

1.130.043



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PATENT SPECIFICATION

NO DRAWINGS

1.130.043

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Int. Cl.:—C 09 d 3/74

COMPLETE SPECIFICATION

Acrylic Coating Compositions

We, E. I. DU PONT DE NEMOURS AND COMPANY, a corporation organised and existing under the laws of the State of Delaware, of Wilmington, State of Delaware, United States of America, do hereby declare this invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a polymeric coating composition for metallic substrates which is particularly useful in the repair of painted metal substrates and more particularly, this invention concerns a pigmented polymeric coating composition useful primarily in automotive refinishing of thermosetting enamel paints and in particular refinishing of acrylic enamel paints.

Prior to this invention, it was extremely difficult and costly to repair thermosetting enamel coatings on metallic substrates which are used on a variety of automobiles manufactured today. Previously, repair of these enamel coatings required roughening of the enamel coat followed by a primer and/or a sealer coat before a repair coat of either an enamel or a lacquer was applied. Moreover, in order to obtain an unnoticeable repair, the entire panel usually had to be refinished. Another method for repairing thermosetting enamels comprised using a nitrocellulose based lacquer which adhered tenaciously to a roughened enamel substrate without using a primer or a sealer coat, but the nitrocellulose repair coating deteriorated quite rapidly upon weathering which made the refinished area noticeable after only a few months exposure. The novel coating composition of this invention provides excellent adhesion to thermo-

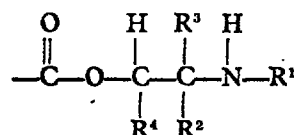
[Price 4s. 6d.]

setting enamel substrates without first priming or sealing the surface of the enamel and also has excellent resistance to cracking and good outdoor durability.

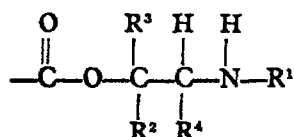
According to the present invention we provide a coating composition which contains, as the film-forming component thereof, a polymer mixture which consists essentially of

(a) from 40 to 90% by weight, based on the weight of the polymer mixture, of Interpolymer A which consists essentially of

(1) from 75 to 90% by weight, based on the weight of the interpolymer, of units derived from methyl methacrylate, (2) up to 20% by weight of units derived from at least one ester of an α,β -ethylenically unsaturated carboxylic acid and a saturated aliphatic monohydric alcohol containing from 2 to 12 carbon atoms, and (3) from 3 to 25% by weight of units containing monovalent amino-ester radicals attached to carbon atoms of the interpolymer backbone, the amino-ester radicals having the formula

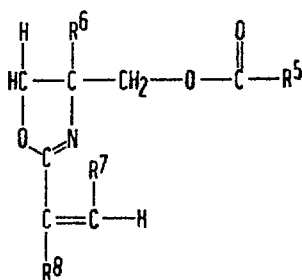


(FORMULA 1A) and/or



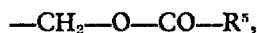
(FORMULA 1B)

wherein R^1 is hydrogen, a benzyl radical, or an alkyl radical containing from 1 to 5 carbon atoms, R^2 and R^3 , which may be the same or different, are hydrogen, benzyl or aryl radicals or alkyl radicals containing from 1 to 5 carbon atoms, and R_4 is hydrogen or an alkyl radical containing from 1 to 5 carbon atoms, and (b) from 60 to 10% by weight, based on the weight of the polymer mixture, of Interpolymer B which consists essentially of (1) from 30 to 70% by weight, based on the weight of the interpolymer, of units derived from methyl methacrylate, (2) up to 35% by weight of units derived from at least one ester of an α,β -ethylenically unsaturated carboxylic acid and a saturated aliphatic monohydric alcohol containing from 2 to 12 carbon atoms, (3) up to 10% by weight of units derived from acrylonitrile, and (4) from 15 to 35% by weight of units derived from a compound of the formula



(FORMULA 2)

wherein R^5 -CO- is a fatty acid acyl radical containing from 4 to 22 carbon atoms derived from a saturated or unsaturated fatty acid, R^6 is hydrogen, an alkyl group containing from 1 to 4 carbon atoms or a group of the formula



R^7 is hydrogen or an alkyl group containing from 1 to 4 carbon atoms, and R^8 is the residue of a saturated or unsaturated fatty acid containing from 4 to 22 carbon atoms minus the carboxyl group and the α -carbon atom.

The film-forming polymeric component is made up of a mixture of 40 to 90% by weight of Interpolymer A and correspondingly 60 to 10% of Interpolymer B. Preferably, the mixture contains 50 to 60% by weight Interpolymer A and 50 to 40% by weight Interpolymer B. One particularly preferred composition contains 55% by weight Interpolymer A and 45% by weight Interpolymer B.

