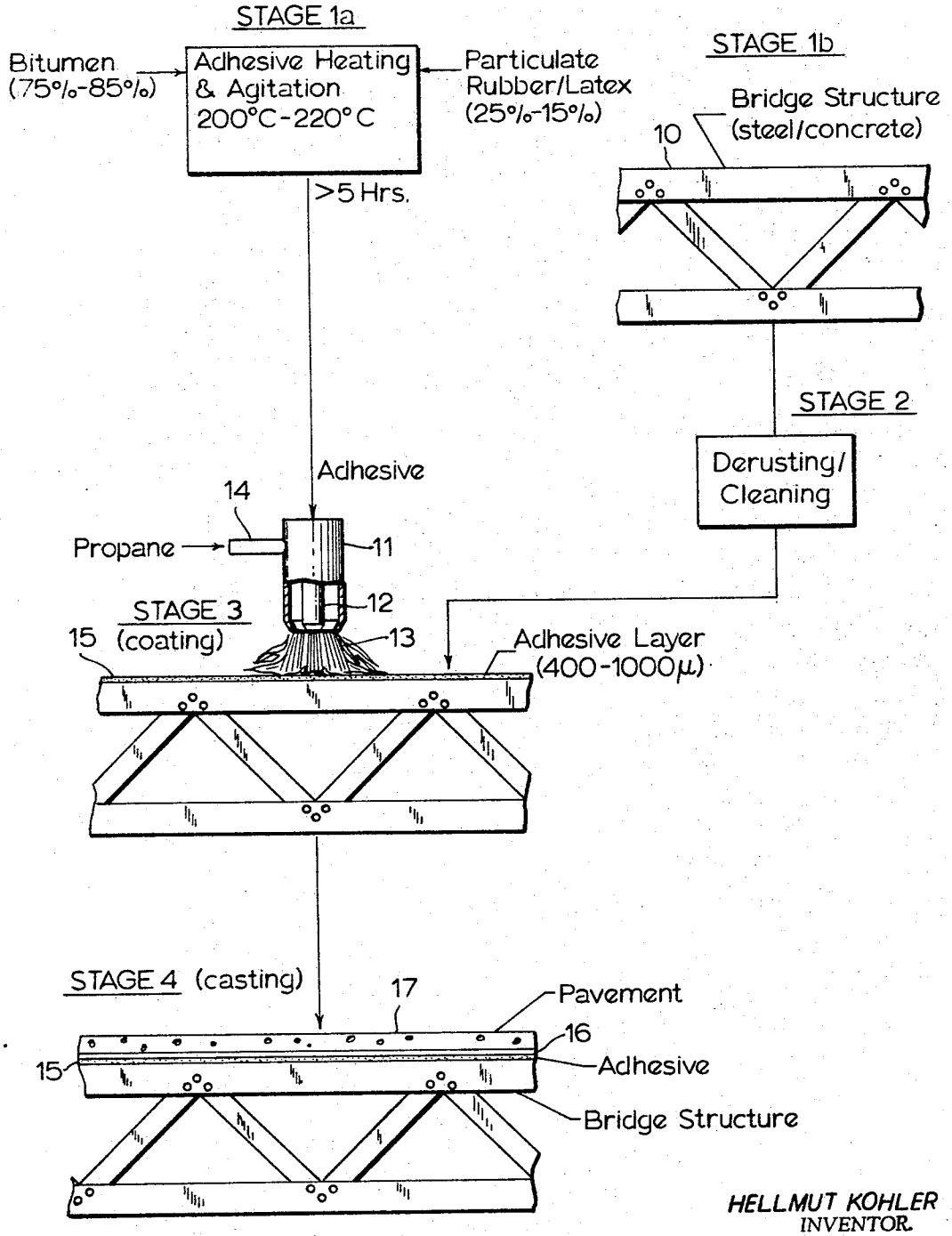
Aug. 1, 1967 H. KOHLER 3,333,517

METHOD OF BONDING PAVEMENTS TO CONCRETE OR STEEL SUBSURFACES

Filed Oct. 27, 1964



HELLMUT KOHLER
INVENTOR.

