This invention relates to magnetic coatings and magnetic coating compositions, and more particularly, to durable and abrasion resistant magnetic coatings and compositions especially adapted for use on relatively rigid media such as discs and drums.

Magnetic coatings of the type heretofore used in the art have not, as far as is known, been completely satisfactory from the standpoint of offering adequate resistance to mechanical abrasion, sufficient hardness and an ability to adhere to metal and metallized surfaces, to name but a few of the deficiencies. Further, certain of the materials and compositions used in the prior art as magnetic coatings have shown wide variances in operating characteristics with age of the coating, which condition is particularly prevalent in cases where cellulose derivatives employing plasticizers are used. Still other magnetic coatings are deficient in heat, chemical or moisture resistance, and in other respects.

One of the primary objects of the invention herein to be described is the development of a magnetic coating which avoids the aforementioned and other deficiencies of the prior art and at the same time provides a hard and durable magnetizable coating for the surfaces of relatively rigid media such as discs and drums. Another primary object of the invention is the provision of a magnetic coating by which a magnetizable surface is obtainable which is highly resistant to repeated mechanical abrasion and which is, furthermore, free from flaking, chipping, peeling or dusting as a result of such mechanical abrasion. Another object of the invention is to provide a magnetic coating having excellent adhesiveness to metal and metallized surfaces, and which is non-corrosive with respect to such surfaces, and, in addition, inhibits corrosion thereon.

Other objects of the invention are to provide a coating composition which is relatively inexpensive and easy to prepare, and which results in a coating which is tough and resilient relative to its hardness, which does not change its characteristics appreciably with age, which does not change its characteristics appreciably over any heat range which is liable to be encountered in ordinary usage, which is resistant to crazing and which is very tough. Still another object of the invention is to provide a coating wherein the proportion of magnetic material may be very high without sacrificing the abrasion resistance, durability, absence of flaking, peeling, and dusting, and other qualities, and the provision of a coating which retains its cohesiveness and hardness notwithstanding such high proportion of magnetic material.

Finally, it is a primary object of the invention to provide a coating wherein such high proportions of magnetic material may be employed that the magnetic characteristics are practically limited only by the magnetic pigment employed; that is, wherein the coating itself may substantially duplicate the magnetic characteristics of the undiluted pigment employed.

In the magnetic coating of the invention, a thermo-

plastic modified aldehyde polyvinyl resin, polyvinyl butyral, is combined with a thermosetting amino triazine aldehyde resin, melamine formaldehyde, which has preferably been alkylated with a butyl alcohol, and a magnetic pigment, for example, magnetic iron oxide (red oxide). These components, which are non-volatile in character, are mixed with a number of volatile components to give fluidity, which volatile components preferably include a small amount of an acid catalyst. The acid catalyst, if employed, is preferably added only shortly before the coating is to be applied. The volatile components vaporize after application, leaving a final coating comprised of polyvinyl butyral, butylated melamine formaldehyde, and magnetic pigment, with a small amount of absorbed water vapor.

Varying proportions of polyvinyl butyral and melamine formaldehyde may be used in the coating of the invention, but a proportion giving the most desirable qualities with high proportions of magnetic pigment has been found to be about two parts of polyvinyl butyral to one part of melamine formaldehyde. (The term melamine formaldehyde as used herein is intended to include modified melamine formaldehyde such as butylated melamine formaldehyde.) The combination of the melamine formaldehyde resin and the polyvinyl acetal resin results in the introduction of thermosetting characteristics into the mixture, the components interacting to eliminate substantially all the thermoplastic tendencies of the polyvinyl acetal resin, and creates unusual and outstanding characteristics of toughness and abrasion resistance. Considerable variation in the ratio of melamine formaldehyde and polyvinyl butyral is possible without sacrificing these and the other unique qualities of the combination.

The combination of polyvinyl butyral and melamine formaldehyde has another outstanding characteristic in that it allows very high proportions of magnetic pigment to be employed. With most if not all magnetic materials the proportion of magnetic material may be made so high that the resultant coating, so far as its magnetic characteristics are concerned, substantially duplicates the characteristics of the undiluted magnetic material itself.

In the dispersion of the non-volatile components for application, various combinations of active solvents, diluents and couplers may be necessary or desirable to meet differing application methods and conditions. (The word "solvent" will be used hereinafter to include solvents, diluents, couplers and extenders, or any combination of them, or any other dispersing agent, as the context will allow.)