INTERPOLYMER A

Interpolymer A can be formed by first preparing a carboxylic polymer by conventional

methods of solution polymerization containing units of about:

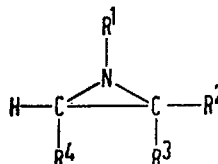
(1) 75 to 95% by weight methyl methacrylate (MMA),

(2) less than about 20% by weight of an ester of an α,β -ethylenically unsaturated carboxylic acid and a C_2 to C_{12} saturated aliphatic monohydric alcohol, preferably an ester of acrylic acid or methacrylic acid, with the particularly preferred ester being ethyl acrylate (EA),

(3) 1.5 to 15% by weight of an α,β -ethylenically unsaturated carboxylic acid such as methacrylic acid, acrylic acid or crotonic acid, with methacrylic acid being the preferred constituent.

The carboxylic polymer is then reacted with an aziridine compound, which is often referred to as an alkylene imine, of the following structural formula:

FORMULA 3

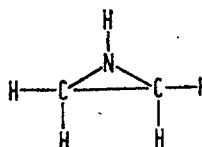


wherein R^1 , R^2 , R^3 and R^4 are as defined in Formula 1.

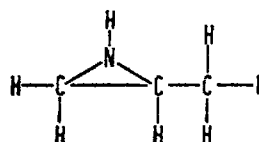
Depending on the structure of the aziridine compound, either of the N-C bonds in the ring may be broken in the esterification reaction, giving rise to a polymer having one or both types of the aminoester groups of Formula 1A and Formula 1B attached to carbon atoms of the polymer backbone.

Ethylenimine (Formula 4) and 1,2-propylenimine (Formula 5) as shown hereinafter are particularly preferred aziridines useful in this invention because of their relatively low cost and plentiful supply and because they tend to provide the final product with excellent adhesive properties.

FORMULA 4



FORMULA 5



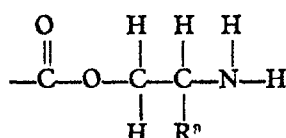
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The alkylene imine reacts with the acid groups connected to the polymer chain to form pendant monovalent amino-ester radicals as previously shown in Formulae 1A and 1B.

- 5 Preferably, Interpolymer A is composed of 78 to 82% by weight MMA, 12 to 14% by weight EA, and 5 to 8% by weight of units containing monovalent amino ester radicals attached to the polymer backbone which are formed by reaction of methacrylic acid groups with either propylenimine or ethylenimine and have the formula:

FORMULA 6



in which R^a is either H or methyl.

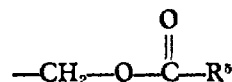
- 15 One particularly preferred composition of Interpolymer A consists of 80% by weight MMA, 13% by weight EA and 7% by weight of the amino ester formed from methacrylic acid and propylenimine.
- 20 Polymerization of the monomers to form the carboxylic polymer is carried out by mixing the monomers with suitable solvents, such as ethyl acetate, isopropyl alcohol, toluene or butyl alcohol. A polymerization catalyst is then added to the mixture, such as tertiary butyl peroxide, cumene hydroperoxide, benzoyl peroxide and azobisisobutyronitrile. The amount of catalyst used is 0.1 to 2% by weight of the monomers present. The reaction mixture is then refluxed until the polymerization is completed which can be checked by a polymer solids determination.
- 30 The carboxylic polymer is then reacted with an alkylene imine. In a typical imination reaction, the alkylene imine is mixed with the carboxylic polymer in a reaction vessel under atmospheric pressure. Preferably, the amount of alkylene imine added to the carboxylic polymer is about 25% in excess of the total molar amount of alkylene imine which is necessary to esterify all the pendant carboxyl groups of the polymer to aminoester groups. The mixture is stirred and reacted at about 35 to 90°C. until the reaction is completed (e.g., about 1/2 hour at the higher temperatures to about 12 hours at the lower temperatures). Finally, the reaction product is cooled to room temperature. The upper temperature limit of the imination reaction is determined largely by the solvents used in the system and vaporization temperature of the imine. The entire reaction can be carried out at room temperature, but heating is much preferred because of the shorter reaction time.

INTERPOLYMER B

Interpolymer B can be prepared by conventional methods of solution polymerization of a monomeric mixture comprising

- (1) 30 to 70% by weight methyl methacrylate (MMA),
- (2) up to 35% by weight of an ester of an α,β -ethylenically unsaturated carboxylic acid and a C₂ to C₁₂ saturated aliphatic monohydric alcohol, preferably an ester of acrylic or methacrylic acid with the preferred being ethyl acrylate (EA),
- (3) up to 10% by weight of acrylonitrile (AN), and
- (4) 15 to 35% by weight of a compound as previously defined by the structural Formula 2.