BY Karl F. Ross
AGENT

United States Patent Office 3,333,517
Patented Aug. 1, 1967

3,333,517

METHOD OF BONDING PAVEMENTS TO CONCRETE OR STEEL SUBSURFACES

Hellmut Kohler, Essen-Stadtwald, Germany, assignor to Jeerbau Gesellschaft fur Strassenbau m.b.H., Essen, Germany, a corporation of Germany

Filed Oct. 27, 1964, Ser. No. 406,934
7 Claims. (Cl. 94—22)

ABSTRACT OF THE DISCLOSURE

A method of bonding a pavement to a concrete or steel subsurface wherein a gelatinous adhesive composition is formed by heating a mixture of 75 to 85% by weight of a bitumen having a standard penetrability of 10 to 320 units (100 gr./5 seconds/25° C.) and ring-and-ball standard softening point of 27° to 72° C., with 25 to 15% by weight of comminuted vulcanized rubber, rubber latex or other rubber substance for a period of upwardly of about 5 hours and at a temperature between substantially 150° and 250° C. The adhesive is coated onto the subsurface by flame-liquid spray to a depth of 400 to 1000 microns and the asphaltic paving is then applied.

The present invention relates to pavements for bridges and like structures wherein a layer of a paving composition is bonded to a support of steel or concrete.

It is common practice in the construction of bridges from prestressed and reinforced concrete and other structures of concrete or steel to provide a pavement of bituminous substances, e.g. cast asphalt, this pavement usually containing a filler of stone or other comminuted material. A principal disadvantage of conventional structures of this type is that the bond between the bituminous pavement layer and the support frequently cannot withstand the shear stresses and forces resulting from the travel of vehicles over the pavement and/or temperature fluctuations. An effective cementing of the asphalt layer to the concrete or steel support has not been possible heretofore and conventional pavements, wherein the asphalt is deposited directly on the support, have suffered to a large extent from a tendency to develop pores and air holes between the support and the pavement layer. The resulting cellular structure acts as a trap for moisture and the like. When the pavement is not deposited directly on the superstructure and an intervening layer of a moisture-resistant or corrosion-resistant material is disposed between the pavement and the superstructure, difficulties arise owing to the inability of the adhesive layer to withstand the considerable shear stresses referred to above. The natural adhesive power of the bituminous pavement is insufficient to enable it to resist the shear forces and intervening layers of corrosion-resistant or moisture-resistant materials do little more than increase the number of interfaces at which shear stresses can act with a consequent increase in the relative slippage of the layers. To avoid these difficulties, it has been proposed, principally for steel bridges, to provide a layer of an asphaltic adhesive between the bituminous pavement and the steel structure; such adhesives, however, were found not to have sufficient power to withstand the shear forces and could not be easily applied to the structure. In general, the most effective bituminous adhesives used heretofore have consisted essentially of tarry pitches, fluxes and other flowable bitumens, and are liquid at normal temperatures. Such adhesives, which were compatible with the pavement at low temperatures, could not as is evident prevent slipping between the pavement and the support and provide the necessary adhesive strength.

On the other hand, the use of bituminous materials which were solid and highly viscous at normal temperature and which were applied in a heated state to the relatively cold steel or concrete body was also disadvantageous, at least in part as a result of the sudden cooling of quenching of the adhesives simultaneously with their application to the superstructure, this cooling preventing the adhesives from bonding to the pavement. Thus conventional adhesives which were composed almost entirely of asphaltic materials, e.g. more or less viscous pitch, were ineffective whether applied hot or cold and either were incapable of forming a secure bond with the pavement and the support or were unsatisfactory with regard to their ability to withstand shear stresses. More recently, it has been proposed to use synthetic-resin adhesives, generally of the thermosetting type; these adhesives are capable of withstanding considerable shear stresses although they are significantly more expensive than the asphaltic adhesives they were designed to replace and were unsatisfactory under conditions in which wide temperature variations were common.

