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METHOD OF MAKING AUTOMOBILE BODY PARTS AND THE LIKE

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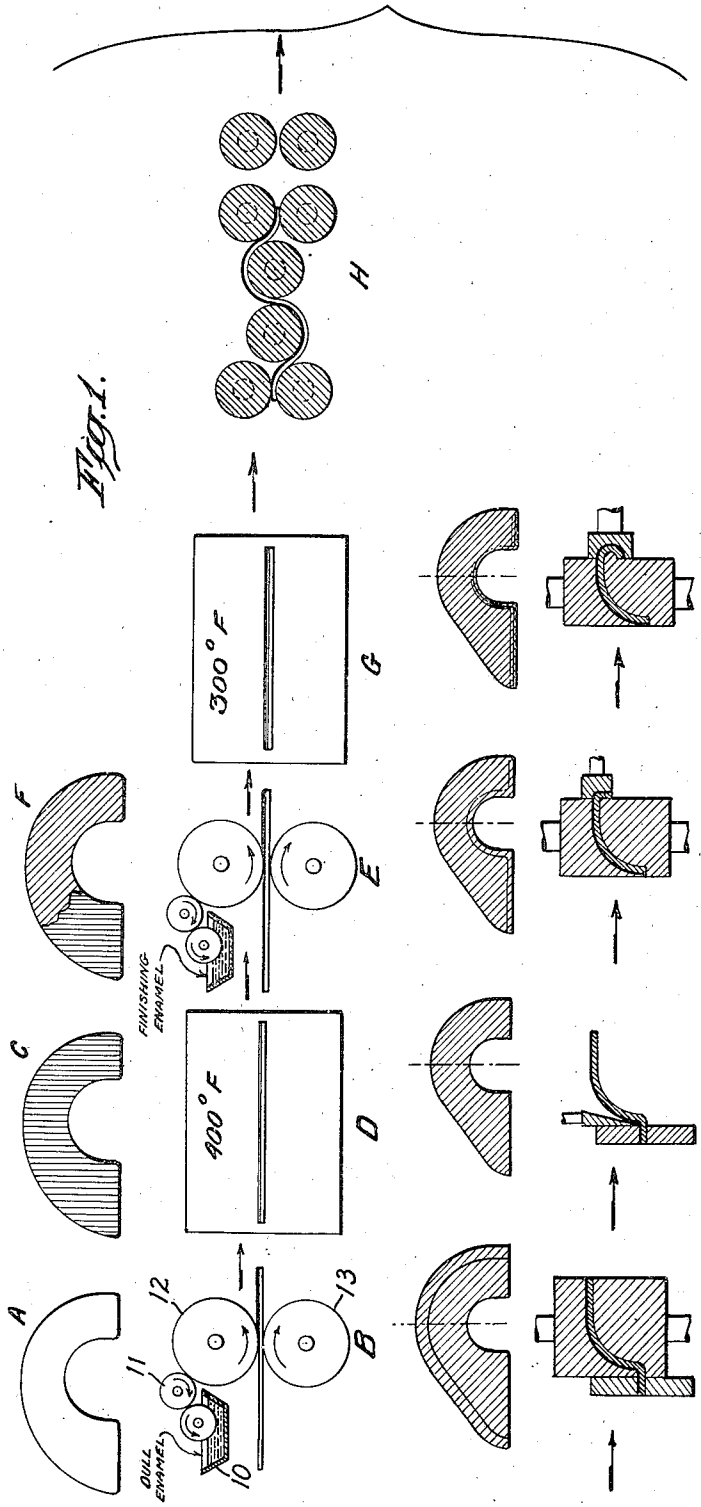


Fig. 1.

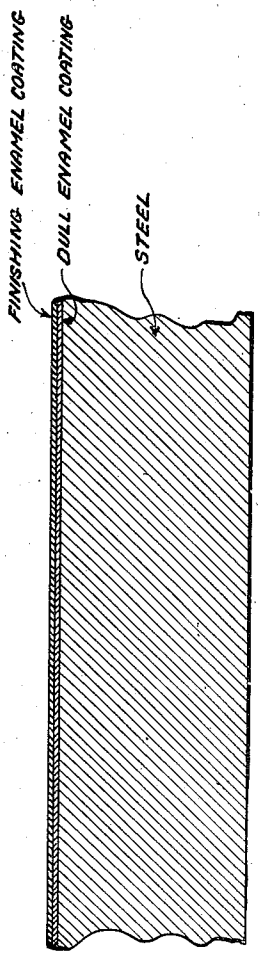


Fig. 2.

