved roadway and the substrate underlying the roadway provide a large heat sink, so that to successfully perform the marking operation, the roadway surface and marking material should be directly heated to a rather high temperature, as with a flame. Even so, the thermally softened particulate marking materials must wet the roadway surface and form a continuous adherent film almost instantly after application. That means that for an organic polymeric material to be useful in a solid particulate marking material for roadways, the organic polymeric material should have a rather sharp melting point and a low melt-viscosity; but such materials tend to be brittle and more susceptible to the effects of wear that prevent long life. Another limiting condition of roadway marking is the fact that, for a roadway marking operation to be practical, the marking must be achieved by single passes of the marking equipment.

These limitations have made it difficult to improve the life of traffic-control markings prepared from solid particulate thermosoftening marking materials. While the instant-traffic-bearing capabilities of the markings

formed from such materials gives them an important utility, their utility would be greatly increased if a way could be found to lengthen the life of the markings.

SUMMARY OF THE INVENTION

The present invention is based on the discovery that the useful life of markings prepared from solid particulate thermosoftening marking materials can be significantly extended by forming a thin adherent bonding layer on the roadway with a liquid coating composition prior to application of the solid particulate marking material. Despite the adverse conditions listed above, markings of significantly improved durability result.

Briefly, a method of the invention comprises the steps of

A. coating onto a paved roadway surface a thin bonding layer of liquid coating composition that has a viscosity less than about 1,000 centipoises, comprises a film-forming organic binder material, and (1) readily wets the paved roadway surface, (2) then advances within about 30 seconds to a non-spreading form that is sufficiently free of flammable solvents so that when briefly exposed to an elevated temperature between 150° and 500°F, it does not char or burn but softens to a tacky condition, and (3) ultimately advances to a tough film that adheres well to the paved surface; then, within about one hour after completion of step (A),

B. momentarily heating the paved roadway surface and the bonding layer to an elevated temperature;

C. projecting toward the thus-heated bonding layer a marking material that comprises a continuous stream of solid individual organic-based particles that

1. are capable of passing a screen of about 20 mesh, with at least 80 weight-percent being retained on a screen of about 200 mesh;

2. are non-tacky, non-blocking, free-flowing, and solid at temperatures up to about 120°F; and

3. comprise (a) a coloring agent in an amount sufficient to color a marking formed from the marking material and (b) an organic thermoplastic phase that accounts on the average for at least about 25 volume-percent of the marking material and that rapidly melts to a low-viscosity condition such that its melt-viscosity is less than about 4,000 centipoises at 300°F and less than about 15,000 centipoises at 250°F; and

D. heating the individual particles as they proceed toward the bonding layer to a temperature sufficiently above 150°F to at least soften a major portion of the organic thermoplastic phase of the particles before they reach the bonding layer.

The heated condition of the bonding layer and the particles is such that the particles wet and bond to the surface of the bonding layer and coalesce into a film, which subsequently becomes solid, non-tacky, and capable of bearing wheeled road traffic without tracking.

PRIOR ART

The application of a liquid coating composition to a substrate prior to application of a second marking material to the substrate is akin to a "priming" operation. And such priming operations have been previously performed prior to application of solid particulate thermosoftening marking materials; see U.S. Pat. Nos. 2,716,075 and 3,264,131, for example. But the use of a preliminary bonding layer in a roadway marking op-

eration is a novel extension of "priming" operations. Prior priming operations call for a severe cleaning of the surface that is to be coated and a careful application of the priming and final coating materials. Such operations contrast with roadway-marking operations, which are performed under conditions that would be thought to prevent a productive use of priming: the unclean and diverse nature of the roadway surface; the need to use single-pass marking operations; the need to permit traffic to travel over the applied bonding layer prior to application of the particulate marking material so as to avoid interruption of traffic; the need to apply the particulate marking material more quickly after application of the bonding layer than is normally used for drying a primer; the direct application of high temperatures to the bonding layer, as with a flame; the use of rather brittle, low-melt-viscosity marking materials to achieve instant traffic-bearing ability; and exposure of the markings to severe winter conditions. The improvement in durability achieved by the present invention under such conditions was not suggested by the prior art.