It is not unusual that bridge structures and the pavement systems thereof may be exposed to summer temperatures in the sun which are as high as 60° and winter temperatures which can fall as low as —30° C. and sometimes even lower. This variation in the temperature of about 100° C. decreases the effectiveness of conventional asphaltic adhesives which consist at least 95% by weight of the bituminous material, and renders the pavement structure particularly sensitive to seasons, e.g. spring, in which wide temperature variations are not uncommon.

It is the principal object of the present invention to provide, in a pavement structure for bridges and the like, improved means for bonding a bituminous layer to the concrete or steel surface of a support.

Another object of this invention is to provide a bridge structure wherein a support of concrete or steel is bonded to a pavement in such manner that the bond can withstand considerable shear stresses and remains effective through a wide range of temperature variations.

Still another object of this invention is to provide a pavement system whereby a bituminous pavement layer can be simply and economically affixed to a support without significant relaxation of the bond with time.

A further object of the instant invention is to provide an improved method of bonding bituminous pavement materials with concrete or steel subsurfaces.

These objects and others which will become apparent hereinafter, have been attained, in accordance with the present invention, by providing an adhesive or bonding agent, interposable between a bituminous pavement layer and a concrete or steel surface, which consists essentially of a bitumen or rubber admixed under heating (i.e. by cooking them together with agitation), the adhesive combination containing between 15 and 25% by weight of the rubber and 85 to 75% by weight of the bitumen. The adhesive thus contains no significant amount of other substances and can be considered to have a ratio of the elastomeric component to the bitumen (by weight) of 1:6 to 1:4. The rubber can be admixed with the bitumen in a finely divided form, e.g. as powder, granules, filings or the like, or in the form of a liquid (e.g. as a latex). Advantageously, the heating and agitation of the mixture is carried out for a period of at least 5 hours and preferably of 10–15 hours and, in any event, until the adhesive mixture is found to contain some insoluble gelatinous rubber. The heating can be effected at temperatures between 150° C. and 250° C. although best results are obtained when the heating is carried out at a temperature range of 200–220° C. The bituminous component of the adhesive is, according to the invention, a road-paving

bituminous binder of the type described in German Industrial Standard (DIN) 1995 and is preferably one of the bitumens identified with the prefix letter B of this standard. The bitumens B15, B25, B45, B65, B80, B200 and B300 are, as set forth in this standard, bitumens having a penetrability (under standard conditions) of 100 gr. load, 5 seconds duration, at 25° C. and a cylindrical steel needle of 1.00 to 1.02 mm. diameter) or 10 to 20, 20 to 30, 35 to 50, 50 to 70, 70 to 100, 160 to 210 and 250 to 320 (in tenths of a mm.) The point of the needle was conical with an altitude of 6.35 mm. and an apex angle of 8°40′ to 9°40′. (See ASTM standard penetration of bituminous materials D–5.) The ring-and-ball softening points range from 27° C. to 72° C. Best results are obtained from bitumens identified as B65 and B200. The latter has a softening point, as measured in the usual manner, of 37°–44° C., an ash content of at most 0.5 weight percent, a paraffins content of at most 2.0 weight percent, a specific gravity at 25° C. of at least 1.0 and a weight loss at a temperature of 163° C. in 5 hours of a maximum of 2.0 weight percent. The bitumen B65 has a softening point between 49° and 54° C. and a weight loss under the same conditions of at most 1.0 weight percent, the remainder of the parameters being the same as those given for the bitumen B200. The hot liquid is an excellent adhesive for the joining of bituminous pavement layers to concrete and steel subsurfaces of bridges and the like.