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METHOD OF MAKING AUTOMOBILE BODY PARTS AND THE LIKE

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7 Claims. (Cl. 113—116)

This invention relates to a method of making automobile body parts and the like, including not only parts of the body proper but also fenders and hoods, which, like the parts of the body proper, are made of steel plates and provided with a weatherproof gloss finish.

The object of the invention is to provide for making better parts at a substantial saving in expense.

Automobile body parts are made of heavy steel plates, 16 to 24 gauge plates, and are given their required shape by severe die-forming operations in which very heavy pressures are applied to the surfaces of the plates to distort them and frequently to bend them on short radii, so that their surfaces are substantially stretched or contracted—often as much as 30%. The finish required on automobile body parts cannot be obtained by applying a gloss or finishing enamel directly to the metal. In order to obtain the necessary adherence and the desired appearance and durability in the finish, the finishing enamel is applied over a rust-inhibitive undercoat having a smooth but dull surface. According to present practice, such an undercoat is obtained by applying to die-formed parts of irregular form, by hand-spraying or by dipping, one or more coatings of priming and filling compositions. When the application is by hand-spraying, about half the coating composition is wasted and the coats have irregular surfaces which are sanded by hand in order to obtain a surface sufficiently smooth for the application of the finishing enamel. The cost and waste of the hand-spraying and sanding operations are important items in the cost of the finished body parts made by such methods. When the application of the priming coat is by dipping, the coating is irregular in thickness, so that the finish of the parts lacks durability at the places where the priming coat is thinnest.

Our invention produces durable finished body parts at a very substantial reduction in cost by providing an undercoat of uniform thickness having the dull but smooth surface required for the application of a finishing enamel, without sanding or other manual operations.

The method which we have invented involves the mechanical application to a flat steel plate of a smooth, uniformly thick, dull-surfaced, adherent undercoat of highly-pigmented enamel which is ductile, and thereafter die-forming the coated steel plate to the required shape without breaking or injuring the coating or changing the smoothness of its surface. A finishing enamel is applied over the undercoat. This may be done, as at present, by spraying after the part is formed, but, according to the preferred form of our method, a smooth, uniformly thick, ductile, gloss coat of finishing enamel is applied over the dull-surfaced coating on the flat plate before the forming, so that the expense of polishing required by ordinary hand-sprayed coats of finishing enamel is eliminated.

By a "ductile" coating, we mean a coating which, while solid, nevertheless has the capability of flowing without rupture, so that, when the coating is applied to a steel plate, such for example as a 16 gauge plate of 60 mils thickness, it is not cracked, broken or in any way injured by the stretching or contraction of the surface of the steel plate which occurs in die-forming operations. This means that the ductility of the coating on the metal is such that it is capable of an elongation or contraction of at least 30% without fracture. We have discovered that this quality of ductility, which should be distinguished from mere flexibility, is possessed by some known gloss enamel coatings, but not by coatings of the priming and filling compositions which are being used under such enamels. Our researches have led us to the conclusion that the condition of the pigment is a factor of great importance in determining the ductility of a coating. We have found that, no matter how highly plasticized the binder of a coating may be, the coating cannot be stretched without injury if irregular strains are set up by the presence of pigment agglomerates or flocculates or incompletely wetted pigment.

Ordinary enamels have their pigment in a fine, deflocculated, completely-wetted condition which is recognized as essential in order to obtain a gloss surface. In this enamel condition, the pigment does not set up irregular strains on the stretching of the binder. The volume of pigment to binder is, as a rule, not over 1:9. Some such enamels have flexible binders, and these, we have found, make coatings having the property of ductility.

We have found that the volume of pigment in an enamel may be increased to approximate equality to the volume of the binder without changing the condition of the pigment usual in enamels, so that in the dried coating the increased volume of pigment does not set up irregular strains in the binder when the coating is stretched. The increased pigmentation therefore does not interfere with the ductility of the coating, but gives the coating a dull rather than

a gloss surface, so that an ordinary finishing enamel will adhere firmly to it.

By using an adherent undercoat of highly-pigmented, dull enamel which is ductile, we are able to provide a practical method of obtaining a smooth undercoat of uniform thickness by roll-coating a flat plate before forming, and thus avoid the expense of sanding required to smooth the uneven surfaces of primer coats which are made by spraying a part after forming, and to avoid the irregularity in thickness of primer coats applied by dipping parts after forming.