DETAILED DESCRIPTION

A wide variety of film-forming binder materials are useful to form bonding layers according to the invention. Some exemplary binder materials are compositions of acrylonitrilebutadiene copolymers and heat-reactive phenol-formaldehyde resins; compositions of polychloroprene and heat-reactive phenol-formaldehyde resins; drying-oil-modified alkyd resins; water-insoluble, isocyanate-terminated polyurethane prepolymers; and epoxy-resin-based compositions. Bonding layers consisting of the listed binder materials generally have sufficient toughness and film integrity, even when exposed to moisture and other normal environmental roadway conditions, so as to hold the marking layer onto the roadway; they are readily wetted by the molten marking material (meaning that their surface energy is generally about the same as or greater than the surface energy of the molten marking material); they adhere well to the roadway; and they adhere well to the marking material.

Film-forming binder materials that have adhesion-promoting groups like those contained in the compositions above are usually especially suited to use as binder materials in the invention. And the best adhesion between the bonding layer and the marking layer generally occurs when an intermixture of the two develops during application. Such an intermixture generally is obtained if the bonding layer softens sufficiently to become tacky in the presence of the heat applied prior to and during application of the marking material.

Reaction between the bonding layer and the marking materials is also desirable. In general, binder materials that cure or crosslink—as by a reaction between two parts of a binder material or as a result of exposure of the bonding layer to oxygen or moisture—after the bonding layer has been applied form the most tough films, and such binder materials are preferred.

The binder material is usually dissolved in an organic solvent to form a liquid low-viscosity coating composition that will wet the paved surface. The coating composition may or may not be colored by a coloring agent. Generally the desired wetting occurs with coating compositions that have a viscosity at application of less than about 1000 centipoises, and preferably the coating

composition has a viscosity less than about 500 centipoises and more preferably less than about 100 centipoises at application (viscosities given herein are as measured on a Model RVT Brookfield viscometer, using a number 3 spindle at 100 revolutions per minute). Such low-viscosity coating compositions not only wet the paved surface well (generally penetrating 50–75 percent or more of the interstices of the paved surface), but also form a thin layer from which solvents rapidly escape. In the ultimate form of the bonding layer, after elimination of solvent, etc., the average thickness of the layer over its whole width is preferably less than about 3 mils, and more preferably is less than about 1 mil.

Once the coating composition has been applied to the paved roadway surface, it rapidly advances (preferably in less than 30 seconds) to a non-spreading form that is sufficiently free of flammable solvents so that, when briefly exposed to an elevated temperature between 150° and 500°F, or a flame, it will not char or burn. At the same time, the bonding layer preferably becomes nontacky, preferably within 30 seconds after application of the coating liquid.

After the bonding layer has been formed on the roadway, usually within a few minutes after application of the coating composition, the solid particulate marking material is applied to the bonding layer. The marking material is applied by procedures generally described in the above-identified U.S. Pat. Nos. 3,410,185 and 3,664,242, both of which are incorporated herein by reference. One typical apparatus for applying marking material by these procedures is described in Micheln, U.S. Pat. No. 3,393,615. That apparatus uses a flame (as fed by a gaseous or atomized fossil fuel) that strikes the roadway and extends somewhat in front of the apparatus, where it preheats surface portions of the roadway and the bonding layer on the roadway. Generally, the surface portions of the roadway and bonding layer are heated to a temperature between about 150° and 500°F (as measured, for example, by a heat-sensitive crayon marked on the roadway). The marking material is sprayed through the flame onto the bonding layer, and in traveling through the flame, the marking material is softened so that at least a major portion of the organic thermoplastic phase of the particles is softened before they reach the bonding layer.