In its preferred form, Interpolymer B consists of 53 to 57% by weight MMA, 13 to 17% EA, 3 to 7% AN, and 23 to 27% of a reaction product of 1 mole of tris(hydroxymethyl)-aminomethane and 3 moles of tall oil fatty acid which is subsequently reacted with formaldehyde. This compound is currently sold under the trademark of "Chemacoil TA 100". In relating the structural Formula 2 to the above reaction product, R^a is the hydrocarbon group of tall oil fatty acid, R^b is the hydrocarbon group of a tall oil fatty acid less the —CH₂— group, which is adjacent to the carboxyl group of the acid, R^c is



and R^c is H.

In general, the compounds of Formula 2 can be prepared by the reaction of a suitable amino hydroxy compound, organic carboxylic acid and aldehyde according to the process disclosed in U.S. Patent No. 2,559,440. Although the products of this process are described in the patent as being acyclic, it is disclosed in U.S. Patent No. 3,248,397 that these products are in fact cyclic oxazolines.

In both Interpolymers A and B, up to 15% by weight of units of styrene can be substituted for part or all of the (2) constituent without adversely affecting the properties of the coating composition.

A coating composition is formulated from Interpolymers A and B by properly blending these constituents to obtain desired film properties. This polymer blend is then pigmented and can be subsequently diluted with solvents to form a lacquer composition.

The coating composition of this invention is preferably pigmented to pigment volume concentration of 1 to 50%, more preferably 1 to 20%. The term "pigment volume concentra-

tion" is the ratio expressed on a percentage basis of the volume of the pigment relative to the total volume of the non-volatile content of the coating composition including the organic film-forming materials and pigment.

5 A wide variety of pigments can be used with the only requirement being that the pigment used does not react with the film-forming polymer. Following are some typically
10 useful pigments: magnesium silicate, zinc oxide, barytes, silica, zinc dust, aluminum (finely divided flakes or powder), titanium dioxide, Wollastonite, carbon black, monastral red, monastral blue, indo blue, chrome yellow,
15 monastral green, copper bronze, green gold and iron oxides.

The following solvents or mixtures thereof are useful for forming a lacquer composition from a pigmented film-forming polymer of
20 this invention: acetone, methylethyl ketone, amyl alcohol, the acetic acid ester of ethylene glycol, monethyl ether, ethyl acetate (denatured), ethyl alcohol (denatured), isopropanol, ethylene dichloride, butyl lactate, diacetone alcohol, diisobutyl ketone, cyclohexanone, amyl acetate, ethylene glycol monobutyl
25 ether, cyclohexanol, methyl acetate, furfural, petroleum naphtha, toluene, cyclohexane, benzene, substituted benzene, substituted toluene, hexane, aromatic hydrocarbons, high boiling petroleum naphtha, xylene, high solvency petroleum hydrocarbon, diethyl ether, methylamyl acetate, and butanol. Useful lacquer
30 compositions contain 90 to 50% by weight organic solvent and 10 to 50% by weight of the film-forming polymer mixture.

A particularly preferred solvent consists of 38% by weight of a mixture of hexane and acetone, 52% by weight of a mixture of isopropyl alcohol, xylene, toluene and butyl alcohol and 10% by weight of a mixture of methylamyl acetate and the acetic acid ester of ethylene glycol monoethyl ether.

45 The coating composition of this invention adheres quite well to either buffed or weathered enamel surfaces, but preferably the surface is buffed before the coating is applied. If the coating composition is to be applied over a new or an unweathered enamel, buffing
50 is essential for good adhesion. The coating

can be applied by handspray or electrostatic spray techniques, or by dip or flow coating. After application, the composition can be air dried or baked at 220°F. for about 20 to 30 minutes.

Another novel feature of the coating composition of this invention is that after the dried coating is exposed to ultraviolet light, for example, sunlight, for about 2 weeks, the polymer cross-links and becomes insoluble in solvents which were used to apply the coating and also becomes more resistant to cracking upon weathering. The composition before exposure to ultraviolet light acts as a conventional lacquer but after exposure, it has the characteristics of an enamel. This and the other desirable characteristics of the coating composition of this invention make it useful not only for repair and refinishing of enamels, and in particular acrylic enamels, but also as a suitable composition for repairing all types of coated metal substrates, such as metals coated with acrylic lacquers, nitrocellulose lacquers and alkyd-melamine paints. Furthermore, the composition of this invention can be used as the primary topcoat on suitably primed metal substrates.

