

Baked Enamel Painting on the Cars of the Hudson & Manhattan Railroad

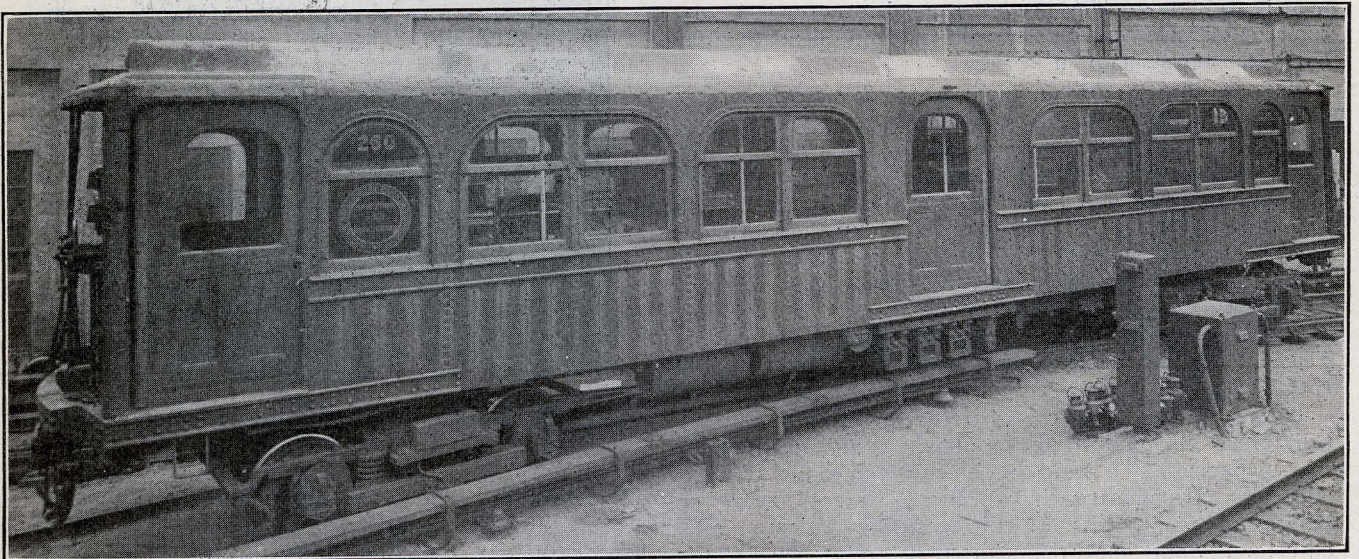
A Description of a Revolutionary Method of Car Painting by Which Cars Can Be Put Through the Paint Shop in Two Days Without Sacrifice in the Appearance or Durability of the Protective Covering

On the Hudson & Manhattan Railroad there has recently been introduced a new system of painting cars which bids fair to revolutionize paint-shop practice in the electric railway industry. Briefly, the method consists in the use of the so-called "baking enamel," which hardens within a few hours under the influence of a mild artificial heat. By its use a finish of great hardness and of extremely high gloss is obtained, so that the appearance of the finished surface is not only equal but in general superior to that given by the best grades of air-drying coach colors and rubbing varnishes.

The most important feature of the process lies in the extraordinary rapidity of the work. The baking on of a coat of enamel, instead of taking one or two days for dry-

is usually applied by sprinkling the material in the form of powder over the surface to be covered and then subjecting the metal to a gentle heat, just sufficient to fuse the powdered enamel into a homogeneous covering.

In the case of varnish makers' enamel no fusing of any description takes place. The action of hardening after application is produced by the evaporation of the turpentine, or "thinner," and by the oxidation of the oils used in the enamel exactly as in the case of paint, except that with enamels the hardening action is assisted by the fossil gum content. Baking enamels differ from air-drying enamels only in the details of treatment. They are made from the same gums, the same oils and the same classes of pigments; but because they are artificially dried at a rapid



Hudson & Manhattan Painting—Exterior View of Car, Showing Ventilators Covered with Paper Pasted to the Roof

ing as required by air-drying paints, is completed in about three hours. The four coats used on the Hudson & Manhattan cars therefore involve a loss of but twelve hours' time, and, with a liberal allowance of time for application, it becomes easily possible to get a car through the shop in two days. With a sufficiently large force, this time might even be made to include cleaning off, although should an extra day be allowed for the removal of the old paint the cars need be held hardly more than one-fourth as long as they would be under standard methods. The saving through the increase in equipment available for service is obvious. In fact, the coat of varnish which is given annually to surface cars could by this means be applied practically between rush hours.

DEVELOPMENT OF BAKING ENAMELS

As understood in the varnish-manufacturing industry the term enamel applies to that class of covering composed of pigment ground in varnish, just as the term paint is applied to pigment ground in linseed oil. In this application the material is in no respect similar to the enamel which is applied to metal by fusing and is used in that manner as a permanent protective covering for metals, as in the case of the sanitary white-enamelled hand-holds recently introduced for use on surface cars. The latter class of enamel is in effect a glass which is fusible at low temperature. It

rate considerably more leeway is permitted in the composition, and this in turn permits the use of combinations of ingredients which give a hard, tough surface.

