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# UNITED STATES PATENT OFFICE

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## CORROSION-RESISTANT COATING

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The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to a corrosion-resisting material and particularly relates to a material which is adapted to be used as a corrosion-resisting coating for aircraft control cables or the like.

In the past, protection of aircraft control cables was attempted to be attained by mixtures of oxygenated higher hydrocarbons obtained from the residue of petroleum distillation together with various corrosion inhibitors. These compositions, however, were not able to withstand extreme conditions of temperature and when applied to the cable, became brittle at low temperatures approximating —67° F., and cracked and peeled from the cable as it was flexed over a pulley, thereby exposing the metal cable to corrosive conditions. At elevated temperatures, on the other hand, these compositions became tacky causing them to pick up dust and dirt and allowing grit to work its way into the strands of the cable. Furthermore, the color of these compositions varied from dark amber to black and, when combined with the dust and dirt picked up at high temperatures, provided complete opaqueness. Because of this opaqueness, if any corrosion developed beneath the coating, it was not possible to detect it in time to take any real preventative measures.

This invention was devised for the purpose of avoiding the objectionable features set forth above and generally comprises a mixture of vinyl-methacrylate resins in low boiling solvents, properly plasticized to provide good flexing ability at low temperature conditions and to be sufficiently firm and hard at high temperature conditions. The composition is also lightly pigmented with a corrosion inhibitor which, however, leaves the composition substantially transparent. It is, therefore, one object of this invention to provide an anti-corrosive coating for aircraft cables or the like which exhibits the desired properties of flexibility and adhesiveness at very low temperatures and which also remains hard and firm at very high temperatures.

Another object of this invention is to provide an anti-corrosive coating which is substantially transparent.

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Another object of this invention is to provide an anti-corrosive coating which is relatively cheap and easy to produce.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description and claims.

After a brief attempt at using wax and petroleum base type formulations which did not exhibit the desired properties, it was decided to explore the field of synthetic resins. It was believed that it would be possible to formulate coatings, utilizing synthetic resins, that would exhibit the desired properties of low temperature flexing and adhesiveness and, at the same time, provide a hard and firm coating in the temperature range of —67° F. to +160° F. In such formulations involving synthetic resins these properties may be controlled through the choice and quantity of the proper plasticizer.

It has been found that several of the methacrylate polymers, when coated on metal, not only protect the metal from corrosion for great lengths of time and at high humidities but also exhibit good low temperature flexing and adhesiveness so that they act, in many ways, as their own plasticizer in a formulation. The particular methacrylate polymers which best exhibit these characteristics are n-butyl methacrylate, isobutyl methacrylate and n-propyl methacrylate polymers. Of these, the n-butyl methacrylate has been found to be the most preferable since it has the lowest softening temperature (65° F.) and is, therefore, most flexible at the lower temperatures.

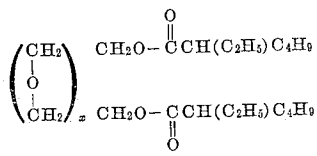
The resin n-butyl methacrylate, however, has a relatively low melting point and at elevated temperatures approximating +160° F., it forms a very soft film. In order to provide a harder coating at elevated temperatures, various vinyl chloride-vinyl acetate copolymers are added to the composition. It is known that vinyl coatings exhibit poor adhesion when applied to metal unless they are baked at fairly high temperatures, and since the control cables of an aircraft contain an internal lubricant which might be destroyed or caused to flow out when undue heat is applied, it is necessary to form the coating by airdrying and not baking. However, this difficulty is overcome by using the vinyl chloride-vinyl acetate co-

polymer known industrially as VMCH. This composition consists of about 86 percent vinyl chloride, 13 percent vinyl acetate and about one percent of either maleic acid or maleic anhydride. The maleic acid or anhydride contains a polar bond which has a strong affinity for metal and, therefore, makes it possible to air dry the coating and yet obtain a strong adherence of the coating to the metal cable.

It was found that the above resins were best applied to a cable from a volatile solution. After testing various mixtures of solvents for these resins until the proper low boiling volatile solvents and their correct proportions were discovered, it was determined that a solvent be used comprising a mixture of xylol, toluol and methyl isobutyl ketone in approximate proportions of 1, 1 and 7. It was found to be necessary to use such low boiling volatile solvents in the solution so that the coating, when applied to a cable, would not flow off before it has had a chance to set up. In addition, all three of these solvents are substantially colorless liquids which would not tend to discolor the coating.

In order to use the vinyl polymer VMCH with the methacrylate resin, it is necessary to incorporate a plasticizer in the composition. The plasticizer must be of a nature to achieve the desired low temperature flexing and, at the same time, not produce a tacky film at elevated temperatures.