The examples illustrate the invention. All quantities shown are on a weight basis unless otherwise indicated.

EXAMPLE 1

A coating composition was prepared by formulating two Interpolymers A and B having the following compositions:

Interpolymer A

A polymer was formed of methyl methacrylate/ethyl acrylate/methacrylic acid in a weight ratio of 80/13/7, this polymer was subsequently treated with 4.64 parts by weight, per 100 parts by weight of the polymer, of 1,2-propylenimine to form pendant aminoester groups on the polymer backbone.

Interpolymer B

A polymer was formed of methyl methacrylate/ethyl acrylate/acrylonitrile/"Chema-coil TA-100" (described hereinafter) in a weight ratio of 55/15/5/25.

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Preparation of Interpolymer A
MMA/EA/MAA-Propyleneimine
(80/13/7) (4.64)

	Parts By Weight
Portion 1	
Toluene	1725.0
Anhydrous isopropyl alcohol	1145.0
Ethyl acetate	843.0
Portion 2	
Methyl methacrylate monomer	2445.0
Azobisisobutyronitrile	9.0
Ethyl acrylate monomer	397.0
Methacrylic acid	214.0
Portion 3	
Azobisisobutyronitrile	9.0
Ethyl acetate	30.0
Portion 4	
Azobisisobutyronitrile	10.0
Ethyl acetate	30.0
Portion 5	
Ethyl acetate	724.0
Portion 6	
Propylenimine	142.0
Anhydrous isopropyl alcohol	183.0
Portion 7	
Anhydrous isopropyl alcohol	77.0
Total	7983.0

Each of the monomers was of the ordinary commercially available inhibited grade which contains a small amount of inhibitor, such as the methyl ether of hydroquinone.

The multi-component proportions were premixed before they were added. Portion 1 was charged into a conventional polymerization vessel equipped with a stirrer, thermometer and means to introduce reagents, and means of heating and cooling the reaction mix-

ture and was heated to its reflux temperature of about 80 to 83°C. Portion 2 was premixed just before it was added since it was not stable and was added continuously over a 2 hour period to the reaction vessel while maintaining the temperature of the ingredients at about 80°C. After Portion 2 was added, the reaction mixture was held at this temperature for about 2 hours. Portion 3 was then added with constant agitation while the temperature of the

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- 5 reaction mixture was maintained at about 80°C. and the mixture was held at this temperature for about one hour. Portion 4 was slowly added with constant stirring and Portion 5 was then added while the temperature of the reaction mixture was held at about 70°C. until a Gardner Holt viscosity of Z_2-Z_4 was reached. Next, Portion 6 was slowly added with constant agitation, then Portion 7 was added and the reaction mixture was held at about 77°C. until the acid number of the mixture reached about 1 or below. The resulting reaction mixture which had about a 40% solids content was cooled to room temperature and filtered to remove coagulum formed during the reaction.

Preparation of Interpolymer B
MMA/EA/AN/"Chemacoil" TA-100

	Parts by Weight
<u>Portion 1</u>	
Methyl amyl acetate	102.30
Xylol	152.00
<u>Portion 2</u>	
Methyl methacrylate monomer	224.80
"Chemacoil" TA-100 (reaction product of one mol of tris-(hydroxymethyl)-aminomethane with 3 mols of tall oil fatty acid which is subsequently reacted with one mol of formaldehyde using the process of U.S.P. 2,559,440.	102.20
Acetic acid ester of ethylene glycol monoethyl ether	74.10
Dicumyl peroxide	4.10
Acrylonitrile	20.50
Ethyl acrylate monomer	61.30
Di-tertiary-butyl peroxide	6.20
<u>Portion 3</u>	
Toluene	74.10
Total	821.60

- 20 The multi-component portions were pre-mixed before they were added. Portion 1 was charged into a conventional polymerization vessel equipped with stirrer, thermometer and means to introduce the reagents, and means of heating and cooling the reaction mixture and was heated with agitation to its reflux temperature which was about 132°C. to 25 135°C. Portion 2 was premixed only a short time before it was added since it was not stable and was added at an even and continuous rate over a 5-hour period with constant 30 agitation while maintaining a reflux temperature of about 132 to 133°C. The mixture was

held at its reflux temperature until a conversion of about 53.5% polymer solids was reached and a constant viscosity was obtained between Z_2-Z_4 Gardner Holt viscosity. The mixture was then cooled to room temperature and Portion 3 was added. The resulting mixture which has a solids content of about 40% was filtered to remove coagulum that has formed during the reaction.