Preferred marking materials for use in this method are also described in the above-identified U.S. Pat. Nos. 3,410,185 and 3,664,242. These marking materials include organic-based particles, as well preferably as an inert nonmelting particulate material, such as transparent glass beads. In the preferred marking materials, the organic phase of the organic-based particles principally comprises a polyamide condensation product of polycarboxylic acid and polyamine (generally accounting for at least about 50 weight-percent of the organic phase), and in the most preferred embodiments also includes a low-molecular-weight viscosity reductant. Another useful marking material comprises epoxy resin and a low-molecular weight viscosity reductant such as phthalic anhydride. As previously noted, the organic phase of the particles melts quickly to a low-viscosity condition when heated but achieves a solid non-tacky condition within seconds up to one minute when cooled to about 75°F. Generally the melt-viscosity of the organic phase should be less than about 4,000 centipoises at 300°F, and less than about 15,000

centipoises at 250°F; preferably it is less than 3,000 centipoises and 10,000 centipoises at 300°F and 250°F, respectively.

As also previously noted, the organic-based particles of marking material are generally capable of passing a screen of about 20 mesh, with at least about 80 weight-percent being retained on a screen of about 200 mesh. Preferably the particles pass a screen of 40 mesh, with at least about 80 weight-percent being retained on a screen of about 100 mesh. The particles should be non-tacky, nonblocking, free-flowing, and solid at normal ambient temperature up to about 120°F to permit them to be handled practicably in marking equipment. A coloring agent is generally included in the particles in an amount sufficient to color a marking formed from the marking material.

The invention is further illustrated by the following examples.

EXAMPLES 1 - 5

A set of test markings was prepared using different bonding layers formed from different coating compositions. Each coating composition was first roller-coated onto a concrete city street. After about 15 minutes, a polyamide-based marking material as described in Example 2 of U.S. Pat. No. 3,664,242 was applied to each of the resulting bonding layers through an applicator as described in U.S. Pat. No. 3,393,615. A control marking was also formed by applying the same marking material directly to the concrete roadway next to the set of test markings. The markings were applied in very early spring so that the markings would experience freeze-thaw cycles, etc. that would accelerate failure of the markings.

The coating compositions for the bonding layers of the different test markings were as follows. For the first test marking, labeled Example 1, the coating composition comprised 11.3 parts of polychloroprene (Neoprene AC and WHR made by duPont in a ratio of one part to three parts), 5 parts of a heat-reactive phenol-formaldehyde resin (Bakelite CKR 1634 made by Union Carbide), 2.2 parts of magnesium oxide, 0.5 part of zinc oxide, 43.8 parts of petroleum solvent, 27.4 parts acetone, and 9.1 parts toluol, and had a viscosity of about 60 centipoises. The coating composition of Example 2 comprised an alkyd resin that included 35 weight-percent soya oil and 31 weight-percent phthalic anhydride and was dissolved in xylol to give a 30 weight-percent solution having a viscosity of about 25 centipoises (diluted Syntex 3638 made by Celanese). The coating composition of Example 3 comprised 10.6 parts of acrylonitrile-butadiene elastomer (Paracril BS made by Uniroyal), 10.7 parts of heat-reactive phenol-formaldehyde resin (5.4 parts Bakelite 1003 and 5.3 parts of Varcum 5485 made by Reichhold), 1.1 part of zinc oxide, 1.5 salicylic acid, and 0.2 part antioxidant, all dissolved in ketone solvents to prepare a 10 weight-percent-solids solution having a viscosity of about 30 centipoises. The coating composition of Example 4 comprised a water-insoluble isocyanate-terminated polyurethane which in turn comprised a polyethylene oxide having an average molecular weight of 200 terminated at both ends with isocyanate groups formed by reaction of the polyethyleneoxide with toluene diisocyanate, dissolved in acetone to give a 30 weight-percent-solids solution at 250 centipoises. The coating composition of Example 5 also comprised a water-insoluble

isocyanate-terminated polyurethane as described, but was formed from a polyethyleneoxide having a molecular weight of 400.