According to a more specific feature of the present invention, the rubber, when in the form of a comminuted solid, can be derived from vulcanized scrap rubber (e.g. by grinding, abrading or otherwise comminuting old automobile tires). It has been found that optimum effectiveness of the adhesive is attained when the mixture contains about 80% by weight of the bitumen B200 of DIN 1995 and 20% by weight of rubber filings from automobile tires, the mass being heated at a temperature of 200–220° C. for a period ranging between 10 and 15 hours. The presence of a gelatinous rubber fraction is observed in the agitated and cooked batch.

According to another aspect of this invention, the adhesive prepared in the above manner is uniformly distributed onto the subsurface of steel or concrete in a film or layer whose thickness ranges between substantially 400 and 1000 microns and is preferably about 500 microns. A bituminous pavement layer can then be cast or mounted (e.g. in precast form) upon the adhesive layer. The adhesive layer, however, can be used without a pavement layer, because of its tenacious bond to steel and concrete surfaces, as a corrosion-resistant and moisture-resistant coating; in this case, the thickness of the layer or film will also be between 400 and 1000 microns with a preferential thickness of 500 microns. The adhesive layer is applied to the concrete or steel subsurface, in accordance with the present invention, by a so-called "flame spray" wherein the spray of liquid adhesive is surrounded by a sheath of a gas flame, this thickness permitting the droplets of spray to flow together in a continuous and homogeneous film. The subsurface can be prewarmed by exposing it to a flame although the flame of the spray itself may be sufficient to reduce quenching or sudden cooling of the spray. The advantage of prewarming the surface is twofold since the heating serves to dry the region in which the adhesive will be deposited. Moreover, it is also possible to pass a flame over the flame-spray deposited layer to effect uniform distribution of the adhesive.

The above and other objects, features and advantages of the present invention will become more readily apparent from the subsequent description, reference being made to the following specific examples and the accompanying drawing, the sole figure of which diagrammatically represents successive stages in the preparation of a bridge structure in accordance with the present invention.

In the drawing I show a stage **1***a* in which the bitumen and the particulate rubber or latex suspension are admixed under heating and agitation at 200° C.–220° C. for a period of at least 5 hours. Simultaneously the bridge structure (stage **1***b*) whose subsurface **10** is to be provided with the pavement layer is subjected in stage **2** to derusting or cleaning depending upon whether the surface is steel or concerete. When the surface **10** is of steel, it can be subjected to derusting by sandblasting in accordance with the German Industrial Standard (DIN) 18,364 section 3.212.3. Thus sandblasting should be carried out until the surface is metallically bright and all paintwork, rust and millscale are removed down to the bright steel. After stage **2**, the adhesive from stage **1***a* is supplied onto the surface **10** by a spray head **11** in which the spray nozzle **12** through which the adhesive is forced is surrounded by a sheath **13** of flame. Propane gas is fed into the supply head **11** via a conduit **14** and burns in air to provide the sheath or mantle of flame. A layer **15** of the adhesive is homogeneously disposed upon the subsurface. In stage **4**, a moisture-resistant "insulating" layer **16** of asphalt mastic is shown to be disposed upon the adhesive film and covered with a cast layer **17** of paving asphalt in which a filler such as stone is distributed.

Example I

800 kg. bitumen B200 (DIN 1995) is heated to a temperature of 200–220° C. with constant agitation. Under continuous agitation and with maintenance of this temperature, 200 kg. of automobile-tire rubber filings are added to the bituminous mass over a period of 4 hours. The rubber is of the vulcanized, oil-extended GR–S type and thus may be considered to be a copolymer of butadiene and styrene plasticized with naphthenic petroleum oil. The particle size of the rubber ranges from substantially 10 microns to 200 microns. The mixture is cooked at the indicated temperature with stirring for a further period of 8 hours and then is poured into a vessel and permitted to cool.