An acrylic lacquer was then formulated by forming a pigment dispersion, mixing this dispersion with the blend of Polymers A and B and diluting this mixture to a spray viscosity with solvents.

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Formula Y Pigment Dispersion

	Parts by Weight
Interpolymer B solution (50% solids)	188
Titanium dioxide pigment	580
Acetone	77
Toluene	129
Acetic acid ester of ethylene glycol monoethyl ether	26
Total	1000

The ingredients were premixed and charged into a conventional sand-grinding mill and ground to about a 0.3 mil fineness.

The acrylic lacquer was formed by mixing the following ingredients: 5

	Parts by Weight
Formula Y Pigment dispersion	344.7
Polymer A solution (40% solids)	323.5
Polymer B solution (50% solids)	146.8
Acetone	72.0
Hexane	113.0
Total	1000.0

- A coat of the acrylic lacquer about 2 mils in thickness was sprayed onto each of the following sets of panels (15 panels per set):
- 10 autobody steel panels which had been suitably primed; steel panels coated with acrylic lacquer; steel panels coated with a pigmented nitrocellulose lacquer; steel panels coated with a thermosetting acrylic enamel; steel panels coated with an alkyd enamel; steel panels coated with an alkyd-melamine enamel; the surface of the thermosetting acrylic enamel, the alkyd enamel and the alkyd-melamine enamel were machine buffed with a conventional buffing compound before the acrylic lacquer was applied.
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- The initial appearance of each of these sets of panels and adhesion of the lacquer to the various substrates was excellent.
- Five panels of each of the above sets were subjected to a high-humidity-low temperature crack test which consisted of 24 cycles. In each cycle, the panels were subjected to (1) 100% relative humidity and 100°F. for 24 hours, (2) -10°F. for 24 hours and (3) room temperature for 4 hours. At the completion of each cycle, the panels were examined with a magnifying glass for cracks. At the end of the test, many of the above panels showed no cracking, while several had some slight insignificant cracks.
- Ten panels of each of the sets were exposed in Florida at a 45° angle facing south. The panels were examined after 6 months and 12 months. After 12 months of weathering, each of the panels showed good color retention, excellent gloss, very little chalking and water spotting, and no loss of adhesion to the substrate.
- Both the high humidity-cold crack test and the outdoor exposure test indicate that the novel acrylic lacquer composition of this invention is an excellent primary coating for metals and adheres well to all types of thermosetting enamel substrates even under severe testing conditions.

EXAMPLE 2

A nitrocellulose lacquer coating was compared to the acrylic lacquer of Example 1 for outdoor durability. A nitrocellulose lacquer

having the same pigment and pigment volume concentration as the acrylic lacquer of Example 1 was formulated by mixing the following ingredients:

	Percent Solids
Nitrocellulose (1/8 to 3/8 sec. Saybolt viscosity solution of a ketone solvent)	52
Coconut oil modified glycerol phthalate resin (50% solids solution in which the solvent is a mixture of xylene and toluene)	22
Di-butyl phthalate	15
Air blown castor oil	11
Total	100

- 10 The resulting composition had a solids content of about 45%. A pigment dispersion was then formed according to Formula Y Pigment Dispersion of Example 1 with the exception that the above nitrocellulose solution was substituted for the Interpolymer B solution. This pigment dispersion was then mixed with the above nitrocellulose composition according to the procedure of Example 1 to form a pigmented nitrocellulose lacquer.
- 15 Four sets (10 panels per set) of suitable primed steel panels were prepared and each set was coated with a different commercially available thermosetting acrylic paint. The following thermosetting acrylic paints were used:
- 25 Du Pont, Cook, Jones-Dabney and Dizler. Each of the acrylic paint surfaces was first

buffed. About a 2 mil coat of the acrylic lacquer of Example 1 was sprayed on 5 panels of each set and air dried. A 2 mil coat of the above prepared nitrocellulose lacquer was sprayed on the remaining 5 panels of each set and air dried. Both the nitrocellulose lacquer coated panels and the acrylic lacquer coated panels had a good appearance and both lacquers had excellent adhesion to the acrylic paint substrate.

All of the panels were then exposed out of doors in Florida at a 45° angle facing south. After 2 months, each panel was checked for appearance and adhesion of the topcoat to the acrylic paint. The results of the test (average of 5 panels) are as follows:

Acrylic Thermosetting Paint	Adhesion/Appearance	
	Example 1 Acrylic Lacquer	Nitrocellulose Lacquer
Du Pont	10/Excellent	5/Chalked
Cook	10/Excellent	0/*
Jones-Dabney	10/Excellent	5/Chalked
Dizler	10/Excellent	7/Chalked

Adhesion rating — 10 = Excellent adhesion
0 = No adhesion

*No lacquer remained on the panels.