To clarify the nature of our invention, we will describe a preferred method of making an automobile part in accordance with our invention and will refer to the accompanying drawing in which:

Fig. 1 is a flow diagram illustrating the successive steps of the method. The lower part of the figure is a series of diagrammatic elevations showing the various steps, while the upper part of the figure is a series of plan views of a fender blank showing the effects of the various operations indicated in the elevations in the lower part of the figure. The ratio of the thickness of the enamel layers and that of the steel plate is greatly exaggerated in Fig. 1 for sake of clearness.

Fig. 2 is a fragmentary transverse section of the completed fender showing approximately to scale the relative thickness of the steel and the enamel coatings.

The first step of this illustrative embodiment of our invention consists in applying to one surface of a flat steel plate a smooth layer of a highly-pigmented, dull enamel having a flexible binder adherent to metal and containing rust-inhibiting, filling and covering pigment. The plate to which the enamel is applied is a steel plate of from 16 to 24 gauge (60 to 25 mils thickness). The plate is most desirably cut to the shape of a flat blank for the part to be made before the coating is applied, but the blanking may be done after the coating. The specific plate illustrated in Fig. 1 is a 20 gauge steel plate cut to the shape of a fender blank, as shown at A. The enamel is applied to the flat plate by a roller-coating machine shown diagrammatically at B in Fig. 1. The enamel is fed from a trough 10 by feed rollers 11 to a soft gelatine coating roller 12 and the steel plate is passed between this coating roller and a steel roller 13. The thickness of the film applied is from ¼ mil to 1 mil, after drying, which means that the wet film as applied should have about twice this thickness. The thickness is regulated by adjustment of the distance between the feed rollers and the coating roller.

The second step consists in setting the first coating on the steel plate. This may be accomplished by baking the coated plate, shown at C in Fig. 1, in an oven heated to about 400° F. for several minutes, as shown at D in Fig. 1.

The third step consists in mechanically applying to the coated steel plate a smooth coating of a normally-pigmented enamel having a plasticized binder. This step is shown at E in Fig. 1 and may be carried out with a type of roller-coating machine already described. The thickness of the second coating when dry is from 0.8 to 1.5 mils. A special feature of our invention consists in the use of a hard, quick-baking enamel for the second coating.

The fourth step consists in setting the second coating. If a quick-baking enamel is used for the second coating, this step is carried out by placing the double-coated blank, shown at F in Fig. 1, in an oven heated to about 300° F. for several minutes, as shown at G in Fig. 1.

The fifth step consists in making the steel plate ductile and malleable by passing it through a so-called "strain remover" such as that shown in Miller U. S. Patent No. 2,006,087 and indicated diagrammatically at H in Fig. 1. The steel plate is subjected to tension, and to severe reverse bending by staggered rollers. The ductility thus imparted to the plate would be eliminated by heating the plate after it is passed through the strain remover. It is, therefore, important that this step be carried out after the baking of the enamels. The plate is passed through the strain remover after the two enamel coats have been applied and baked. The severe reverse bending of the plate in the strain remover does not crack or otherwise injure either of the enamel coatings.

The remaining steps consist in giving the flat blank the curved form and rolled edge required in a fender. These steps, indicated diagrammatically at J, K, L and M in Fig. 1, involve three severe die-forming operations (J, L, M) in which the forming dies are forced against the blank under pressures of several hundred tons and a trimming operation (K). These operations do not crack or injure either of the two enamel layers, so that, at the conclusion of the last die-forming operation (M), the blank has become a completely formed fender having a smooth, full-bodied, gloss finish which does not require either sanding or polishing.

As a specific example of a suitable dull enamel for the first coating, we cite the following:

A paste is made by mixing the following ingredients:

	Parts by weight
Venetian red	60.0
Zinc chromate (pH value 6.5)	6.7
50% solution of oil-modified alkyd resin in hi-flash naphtha	23.3
Hi-flash naphtha	10.0
	100.0

This paste is ground, preferably in a steel ball mill, until the pigment is fully deflocculated and wetted. A minimum of 36 hours of such grinding is required, according to our experience, to put the pigment into enamel condition. The paste is then thinned by additional solvent and additional binder to the following composition:

	Parts by weight
Pigment (deflocculated):	
Venetian red	34.0
Zinc chromate	3.8
Binder:	
Oil-modified alkyd resin	22.5
Solvents:	
Hi-flash naphtha	36.7
Terpene "B" hydrocarbon	3.0
	100.0

This enamel composition may then be placed in the feed trough 10 of the roller-coating machine shown at B in Fig. 1.