Various plasticizers fulfill the requirements to a greater or lesser extent. The polyethylene glycol di-2-ethyl-hexoates of the general formula



are found to be particularly satisfactory. A polyethylene glycol 400-di-2-ethyl-hexoate which goes by the industrial name of Flexol 4GO and which comprises a blend of various ethylene glycol polymers, and Flexol 3GO which is a triethylene glycol di-2 ethyl hexoate are commercially available and may be used. Another available plasticizer is Flexol TOF which is a tri-2 ethyl-hexyl-phosphate. The Flexol 4GO is preferable to the others because it possesses the required characteristics over the greatest range. It gives a low temperature flexibility which is good at −40° F. and fair at −67° F. It also provides a non-sticky film at +160° F.

In order to improve the anti-corrosion qualities of the composition, a zinc potassium basic chromate of the formula $K_2O.4ZnO.4CrO_3.3H_2O$ which is manufactured under the industrial name of Zinc Yellow Y–539–D is used. This product not only has high anti-corrosive qualities but also increases the adhesiveness of the composition to metal. This product has less basicity than the zinc chromate pigment ordinarily used as a corrosion inhibitor, and this is an important factor in the present composition since the maleic acid present in the VMCH vinyl polymer would react with the more basic zinc chromate to give an unstable product which would gel before being used. The Zinc Yellow Y–539–D is used in a quantity which is sufficient to provide the necessary corrosion inhibiting properties and which yet maintains the required transparancy of the film. This quantity comprises about one percent of the entire composition.



The various formulations are as follows:

*Example 1*

| | Parts |
|---|---|
| VMCH (vinyl chloride 86%, vinyl acetate 13% either maleic acid or maleic anhydride 1%) | 100 to 102 |
| N-butyl methacrylate polymer | 40 to 42 |
| Flexol 4GO (polyethylene glycol 400 di-2 ethyl-hexoate) | 33 to 35 |
| Zinc Yellow Y–539–D(zinc-potassium-basic chromate) | 5 to 7 |
| Xylol | 50 to 60 |
| Toluol | 50 to 60 |
| Methyl isobutyl ketone | 275 to 375 |

*Example 2*

| | |
|---|---|
| VMCH | 100 to 102 |
| Isobutyl methacrylate polymer | 40 to 42 |
| Flexol 4GO | 33 to 35 |
| Zinc Yellow Y–539–D | 5 to 7 |
| Xylol | 50 to 60 |
| Toluol | 50 to 60 |
| Methyl isobutyl ketone | 275 to 375 |

*Example 3*

| | |
|---|---|
| VMCH | 100 to 102 |
| N-propyl methacrylate polymer | 40 to 42 |
| Flexol 4GO | 33 to 35 |
| Zinc Yellow Y–539–D | 5 to 7 |
| Xylol | 50 to 60 |
| Toluol | 50 to 60 |
| Methyl isobutyl ketone | 275 to 375 |

*Example 4*

| | |
|---|---|
| VMCH | 100 to 102 |
| Methacrylate polymer | 40 to 42 |
| Flexol 3GO (triethylene glycol di-2-ethyl hexoate) | 33 to 35 |
| Zinc Yellow Y–539–D | 5 to 7 |
| Xylol | 50 to 60 |
| Toluol | 50 to 60 |
| Methyl isobutyl ketone | 275 to 375 |

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is, therefore, to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed as the invention is:

1. The composition of claim 6 wherein the plasticizer comprises polyethylene glycol di (2-ethyl hexoate) wherein the average molecular weight of the polyethylene glycol is 400.

2. The composition of claim 6 wherein the plasticizer comprises triethylene glycol di-2-ethyl-hexoate.

3. The composition of claim 6 wherein the solvents comprise a mixture of 50 to 60 parts xylol, 50 to 60 parts toluol, and 275 to 375 parts methyl isobutyl ketone.

4. An anti-corrosion coating composition comprising 100 to 102 parts of a coplymer of vinyl chloride, vinyl acetate and maleic acid wherein the vinyl chloride forms 86%, the vinyl acetate 13%, and the maleic acid 1% of the copolymer, 40 to 42 parts of a methacrylate polymer selected from the group consisting of n-butyl methacrylate polymer, isobutyl methacrylate polymer and n-propyl methacrylate polymer, 33 to 35 parts of a plasticizing material selected from the group consisting of the polyethylene glycol-di-2-ethyl-hexoates and tri-2-ethyl-hexyl-phosphate, and 5 to 7 parts of zinc potassium basic chromate, all in a solution of low boiling solvents.

5. The composition of claim 4 wherein the

solvents comprise a mixture of 50 to 60 parts xylol, 50 to 60 parts toluol, and 275 to 375 parts methyl isobutyl ketone.

6. An anti-corrosion coating composition consisting of 100 to 102 parts of a copolymer of vinyl chloride, vinyl acetate and maleic acid wherein the vinyl chloride forms 86%, the vinyl acetate 13%, and the maleic acid 1% of the copolymer, 40 to 42 parts of a methacrylate polymer selected from the group consisting of n-butyl methacrylate polymer, isobutyl methacrylate polymer and



n-propyl methacrylate polymer, a plasticizer comprising 33 to 35 parts of a polyethylene glycol-di-2-ethyl-hexoate, and 5 to 7 parts of zinc potassium basic chromate, all in a solution of low boiling solvents.

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