

1

2,737,465

SYNTHETIC RESIN ENAMEL STRIPPING COMPOSITIONS

Leopold Pessel, Philadelphia, Pa., assignor to Radio Corporation of America, a corporation of Delaware

No Drawing. Application May 28, 1948,
Serial No. 29,931

13 Claims. (Cl. 134—38)

This invention relates, generally, to compositions for stripping synthetic resin coatings from various surfaces and, more particularly, relates to improvements in compositions which have especial utility in removing insulation from copper wire, at the same time preparing the wire to receive a coat of solder.

In the electrical industries, it is frequently necessary to strip coatings comprising synthetic resinous materials from the ends of wires preparatory to soldering them to terminals or to other wires. This necessitates a great deal of hand labor by skilled operators and, in the case of certain insulation materials, such as polyvinyl formal, it is an expensive and time consuming procedure. The present invention relates to improvements in a particular series of compositions which may be used to soften even the most resistant synthetic resin materials in a matter of seconds. These compositions leave the wire base in a clean and bright state to which a layer of solder may immediately be applied without subjecting the wire to any further treatment such as the application of a flux.

The methods described in the present application are closely related to those disclosed in co-pending application, Serial No. 744,775, filed April 29, 1947, Patent No. 2,563,417, Aug. 7, 1951, by the present inventor. The materials disclosed herein are improvements in the compositions disclosed in the said application, in that they are still faster in action. In the previous application, there were disclosed compositions containing pentanedione 2,4, with or without a certain amount of water, and preferably containing a mutual solvent for the pentanedione 2,4 and the water. It has now been found that if formic acid or certain formic acid derivatives be substituted for part of the pentanedione 2,4, the stripping action of the composition is speeded up considerably, enabling it to be used in connection with automatic stripping machines. With the percentages of formic acid derivative found useful in the present invention, the fume removal problem is not serious and the compositions do not introduce any objectionable health hazard to the workers.

One object of the present invention is to provide improvements in compositions containing pentanedione 2,4 for stripping any synthetic resin coating from a base.

Another object of the present invention is to provide improved compositions for facilitating the stripping of synthetic resin coatings from a wire base.

Another object is to provide improved compositions for the very rapid softening of synthetic, resinous materials comprising one or more of the polyvinyl acetal series.

Another object of the present invention is the provision of improved compositions for stripping synthetic, resinous

2

materials from copper wire, which leave the wire in excellent condition for the reception of solder.

The manner in which the improved compositions of the present invention may be used is illustrated in the following example. The end of a copper magnet wire, containing a thin coating of polyvinyl acetal synthetic resin, is dipped in a bath of the stripping agent, maintained at 175° F., until the coating is softened. The wire is removed from the liquid, gentle pressure is applied between the nails of the thumb and forefinger and the coating is enabled to be stripped off with a single motion. Automatic machines may also be used for applying the pressure to the coating and pulling it from the end of the wire. The end of the wire from which the coating has been removed is then dipped immediately in a tinning or soldering bath of conventional composition which provides it with a closely adherent coating of metal which does not deteriorate on long standing, indicating that no corroding deposits have been left upon the wire. This tinned or soldered end may then be immediately soldered to a terminal or to another wire with no further treating. The solder bath may be 60 per cent tin and 40 per cent lead or 40 per cent tin and 60 per cent lead, or of any other conventional solder composition.

The time of treatment necessary to soften the coating material sufficiently to be stripped off with a single motion varies with the temperature of the bath.

The preferred compositions, according to the present invention, are those which contain pentanedione 2,4, formic acid and at least a small amount of water. Use of a mutual solvent for the pentanedione 2,4 and the water produces equally good results. The pentanedione 2,4 should be present in the range of about 30 to about 98 volume per cent. Concentrated formic acid of 85 to 90 per cent strength may be present in the range of about 2 to about 50 volume per cent. Provided that at least 2 per cent of the composition is concentrated formic acid of 85 to 95 per cent strength and at least 30 volume per cent of the composition is pentanedione 2,4, the remainder of the volume may be made up by adding water or mixtures of water with an organic solvent mutually compatible with water and pentanedione 2,4. Compositions within the above range are much more rapid in their stripping action than either the same concentration of the pentanedione 2,4, by itself, or concentrated formic acid in the indicated percentage range, diluted only with water, or the water-solvent mixture, by itself.