The oil-modified alkyd resin specified in the above formula is made by reacting 126 parts of glycerol, 195 parts of phthalic anhydride, 85 parts of soya bean oil acid, 47 parts of dehydrated castor oil acids, 27 parts of soya bean oil and 27 parts of dehydrated castor oil in conventional manner to form a low-acid resin, reducing to 50% non-volatile with hi-flash naphtha, when an acid number of 5 to 10 is attained.

The hi-flash naphtha specified in the above formula is a coal tar distillate having a boiling range of about 150° C.–200° C.

The terpene "B" hydrocarbon specified in the above formula is a pine oil derivative produced as a by-product in the manufacture of synthetic camphor, whose approximate composition is terpinene 25.4%, terpinolene 63.4% and dipentine 11.2%.

The oil-modified alkyd resin binder specified in the above example is a flexible resinous binder which is metal-adherent, that is, it has such affinity for metal as to adhere to it strongly. It may be replaced by other binders known to have these characteristics, such as oleoresinous binders and plasticized chlorinated rubber binders.

The zinc chromate is a rust-inhibitive pigment. We have found it the most satisfactory of known rust-inhibitive pigments, but it may be replaced by other pigments of this class, such, as for example, the commercial grade of red lead known as "orange mineral."

The Venetian red is a natural iron ore pigment containing approximately 25% of iron oxides and 75% of mineral filling pigments. It may be replaced with other iron-oxide-bearing pigments such as burnt umber or burnt sienna, or by other filling or covering pigment which may be deflocculated and fully wetted by the binder. We prefer, however, to use pigments containing oxides of iron, as they have rust-inhibiting properties and are susceptible of complete deflocculation.

The enamel specified in the example is highly pigmented. The volume ratio of total pigment to total binder is approximately 2:3. Although the volume of pigment is nearly equal to the volume of binder, it is low enough to permit retaining the pigment in enamel condition, so that a ductile coating is produced. This enamel condition has the additional advantage of making the coating impermeable so that it cannot absorb a finishing enamel applied over it. The enamel condition of the pigment also has the advantage of avoiding voids in the dried coating, and thus enables the coating to withstand the pressure of the dies without collapse or thinning. The pigmentation is high enough to give the coating a dull surface, notwithstanding the enamel condition of the pigment. The high pigmentation gives the enamel the body required to fill and smooth over scratches in the surface of the steel, so as to provide a smooth surface for the application of a finishing enamel. Some variation in the proportion of pigment may be made without losing any of these important characteristics of the coating, but the volume ratio of pigment to binder should, in general, be between 1:3 and 1:1.

If the dull enamel made in accordance with the above formula be modified by reducing the volume ratio of pigment to binder to a ratio of 1:9, common in enamels, without making any other change in the composition, a film with a gloss surface will result. This shows that the pigment is in enamel condition and the composition is a true enamel in spite of its dull surface.

After the dull enamel composition is coated on the steel plate, the plate is baked to set the binder of the coating. With a coating of the formula given above, this may be effected by subjecting the coated plate to a temperature of about 400° F. for about 12 minutes. The drying of the coating reduces the thickness of the applied coating about one-half, so that the thickness of the dry coating is from ¼ mil to 1 mil. This is thick enough to fill and cover scratches in the surface of the steel plate and to give the full bodied appearance required after a finishing enamel is applied. At the same time, it is thin enough to have the required ductility.