The markings were rated periodically for chipping in the manner described in ASTM D-913-51 until the control marking had totally failed so as to have a zero rating in the test. At this time all of the test markings usually bonding layers still had 10 ratings.

EXAMPLE 6

Markings were formed on a concrete roadway by the procedure described for Examples 1-5 above. One marking was prepared using a bonding layer formed from the liquid coating composition of Example 1, and another control marking was prepared without using a bonding layer. The markings were applied in the spring of the year (May 8) and rated for chipping periodically during the summer and fall.

Date of rating	Marking with bonding layer	Marking without bonding layer
May 8	10	10
May 18	10	9
May 26	10	8
May 31	10	4
July 28	10	0
September 15	9	0
October 20	7	0

From the foregoing it will be seen that one problem in the application of a primer coating to a roadway surface involves the need for such primed surface to bear traffic prior to the application thereon of a suitable marking material. Particularly when the priming composition contains a flammable solvent, it is necessary to avoid elevated temperature or flame exposure of the primed surface until essentially all of the flammable solvent is removed, because of the obvious fire hazard which might result. However, in the interval during which the solvent is removed from the primed surface before the marking composition is applied, it is extremely desirable to minimize any traffic restriction over the roadway surface, and it is therefore one unique feature of the present invention that the priming composition does not lose its priming capability during its exposure to normal traffic in this interval.

What is claimed is:

1. An improved method for marking a paved roadway surface without first severely cleaning the surface comprising

A. coating onto the paved roadway surface a thin bonding layer of liquid coating composition that has a viscosity less than about 1000 centipoises, comprises a film-forming organic bonding material, and (1) readily wets the paved roadway surface, (2) then advances within about 30 seconds to a non-spreading form that is sufficiently free of flammable solvents so that when briefly exposed to an elevated temperature between 150°F and 500°F, it does not char or burn but softens to a tacky condition, and (3) ultimately advances to a tough film that adheres well to the paved surface;

then, within about one hour after completion of step (A),

B. momentarily heating the paved surface and the bonding layer to an elevated temperature;

C. projecting toward the thus-heated bonding layer a marking material that comprises a continuous stream of solid individual organic-based particles that

- 1. are capable of passing a screen of about 20 mesh, with at least 80 weight percent being retained on a screen of about 200 mesh;
- 2. are non-tacky, non-blocking, free-flowing, and solid at temperatures up to about 120°F, and
- 3. comprise (a) a coloring agent in an amount sufficient to color a marking formed from the marking material and (b) an organic thermoplastic phase that accounts on the average for at least about 25 volume-percent of the marking material and that rapidly melts to a low-viscosity condition such that its melt-viscosity is less than about 4000 centipoises at 300°F and less than about 15,000 centipoises at 250°F; and

D. heating the individual particles as they proceed toward the bonding layer to a temperature above 150°F sufficient to at least soften a major portion

of the organic thermoplastic phase of the particles before they reach the bonding layer; the heated condition of the bonding layer and the particles being such that the particles wet and bond to the surface of the bonding layer and coalesce into a film, which subsequently becomes solid, non-tacky, and capable of bearing wheeled road traffic without tracking.

2. A method of claim 1 in which the organic phase of the particles of marking material principally comprises a polyamide resin.

3. A method of claim 1 in which said liquid coating composition material comprises a composition of acrylonitrile-butadiene copolymer and a heat-reactive phenol-formaldehyde resin; a composition of polychloroprene and heat-reactive phenol-formaldehyde resin; an alkyd resin; a water-insoluble isocyanate-terminated polyurethane prepolymer; or an epoxy-resin-based composition.

4. A method of claim 1 in which the coating composition has a viscosity less than about 100 centipoises.

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