The mixtures preferably used as volatile components may be generally described as a blend of aromatic hydrocarbons such as toluol and xylol, with lower alcohols such as ethyl, isopropyl, n-propyl or butyl, and other solvents, such as low molecular weight esters and ketones. The total amount of these volatile components is determined substantially by the consistency, leveling ability, evaporation rate, and other characteristics of temporary mobility desired of the mixture, giving due allowance and regard to the heat, humidity, type of surface, and other external circumstances under which the coating is to be applied and cured or hardened.

The preferred form of the invention is that wherein an acid catalyst is used to render the composition thermosetting at normal temperatures. Alternatively, however, the mixture may be baked with or without such a catalyst. The acid catalyst, such as phosphoric acid, if employed, comprises preferably approximately 4 or 5 percent by weight of the total mixture, and is added preferably only shortly before the mixture is to be applied to a surface. Such an acid catalyst functions not only to stimulate hardening of the resinous mixture, but also to etch and
prepare the sub-surface which is being coated, thereby giving additional adhesion. This preparation of the surface prior to coating is in addition to another preparatory effect, mainly of an anti-corrosive nature, occasioned by the polyvinyl butyral.

The following example of a specific composition will illustrate the composition and method of preparation of a magnetic coating having desirable characteristics including those mentioned hereinabove.

Example 1

Non-volatile constituents (by weight):
- 72.6% magnetic iron oxide pigment
- 10.0% butylated melamine formaldehyde resin
- 17.4% polyvinyl butyral resin

Volatile constituents (by weight):
- 51.6% toluol
- 27.8% n-butanol
- 15.8% denatured ethanol
- 1.6% xylol
- 3.2% methyl ethyl ketone

In the preparation of the magnetic paint, the non-volatile ingredients are mixed at the ratios indicated, together with a sufficient amount of volatile solvent to produce a viscosity of 90-110 Krebs units, and the mixture is charged into a pellable mill where it is ground until the mixture shows a fineness of 7½ minum on a North Standard gauge.

When this degree of fineness is reached, the mixture is drained from the mill and additional solvent added to bring the total ratio of non-volatile constituents to volatile constituents to 1:3. The most desirable form of mixture is that wherein the total amount of solvent is finally added immediately prior to the use of the paint for coating a surface and the phosphoric acid catalyst is introduced with the final addition of solvent or volatile component. After the catalyst is added, the mixture is useful as a magnetic coating material for approximately 24 hours, under normal conditions. The useful life of the mixture varies with the conditions of humidity and temperature, as well as the regularity of the addition of the volatile components.

In the actual mixture, commercial grade phosphoric acid is added to the total components, the amount of phosphoric acid catalyst added before the composition is applied to a surface being approximately 1½% of the total weight.

The foregoing example, it should be borne in mind, is illustrative of the magnetic coating composition prepared under specific conditions of weather, humidity, etc. for application to a specific surface. The following remarks will describe and illustrate the invention in a more general manner.

As previously indicated, the preferable portion of polyvinyl butyral to melamine formaldehyde is approximately 2:1 for high proportions of magnetic material. The ratios of Example 1 are approximately two parts of polyvinyl butyral to one part of melamine formaldehyde to seven parts of magnetic iron oxide. The unusual and desirable characteristics of the coating are retained, however, over a considerable variation in these ratios. For example, the ratio of polyvinyl butyral to melamine formaldehyde may be made as low as 1:1 or as high as 3:1. The proportion of magnetic material may vary from a very small amount up to the proportion and non-volatile components (or less) to as high as 85% of the total weight of the non-volatile components. In most if not all applications, of course, a high proportion of magnetic material is desirable. The upper limit of the proportion of magnetic material which may be used is determined in part by the particle size and shape, and in part by the particular magnetic pigment employed, smaller particles in general permitting the higher proportions of magnetic material.

Proportions of magnetic material such as actually used in the above example (approximately 70% by weight of the non-volatile components) impart to the coating substantially the magnetic characteristics of the magnetic pigment itself, and yet retain in the coating, so far as non-magnetic characteristics are involved, substantially all the advantages of the resins binder employed, some of which advantages have already been detailed herein. Thus the components cooperate together to give a desired and unique result.