Since it is desirable to have compositions which will not separate into two phases at room temperatures, compositions are preferred which have the desired rapid treating time at practical elevated temperatures and which remain in a single phase even after standing at room temperatures of 70° F. for long periods of time. It has been found that mutual solvents for pentanedione 2,4 and water may be added to the system without changing the optimum treating time by a great deal and, at the same time, provide a single phase system. A preferred mutual solvent is diacetone alcohol. A composition containing pentanedione 2,4, 50 volume per cent, water 25 volume per cent and diacetone alcohol 25 per cent by volume may have the pentanedione 2,4 replaced by formic acid within the volume per cent range previously indicated. It provides stable compositions which soften either oil-resin enamel coatings or polyvinyl acetal type coatings and many other types of synthetic resin coatings in a matter of seconds at 175° F.

Although many different types of mutual solvents for pentanedione 2,4 and water were tried, none was found which had any adverse effect, their inclusion, when used in amounts up to 25 per cent, not slowing down the softening effect of the pentanedione 2,4 and water enough to make their use impractical. Besides diacetone alcohol, other ketones, such as acetone, acetonyl acetone, etc., are almost equally applicable. Esters, such as methyl lactate, ethylene-glycol-monoethyl-ether, ethyl lactate, etc., may be used. Alcohols, such as ethyl alcohol, isopropyl alcohol or tetrahydrofurfuryl alcohol, or others, besides diacetonealcohol, have been found almost equally advantageous, while other miscellaneous mutual solvents for pentanedione 2,4 and water, such as gamma-valero lactone, propylene oxide and dioxane have all been tried and found operative.

Although the invention is perhaps most valuable when used with such coatings as the polyvinyl acetal resins or with polymerized oil-resin enamels, since these are extremely difficult to remove by means formerly in use, these softening agents exert a dissolving or a softening action on synthetic resins in general and have useful application in preparing any wire coated with a synthetic resinous material for the application of solder. Besides those resins already mentioned, there have been used resins of the phenolic type, such as phenol formaldehyde, polymerized allyl esters, copolymers of styrene and allyl esters, furane resins, superpolyamides, alkyds, melamine formaldehyde, etc. Although some of these resins may be softened with other solvents, it is advantageous to be able to soften them rapidly with a material which leaves no unwanted residue after the coating is stripped from the wire and, in general, the compositions of the present invention are considerably faster in action.

The following table shows the effect on a number of different types of resin coatings of compositions made up according to the present invention, the time given being that required to soften the resin sufficiently to be stripped off in a single motion:

Wire Gage No.	Type of Coating	Pentanedione 2,4, Seconds	Pentanedione 2,4-90: Formic Acid-10	
			Sec.	Boosting Factor
30.....	Polyvinyl Acetal.....	180	30	6.0
31.....	Phenolic Resin.....	50	20	2.5
35.....	do.....	150	30	5.0
40.....	do.....	180	30	5.0
30.....	Silicone Resin.....	30	10	3.0
30.....	Allyl Ester Resin.....	240	30	8.0
30.....	Styrene Copolymer Resin.....	30	5	6.0
30.....	Furane Resin.....	300	60	5.0
30.....	Polymerized Oil Enamel.....	25	10	2.5
30.....	Superpolyamide.....	4,000	60	67.0
Al Sheet.....	Alkyd Type Enamel.....	10	5	2.0
Glass Rod.....	Melamine Formaldehyde Resin.....	60	10	6.0
Wood Panel.....	do.....	80	15	5.3

The above table shows the softening time for various resins with the composition maintained at 150° F. and shows the comparison between using pentanedione 2,4, alone, and compositions in which some of the pentanedione 2,4 has been replaced with formic acid. The "boosting factor" is obtained by dividing the softening time with pentanedione 2,4, alone, by the softening time required for the corresponding resin composition when using the composition with the formic acid added. This table also indicates that the compositions of the present invention are useful not only in stripping resin coatings from wires but from other surfaces, such as aluminum sheets, glass rods or wood panels. The surfaces listed are merely illustrative and may comprise anything to which synthetic resins are commonly applied as coating materials.

The data given in the above examples were obtained,

using coatings of comparable thickness on commercially available magnet wires. It is quite obvious that the thickness of the coating will influence the speed of softening; the thinner the coating, the more rapid the softening action, providing the same diameter of wire is used. For unexplained reasons, in extremely thin wires, an increase in softening time has been found with decreased wire diameter.

It has been noted that the boosting effect of the water on the softening action of the pentanedione 2,4 increases practically in direct proportion to its content in the compositions up to 50 per cent water or higher but, when using the higher percentages of water, it is necessary to raise the temperature of the compositions to inconvenient points in order to prevent the separation of the mixture into two phases. None of the mutual solvents for water and pentanedione 2,4 which have been used in the compositions, when used alone, has been found to have any significant softening effect on the resistant types of resinous materials.