To provide a pavement for a lightly-traveled road surface of a steel bridge, the adhesive prepared in the manner described above is heated to a temperature of 170–180° C. under agitation and is sprayed via a flame-spray head in a layer of 0.6 kg./m.^{2} onto the bridge surface. The latter has previously been dried and derusted as described above so that the adhesive is brought onto the bright metal. The surface, prior to coating, is treated with a flame to drive off any moisture. The adhesive is sprayed onto the surface through a nozzle under a pressure of about 5 atmospheres while the gas mantle or sheath is produced by combustion of propane gas. A conventional asphalt pavement is then deposited on the adhesive layer.

Example II

200 kg. of bitumen B200 (DIN 1995) is heated in an asphalt-agitating kettle to a temperature of 200–220° C. Under continued heating and agitation, a small stream of 60% rubber latex in aqueous suspension is added in an amount of 200 kg., the addition being relatively slow to avoid foaming. Subsequently, and additional 600 kg. of the bitumen B65 is added and stirred into the heated mass. The total heating time, with agitation and at the indicated temperature, is 15 hours. A pavement subsurface of a prestressed, steel-reinforced concrete bridge is cleaned and freed from loose dirt and contaminants and then swabbed with 0.3 kg./m.^{2} of a highly fluid bituminous solution to trap any dust remaining on the surface. Deposition of the adhesive was then carried out as in Example I by a flame spray so that a layer corresponding to 0.4 kg./m.^{2} of the adhesive remained after evaporation of any volatile constituents. After coating with 20–25 kg./m.^{2} of an asphalt mastic, serving as a moisture insulator, a layer of 5 cm. in thick-

ness of road-paving casting asphalt is deposited in two strata.

While the invention has been described hereinbefore as involving the continuous interposition of an adhesive between the pavement and the subsurface, it should be noted that it is equally possible to employ the adhesive to bond the pavement or an isolating (e.g. moisture-resistant) layer at spaced-apart locations. Even under these circumstances, the adhesive especially in relatively thick layers, is able to withstand the stresses unavoidably present at the interfaces of the layers.

What is claimed is:

1. A method of bonding a pavement to a concrete or steel subsurface, comprising the steps of heating a mixture consisting essentially of 75 to 85% by weight of bitumen from the group of bitumens having a standard penetrability of 10 to 320 units (100 grams/5 sec./ 25° C.) and ring-and-ball standard softening points of 27° to 72° C., and 25 to 15% by weight of rubber with agitation for a period ranging upwards of about 5 hours and at a temperature between substantially 150° and 250° C. until at least part of said rubber is gelatinized to form an adhesive composition; coating said subsurface with a layer of said composition in a heated state thereof to a thickness of substantially 400 to 1000 microns; and thereafter depositing an asphalt paving layer on the layer of said composition.

2. The method defined in claim 1 wherein said composition is deposited on said subsurface by spraying it thereon in a liquid state of said composition while surrounding the spray with a sheath of flame.

3. The method defined in claim 2 wherein the layer of the adhesive composition has a thickness of substantially 500 microns.

4. The method defined in claim 3 wherein the bitumen is selected from the group consisting of the bitumens with penetrabilities between substantially 50 to 210 units (100 grams/5 sec./25° C.), said mixture being heated at a temperature between substantially 200 and 220° C. for a period ranging between substantially 10 and 15 hours.

5. The method defined in claim 3 wherein said rubber is added to said mixture in the form of filings of vulcanized rubber derived from comminuted automobile tires.

6. A method as defined in claim 4 wherein said rubber is added to said mixture as a latex.

7. The method defined in claim 1 wherein said subsurface is the surface of a steel bridge, further comprising the step of sandblasting the steel-bridge surface until it is metallically bright, and treating the steel surface with a flame to drive off any residual moisture.

References Cited

UNITED STATES PATENTS

1,817,933	8/1931	Ross	260—758
2,728,734	12/1955	Cubberly et al.	260—28.5
2,989,494	6/1961	Pitchford	260—28.5

JACOB L. NACKENOFF, *Primary Examiner.*