- 45 The above test illustrates the superiority of adhesion and appearance of the acrylic lacquer composition of this invention in comparison to conventional nitrocellulose lacquers which are frequently used to repair acrylic paints.

A conventional acrylic lacquer was compared to the novel lacquer composition of Example 1 for adhesion to a buffed but unprimed substrate of a thermosetting acrylic paint.

A conventional acrylic lacquer was formulated by combining the following ingredients:

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EXAMPLE 3

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	Parts by Weight
Polymethyl methacrylate in solution in 70:30 toluene/acetone (40% solids)	101
Cellulose acetate butyrate in solution in 70:30 toluene/acetone (25% solids)	120
Butyl cyclohexyl phthalate	11
Coconut oil modified glycerol phthalate (70% solids)	18
Total	250

The resulting polymer solution had a solids content of about 45%.

5 A pigment dispersion was formulated which was the same as Formula Y Pigment Dispersion of Example 1 except an equivalent amount of the aforementioned poly-methyl methacrylate solution was substituted for the Interpolymer B solution of Example 1. An acrylic lacquer was then formulated according to Example 1 except the above prepared pigment dispersion and polymer solution were used.

10 Ten steel panels were primed and coated with a thermosetting acrylic enamel paint and the coating was buffed. A 2 mil thick coat of the acrylic lacquer composition of Example 1 was applied to 5 of the panels and allowed to air dry. Similarly, a 2 mil thick coating of the above conventional acrylic lacquer was applied to the remaining 5 panels and air dried.

After 72 hours, each of the panels was checked for adhesion of the topcoat. The adhesion test involved cutting diamond shapes on the paint in which the cut penetrated the paint film to the metal, then a piece of tape was placed over the cut area and smoothed down. The tape was then removed. If none of the topcoat was removed, the adhesion of the lacquer was considered excellent. Each of the panels coated with the acrylic lacquer composition of Example 1 had excellent adhesion to the acrylic paint while the conventional acrylic lacquer readily peeled off the acrylic enamel.

EXAMPLE 4

The following acrylic lacquers were prepared according to Example 1 using the Formula Y Pigment Dispersion with the exception that the polymer proportions as indicated were used to form the lacquer:

Acrylic Lacquer	Polymer Proportions	Parts by Weight
1	Interpolymer A (Ex. 1) Interpolymer B (Ex. 1)	80 20 100
2	Interpolymer A (Ex. 1) Interpolymer B (Ex. 1)	70 30 100
3	Interpolymer C Interpolymer B (Ex. 1)	80 20 100
Interpolymer C was prepared using the procedure of Example 1 to form Interpolymer A, except methyl methacrylate/methacrylic acid in a weight ratio of 93/7 was used to form the polymer which was subsequently reacted with 4.64 parts by weight propylenimine.		
4	Interpolymer C Interpolymer B (Ex. 1)	60 40 100
5	Interpolymer C Interpolymer B (Ex. 1)	48 52 100

A coating of about 2 mils of each of the above acrylic lacquers 1—5 was sprayed onto separate steel panels, each panel having a buffed acrylic paint coating and the acrylic lacquer was allowed to air dry. The initial appearance and adhesion of the lacquer was excellent. In each case, the results of the high humidity-low temperature crack test as described in Example 1 were similar to those obtained for the acrylic lacquer of Example 1. Also, each of the acrylic lacquer coatings showed excellent outdoor durability even after long periods of exposure.

EXAMPLE 5

An acrylic lacquer was prepared by first forming the following interpolymers:

Interpolymer C—Prepared in Example 4

Interpolymer D—Was prepared using the procedure of Example 1 to form Interpolymer B, except methyl methacrylate/"Chemacoil" TA-100 (described in Example 1) in a weight ratio of 70/30 was used to form the polymer.

A pigment dispersion was formulated which was the same as Formula Y Pigment Disper-

sion of Example 1 except that the above Interpolymer D was substituted for the Interpolymer B of Example 1. A lacquer was then formulated according to Example 1, except the above prepared pigment dispersion and interpolymers were used.

Five steel panels were primed and coated with a thermosetting acrylic enamel paint and the coating was buffed. A 2 mil coat of the above lacquer was applied and air dried. The initial appearance and adhesion of the lacquer was excellent. The results of the high humidity crack test as described in Example 1 were similar to those obtained for the acrylic lacquer of Example 1. Also, the lacquer showed excellent outdoor durability even after a long period of exposure.