As a specific illustration of a quick-baking enamel appropriate for use as the second coating in our method, we cite the following:

	Parts by weight
Pigment (deflocculated):	
Dark chrome green	13.0
Binder:	
Urea formaldehyde resin	15.5
Oil-modified alkyd resin	23.5
Solvents:	
Octyl alcohol	15.5
Hi-flash naphtha	27.5
Terpene "B" hydrocarbons	5.0
	100.0

The urea formaldehyde resin is a quick-baking resin which is extremely hard after baking. It is placed in the enamel composition in the organic-solvent-soluble state. The resin in this state may be made as follows: 1842 grams 40% formaldehyde and 1.68 grams 85% phosphoric acid are heated in a closed chamber fitted with a stirrer and a condenser to 60° C. 492 grams of urea are added in 8 equal quantities at 5 minute intervals, while maintaining the temperature at 60–65° C. The temperature is then raised to 85–90° C., and held for 2 hours. 1000 grams of n-butanol is then added, and the mass refluxed mildly (90–95° C.) for 2 hours. The reflux condenser is then converted into an ordinary condenser, and water and butanol are distilled off over a period of about 8 hours, and 925 grams of octyl alcohol are added, and distillation is continued until substantially all the butanol is removed and the temperature has reached about 130° C., and the solution is adjusted to 50% nonvolatile content with octyl alcohol. It is sometimes necessary to add extra butanol to insure complete dehydration of the resin, before the octyl alcohol is added.

The oil-modified alkyd resin is the same as that used as the binder of the first coating. It is compatible with the urea formaldehyde resin and, being softer than the urea formaldehyde resin, serves to plasticize it.

The pigment is in the fine, deflocculated, fully-wetted condition usual in enamels. The volume ratio of the pigment to binder is about 1:9, which is also usual in enamels.

Enamels having the binder specified in the above formula have been used on preformed metal articles and have been found to provide one of the hardest enamel finishes known. We have discovered the fact, not heretofore suspected, that in spite of the extreme hardness of their binders, these enamel coatings are ductile and are not injured by the surface stretching and surface contraction of steel plates during die-forming operations. We regard the application of a quick-baking, plasticized-urea-formaldehyde enamel to a flat steel plate followed by die-forming the enameled plate as an important, although not absolutely essential, feature of our new method.

Our invention is not limited to the specific method which has been described as an illustrative embodiment of it. In the specific illus-

tration, we have described the making of a fender because the die-forming operations in making this part are as severe as those required in the making of any automobile body part, so that the use of our method in making a fender shows that it is useful in making any other part. When applied to making a fender, our invention achieves a better and more durable fender than those made by present methods, since our invention secures an undercoat of uniform thickness. When applied to the making of parts of the body proper, our invention effects great savings in cost since it eliminates the waste and expense of the sprayings and sandings of the undercoats involved in present methods. These advantages are attained, even though the specific method be modified by applying the finishing coat after forming, and it is for this reason that we do not regard the step of applying the finishing coat before forming as absolutely essential in the practice of our invention. This step and the related steps described in the specific illustration are, however, an important feature of our invention, since they result in parts with a harder and more durable finish than those obtained by present methods and also eliminate the expense of the polishing required by the sprayed finishing coats which are now used on fenders and hoods, as well as on parts of the body proper.

What is claimed is:

1. The method of making automobile body parts and the like, which comprises mechanically laying a smooth, uniform-thickness coating of highly-pigmented, dull enamel on a flat steel plate, mechanically laying a smooth, uniform-thickness coating of a normally-pigmented enamel over the dull coating, and die-forming the double-coated plate to the required shape.

2. The method of making automobile body parts and the like, comprising roll-coating a flat steel plate with a highly-pigmented, dull enamel, baking the coated plate to set the enamel, removing strains from the coated plate by tension and reverse bending, and then die-forming the coated plate to the required shape.

3. The method of making curved metal parts for automobile bodies and the like, which comprises die-forming a flat metal plate coated with a dull-surfaced, highly pigmented enamel of uniform thickness.

4. The method of making curved metal parts, which comprises die-forming a flat steel plate coated with a dull, highly pigmented enamel from about ¼ mil to about 1 mil thick.

5. Method of making curved metal parts for automobile bodies and the like, which comprises mechanically laying a smooth highly pigmented coating of uniform thickness on a flat steel plate, the pigment being present in the fine, fully wetted deflocculated condition of the pigment in enamel and in amount sufficient to give the coating a dull surface, making the coated plate, and distorting the pigmented coating by die-forming the steel plate.

6. The method of making curved metal parts for automobile bodies and the like which comprises die-forming a flat steel plate coated with a dull, highly pigmented enamel primer and a finishing enamel containing urea-formaldehyde resin.

7. The method of making curved metal parts for automobile bodies and the like which comprises removing the strains from a steel plate coated with a dull, highly pigmented enamel primer and a finishing enamel containing urea-formaldehyde resin, by subjecting the steel plate and the enamel coatings to tension and reverse bending.

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