In general, the optimum amount of mutual solvent to be added to the compositions varies with the mutual solvent selected. In a composition comprising pentanedione 2,4 and water in a 2:1 ratio, for every 1 parts of diacetone alcohol, for example, there would be needed only 0.8 part of isopropyl alcohol, 0.7 part of tetrahydrofurfuryl alcohol but 1.4 parts of gamma-valero lactone. The addition of more than the optimum amounts of the various mutual solvents exerts a diluting effect and such proportions may be used to lower the cost of the resulting compositions.

Examples of preferred compositions made up according to the present invention will now be given:

Example I

	Volume percent
Pentanedione 2,4.....	40
Water.....	20
Diacetone alcohol.....	20
85% formic acid.....	20
	100

Example II

	Volume percent
Pentanedione 2,4.....	30
Diacetone alcohol.....	15
Water.....	15
85% formic acid.....	40
	100

The composition of Example II is somewhat more rapid in its action than that of Example I.

Although formic acid, itself, has been used as a stripping agent for some time, if formic acid, by itself, is to be used for this purpose, percentages considerably above 50 per cent formic acid must be used to obtain stripping efficiency. When such higher concentrations are used, however, a number of undesirable features are introduced, such as danger and annoyance due to fumes and contact of the liquid with the human skin, absorption of the formic acid in the unstripped portion of the coils with resultant corrosion. Compositions of the present invention, since they enable such low percentages of formic acid to be used, avoid these shortcomings.

It is to be emphasized that the percentage of formic acid used in accordance with the present invention is always less than 50 volume per cent. Percentages of formic acid used in this invention may be so low that an equivalent percentage in an aqueous solution, without the use of pentanedione 2,4, would be utterly ineffective for the purposes intended. This may be demonstrated by the figures given below which indicate immersion periods in seconds required to render a certain type of

5

polyvinyl acetal magnet wire insulation strippable. The temperature of the bath was held at 175° F.

A stripping agent containing:		Seconds required to soften
Pentanedione 2,4.....	volume percent.....	50
Water.....	do.....	25
Diacetone alcohol.....	do.....	25
		100
Pentanedione 2,4.....	do.....	40
Water.....	do.....	20
Diacetone alcohol.....	do.....	20
85% formic acid.....	do.....	20
		100
Pentanedione 2,4.....	do.....	20
Water.....	do.....	20
Diacetone alcohol.....	do.....	20
85% formic acid.....	do.....	40
		100
85% formic acid.....	do.....	40
Water.....	do.....	60
		100
85% formic acid.....	do.....	20
Water.....	do.....	80
		100

¹ Inactive after 60.

From the above examples, it may be seen that the addition of formic acid to a system containing pentanedione 2,4 and water unexpectedly increases the speed of the stripping action to a point considerably above that of either straight pentanedione 2,4 solutions or comparable formic acid solutions.

There is an indication that the effect of the formic acid on the efficiency of the stripping solutions is linked with the molecular structure of this compound. It has also been found that formic acid derivatives show a similar boosting effect on the speed of action. For example, a composition containing pentanedione 2,4, 98 volume per cent, concentrated formaldehyde solution, 2 volume per cent, has a stripping efficiency 50 per cent higher than straight pentanedione 2,4, while a composition containing pentanedione 2,4, 90 volume per cent, concentrated formaldehyde, 10 volume per cent, has an efficiency thrice that of straight pentanedione 2,4. In comparison with the rapid action of compositions comprising pentanedione 2,4 and formaldehyde, formaldehyde-water compositions containing as much as 20 per cent concentrated formaldehyde are completely inactive in removing most synthetic resin insulation materials. The optimum amount of formaldehyde found useful in the compositions containing pentanedione 2,4 is about 5 to 10 per cent formaldehyde to 90 to 95 per cent pentanedione 2,4. Useful effects, however, have been found by using as much as 50 per cent formaldehyde with 50 per cent pentanedione 2,4. It was found that using an optimum composition of pentanedione 2,4 and formaldehyde on a given polyvinyl acetal coating that the time required for stripping was only one-fourth that required by pentanedione, alone.

Formamide has no stripping effect, whatever, by itself, in aqueous solution, but when combined with pentanedione 2,4-water systems, there is a definite booster effect found when amounts up to 50 per cent formamide are used. The optimum percentage is about 20 to 30 per cent formamide to 70 to 80 per cent pentanedione 2,4. The highest boosting factor obtainable with formamide is about 6 compared with pentanedione 2,4, alone. That is, the time required to strip a given polyvinyl acetal enamel from a given diameter wire is about one-sixth that required using pentanedione 2,4 without the added formamide.