WHAT WE CLAIM IS:—

1. A coating composition which contains, as the film-forming component thereof, a polymer mixture which consists essentially of

(a) from 40 to 90% by weight, based on the weight of the polymer mixture, of Interpolymer A which consists essentially of (1) from 75 to 90% by weight, based on the weight of the interpolymer, of units derived from methyl methacrylate, (2) up to 20% by weight of units derived from at least one



Acrylic Lacquer	Polymer Proportions	Parts by Weight
1	Interpolymer A (Ex. 1) Interpolymer B (Ex. 1)	80 20 100
2	Interpolymer A (Ex. 1) Interpolymer B (Ex. 1)	70 30 100
3	Interpolymer C Interpolymer B (Ex. 1)	80 20 100
4	Interpolymer C Interpolymer B (Ex. 1)	60 40 100
5	Interpolymer C Interpolymer B (Ex. 1)	48 52 100

Interpolymer C was prepared using the procedure of Example 1 to form Interpolymer A, except methyl methacrylate/methacrylic acid in a weight ratio of 93/7 was used to form the polymer which was subsequently reacted with 4.64 parts by weight propylenimine.

5 A coating of about 2 mils of each of the above acrylic lacquers 1—5 was sprayed onto separate steel panels, each panel having a buffed acrylic paint coating and the acrylic lacquer was allowed to air dry. The initial appearance and adhesion of the lacquer was excellent. In each case, the results of the high humidity-low temperature crack test as described in Example 1 were similar to those obtained for the acrylic lacquer of Example 1. Also, each of the acrylic lacquer coatings showed excellent outdoor durability even after long periods of exposure.

15 EXAMPLE 5

An acrylic lacquer was prepared by first forming the following interpolymers:

20 Interpolymer C — Prepared in Example 4
Interpolymer D — Was prepared using the procedure of Example 1 to form Interpolymer B, except methyl methacrylate/"Chemacoil" TA-100 (described in Example 1) in a weight ratio of 70/30 was used to form the polymer.

25 A pigment dispersion was formulated which was the same as Formula Y Pigment Disper-

sion of Example 1 except that the above Interpolymer D was substituted for the Interpolymer B of Example 1. A lacquer was then formulated according to Example 1, except the above prepared pigment dispersion and interpolymers were used.

Five steel panels were primed and coated with a thermosetting acrylic enamel paint and the coating was buffed. A 2 mil coat of the above lacquer was applied and air dried. The initial appearance and adhesion of the lacquer was excellent. The results of the high humidity crack test as described in Example 1 were similar to those obtained for the acrylic lacquer of Example 1. Also, the lacquer showed excellent outdoor durability even after a long period of exposure.

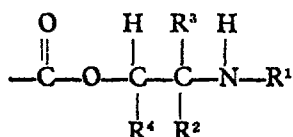
WHAT WE CLAIM IS:—

1. A coating composition which contains, as the film-forming component thereof, a polymer mixture which consists essentially of

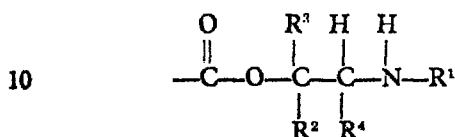
(a) from 40 to 90%, by weight, based on the weight of the polymer mixture, of Interpolymer A which consists essentially of (1) from 75 to 90% by weight, based on the weight of the interpolymer, of units derived from methyl methacrylate, (2) up to 20% by weight of units derived from at least one



- 5 ester of an α,β -ethylenically unsaturated carboxylic acid and a saturated aliphatic monohydric alcohol containing from 2 to 12 carbon atoms, and (3) from 3 to 25% by weight of units containing monovalent amino-ester radicals attached to the carbon atoms of the interpolymer backbone, the amino-ester radicals having the formula

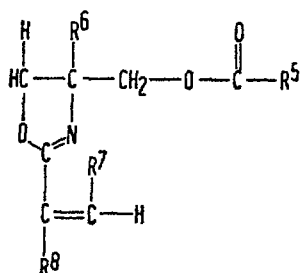


(FORMULA 1A) and/or



(FORMULA 1B)