Copolymerization is of course partly responsible for the unusual and outstanding characteristics of the coating of the invention herein, in addition to the more direct contributions of the components. Another contribution is made by the elimination of the characteristics normally present in the individual components which are not desired in the coating. It is to be noted that the term "mixture" as used herein is used broadly and is intended to include the composition resulting from this copolymerization, and includes as well as other types of action which may or may not be of a chemical nature.

The individual components make a number of desirable contributions. Melamine formaldehyde is compatible with a wide range of fillers, including, for example, mineral fillers such as the iron oxide mentioned hereinabove as a magnetic pigment, and shows strength notwithstanding the incorporation of large amounts of such fillers. The use of melamine formaldehyde results in increased surface hardness. Melamine formaldehyde which has been alkylated with a butyl alcohol is the preferable form of melamine formaldehyde herein, and this modified form of the resin has even greater resistance to crazing and abrasion than melamine formaldehyde which has not been modified. The use of melamine formaldehyde alkyl resin in the combination also imparts hardness, and light, heat, water and chemical resistance. The absence of flaking, chipping, peeling or dusting and resistance to electric-puncture present in the coating of the invention derives partly from the use of this resin also.

Melamine formaldehyde, upon treatment with an acid catalyst, such as phosphoric acid, becomes thermosetting at normal temperatures. Accordingly, the addition of an acid catalyst reduces the thermoplasticity of the liquid unapplied mixture after a period of time. For this reason, it is desirable to add the phosphoric acid or other catalyst only shortly before the mixture is to be coated. After an acid catalyst has been added, the mixture has ordinarily a useful life during which it may be applied, of about 24 hours, under average or normal conditions, as already indicated. Other chemical agents may be added to the mixture to vary this time.

If desired, the acid catalyst mentioned in the foregoing paragraph may be dispensed with, and the mixture caused to harden or cure by the application of heat. The application of approximately 250 to 300 degrees F. for a period of 15 to 20 minutes will ordinarily be sufficient for mixtures having the ingredients of the foregoing specific example.

Polyvinyl butyral is a very tough polyvinyl acetal resin and the combination of the invention benefits by retaining this quality. Furthermore, polyvinyl butyral has an inhibiting effect on corrosion, being sometimes used as a metal conditioner or wash primer and lends this quality to the invention. The use of the polyvinyl butyral, which is tough and elastic, in part of the polyvinyl formaldehyde does not detract from and in fact enhances the desirable qualities which the melamine formaldehyde gives the combination. It accordingly helps make possible the use of even higher proportions of magnetic material than are possible with melamine formaldehyde alone, and size contributes to the other qualities of the invention. Similarly, the thermosetting melamine formaldehyde resin raises the softening temperature and decreases the solubility of the combination from that which would obtain by the use of the polyvinyl resin alone.
Polyvinyl butyral which has been more completely acetalized is superior to the less reacted type for the purposes of the invention, imparting its qualities of greater water resistance, more flexibility at low temperatures and greater compatibility with modifying resins such as the melamine formaldehyde to the combination.

The invention preferably uses an iron oxide as a magnetic material. This is desirable because, in addition to being superior magnetic materials for most purposes, iron oxides are also corrosion inhibiting pigments. Of the iron oxides, the red oxide ($\text{Fe}_2\text{O}_3$) is preferable because of its more desirable magnetic characteristics, but the black oxide ($\text{Fe}_3\text{O}_4$) may be used. Other powdered magnetic substances such as high carbon steel powder, cobalt-nickel alloy powder, Alnico III powder and Alnico V powder may also be used, either alone or in any combination. The foregoing list of magnetic powders is of course illustrative, and not limiting, as many other magnetic materials are known and may be used.

Great variation in the volatile components is possible, and various feasible combinations of these components will suggest themselves to those skilled in the art. It should be mentioned in passing, however, that the mixture given in the specific example has a desirable evaporation rate and gives a desirable degree of disassociation, and also that n-butyl alcohol and the other lower alcohols are especially desirable components, contributing substantially to the leveling or smooth flow-out ability of the mixture during application. Furthermore, the mixtures of volatile components generally or specifically mentioned hereinbefore have other advantages, such as, for example, humidity blush resistance, and cooperate together to facilitate the easy application of the non-volatile components to various surfaces. The volatile components named are, of course, readily available and relatively inexpensive.

The solvents used also have an effect, although usually

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