The esters of formic acid also have a boosting effect on the stripping action of pentanedione 2,4 or pentanedione 2,4 and water, although the effect is much weaker than that of formic acid or formamide, for example. Such esters may be methyl, ethyl, n-propyl, or n-butyl formate, etc., or esters such as ethylene diformate or benzyl formate. In fact, any alkyl or aryl group may be present since the action appears to be due to the formyl group and not to the remainder of the molecule. As an

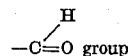
6

example, a composition containing pentanedione 2,4, 80 volume per cent, and methyl formate, 20 volume per cent, strips a given polyvinyl acetal enamel in one-half the time required for pentanedione, alone.

In general, it has been found that those formic acid derivatives having the formula



in which X may be —H, —O—H, —NH₂ or —O—R where R is any alkyl or aryl group are preferred. Since the improvement appears to be due to the



however, the remainder of the molecule does not appear to make much difference except that some exert more boosting effect than others. In general, also, it has been found that these boosting agents should be present in amounts ranging from 2 to 50 volume per cent for best results although with some, higher amounts exhibit a somewhat increasing effect in proportion to the amount used.

There have, thus, been described improved liquid compositions for stripping a synthetic resinous composition from any surface to which it normally adheres. The stripping compositions comprise pentanedione 2,4 and either formic acid or a formic acid derivative. The stripping action is brought about by a rapid softening of the coating being removed. The use of the improved compositions introduces no health hazard and their use is simply and easily carried out. It will be obvious that the preferred mode of carrying out the invention as described is susceptible of various modifications but it is intended that the invention be limited only as defined in the appended claims.

I claim as my invention:

1. A composition for softening synthetic resinous coatings consisting essentially of about 30 to about 98 volume per cent pentanedione 2,4, about 2 to about 50 volume per cent of a compound selected from the group consisting of formic acid, formaldehyde, formamide and esters of formic acid, and which contains up to 68 volume per cent water.

2. A composition according to claim 1 in which said compound is formic acid.

3. A composition for softening synthetic resinous coatings consisting essentially of about 30 to about 98 volume per cent pentanedione 2,4, about 2 to about 50 volume per cent of a compound from the class consisting of formic acid, formaldehyde, formamide and esters of formic acid, and up to 68 per cent water and a mutual solvent for pentanedione 2,4 and water.

4. A composition according to claim 3 in which said compound is formic acid.

5. A composition according to claim 4 in which said mutual solvent is diacetone alcohol.

6. A composition according to claim 5 containing about 2 to about 20 volume per cent formic acid, about 30 to about 50 volume per cent pentanedione 2,4, and up to about 48 volume per cent of equal parts of water and diacetone alcohol.

7. A composition according to claim 6 containing 20 volume per cent of 85% concentrated formic acid, 40 volume per cent pentanedione 2,4, 20 volume per cent water and 20 volume per cent diacetone alcohol.

8. A composition for softening synthetic resinous coatings consisting essentially of 30 volume per cent pentanedione 2,4, 40 volume per cent of 85% concentrated formic acid, 15 volume per cent water and 15 volume per cent diacetone alcohol.

9. A composition for softening synthetic resinous coatings consisting essentially of pentanedione 2,4 and about 2 to about 50 volume per cent formaldehyde.

10. A composition according to claim 9 in which said formaldehyde is present within the range of 5 to 10 volume per cent.

11. A composition for softening synthetic resinous coatings consisting essentially of pentanedione 2,4 and about 2 to about 50 volume per cent formamide. 5

12. A composition according to claim 11 in which said formamide is present within the range of 20 to 30 volume per cent.

13. A method of softening a synthetic resinous coating 10 comprising subjecting said coating to a composition consisting essentially of pentanedione 2,4 and a compound selected from the group consisting of formic acid, formaldehyde, formamide and esters of formic acid, said com-

position being maintained at a temperature of 150° to 175° F.

References Cited in the file of this patent

UNITED STATES PATENTS

871,750	Austen et al.	Nov. 19, 1907
1,095,270	Ellis	May 5, 1914
1,884,765	Lougovoy	Oct. 25, 1932
2,435,239	Schub	Feb. 3, 1948
2,507,985	Kuentzel	May 15, 1950
2,563,417	Pessel	Aug. 7, 1951

OTHER REFERENCES

Gregory: The Condensed Chemical Dictionary, 3rd edition, Reinhold Publ. Corp., 1942, page 45, column 1.