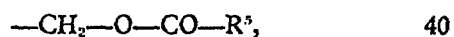
- 15 wherein R^1 is hydrogen, a benzyl radical, or an alkyl radical containing from 1 to 5 carbon atoms, R^2 and R^3 , which may be the same or different, are hydrogen, benzyl or aryl radicals or alkyl radicals containing from 1 to 5 carbon atoms, and R_4 is hydrogen or an alkyl radical containing from 1 to 5 carbon atoms, and (b) from 60 to 10% by weight, based on the weight of the polymer mixture, of Interpolymer B which consists essentially of (1) from 30 to 70% by weight, based on the weight of the interpolymer, of units derived from methyl methacrylate, (2) up to 35% by weight of units derived from at least one ester of an α,β -ethylenically unsaturated carboxylic acid and a saturated aliphatic monohydric alcohol containing from 2 to 12 carbon atoms, (3) up to 10% by weight of units derived from acrylonitrile, and (4) from 15 to 35% by weight of units derived from a compound of the formula



(FORMULA 2)

- 35 wherein $\text{R}^5-\text{CO}-$ is a fatty acid acyl radical containing from 4 to 22 carbon atoms

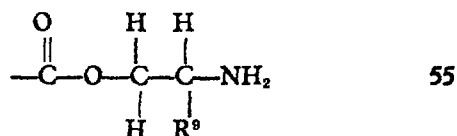
derived from a saturated or unsaturated fatty acid, R^6 is hydrogen, an alkyl group containing from 1 to 4 carbon atoms or a group of the formula



R^7 is hydrogen or an alkyl group containing from 1 to 4 carbon atoms, and R^8 is the residue of a saturated or unsaturated fatty acid containing from 4 to 22 carbon atoms minus the carboxyl group and the α -carbon atom. 45

2. A coating composition according to claim 1, in which the polymer mixture comprises from 50 to 60% by weight of Interpolymer A and from 50 to 40% by weight of Interpolymer B. 50

3. A coating composition according to claim 1 or 2, in which the aminoester radicals attached to Interpolymer A have the formula

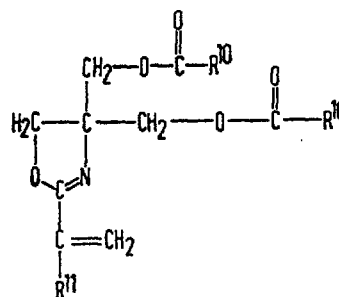


in which R^9 is hydrogen or a methyl group.

4. A coating composition according to claim 3, in which Interpolymer A comprises from 78 to 82% by weight of units derived from methyl methacrylate, from 12 to 14% by weight of units derived from ethyl acrylate, and from 5 to 8% by weight of units containing said aminoester groups. 60

5. A coating composition according to any of claims 1 to 4, in which component (2) of Interpolymer B is derived from an ester of acrylic or methacrylic acid. 65

6. A coating composition according to any of claims 1 to 5, in which component (4) of Interpolymer B is derived from a compound having the formula 70



where R^{10} is the hydrocarbon group of a tall oil fatty acid and R^{11} is the hydrocarbon group of a tall oil fatty acid less the $-\text{CH}_2-$ group adjacent to the carboxyl group of the acid. 75

7. A coating composition according to claim 6, in which Interpolymer B comprises

- from 53 to 57% by weight of units derived from methyl methacrylate, from 13 to 17% by weight of units derived from ethyl acrylate, from 3 to 7% by weight of units derived from acrylonitrile, and from 23 to 27% by weight of units derived from the compound specified in claim 6.
8. A coating composition according to any of claims 1 to 7, which comprises a pigment which is inert to the film-forming polymers in a pigment volume concentration of from 1 to 50%.
9. A coating composition according to any of claims 1 to 8, which contains pigment in a pigment volume concentration of from 1 to 20%, from 10 to 50% by weight, based on the weight of the composition, of the film-forming polymer mixture, and from 90 to 50% by weight, based on the weight of the composition, of an organic solvent.
10. A coating composition according to claim 9, in which the solvent comprises 38% by weight of a mixture of hexane and acetone, 52% by weight of a mixture of isopropyl alcohol, xylene, toluene and butyl alcohol and 10% by weight of a mixture of methylamyl acetate and the acetic acid ester of ethylene glycol monoethyl ether.
11. A modification of the coating composition according to any of claims 1 to 10, in which part or all of component (2) in Interpolymer A and/or Interpolymer B is replaced by up to 15%, based on the weight of the interpolymer, of units derived from styrene.
12. A coating composition according to claim 1, substantially as herein described in any of the Examples.
13. A metal article coated on at least one side with a dried coalesced layer of the composition according to any of Claims 1 to 12.
14. A metal article coated with a paint layer and having adhered to said paint layer a dried coalesced layer of the composition according to any of claims 1 to 12.
15. A metal article coated with an acrylic enamel paint layer and having adhered to said paint layer a dried coalesced layer of the composition according to any of claims 1 to 12.
16. A metal article according to any of claims 13 to 15, in which the metal is steel.

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