The astonishingly high gloss which is a characteristic of baked enamel is due largely to the fact that it can be applied in a much more freely running condition than the air-drying enamels. The result is that the material when applied is much more subject to the influence of surface tension, and the brush marks and other irregularities smooth themselves out. Carried to a hypothetical extreme, an example of this action would be found in the case of a paint with a consistency equal to that of water. If such a covering could be applied, it would obviously give an absolutely perfect surface. It would, of course, be impossible to leave brush marks in a film of water, and the microscopic irregularities in the wood or metal beneath it would manifestly have no influence on the perfect smoothness of the exterior surface of the film.

All varnishes, in order to be applied, have to be thinned with more or less turpentine. This ingredient is practically inactive and evaporates from the film during the process of drying. In the case of air-drying enamels it is necessary to have an even rate of hardening to avoid the formation of a hard surface film which would delay the drying of the varnish underneath it, and it is also necessary to

meet the condition of eliminating the turpentine content by evaporation. In consequence but little turpentine can be added, and the spreading effect, or the thinness of the material during application, is limited. The use of enough turpentine and a sufficiently freely flowing oil varnish to produce extremely easy running and a thin film involves difficulty both by increasing the time of drying and by tending to make a hard surface form while the interior layers of the coat are still soft. With baking enamel, however, the matter of time of drying is unimportant. The high temperature promptly eliminates the surplus turpentine content in practically any amount, and the material can be applied in almost any condition of thinness de-

of railways have in fact made use of it in this manner.

About two years ago attention was directed to the application of the baking process to complete cars, and some very extended experiments were undertaken. Some of these proved to be unsatisfactory, possibly because the manufacturers did not realize the vital differences in handling air-drying and baking enamel and offered exactly the same material for baking which they had been furnishing for air-dried coverings. One reason for this is that since the priming coat is required to stand two or three heats in addition to its original drying heat it should be capable of becoming perfectly hard; in other words, it should take its permanent set before the other coats are



Hudson & Manhattan Painting—View of Interior of Car After Completion of Baking Process, Showing Electric Heaters Hung from the Hand Rods

sired. In practice this is shown by the fact that approximately half as much baking enamel is required to cover a given surface as would be needed if air-drying enamel was used.

Baking enamels were first used commercially on a large scale in the automobile industry. Here the question of output was a serious one from the early days, and the rapidity of the baking process was a great advantage. In the general introduction of the process, however, there was the incidental advantage that, for the first six months at least, the baked enamels were found to possess very much more ability to resist not only the abrasive action of flying dust but also the corrosive action of lubricating oil which might be splashed onto the enameled surfaces of the body. Its use has also been extended to small fittings on cars which could be placed in small kilns, and a number

applied, and this condition does not obtain with air-drying enamels.

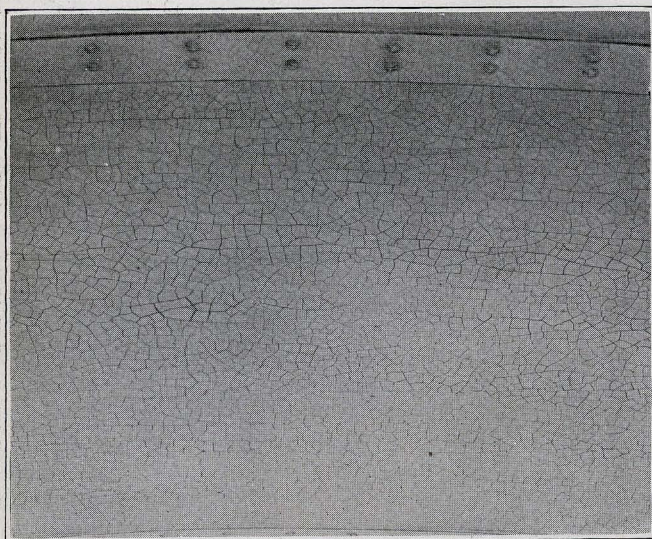
METHODS OF APPLICATION

In general, however, three successful methods of baking have been developed for use with railway cars. These are to bake the primer and first enamel coat at a moderate temperature and to air-dry the subsequent varnish coats, to bake the whole car inside and out for all four coats through the use of a kiln of sufficient size to inclose the car and to bake the interior only by sealing the car and introducing electric heaters.

The latter method is the first to be adopted as standard on any railway and is the one which is described in this article. It has been developed by P. V. C. See, superintendent of car equipment, Hudson & Manhattan Railroad. On this line the cars are operated in a subway practi-

cally all of the time. For this reason the question of exterior appearance is immaterial, and the exterior painting is done only to keep the steel bodies from rusting. However, the interiors of the cars are carefully finished in white and green, the ceiling being a high-gloss white enamel to give the cars the clean and cheerful effect so desirable in tunnel service. In fact, the bright surface acts as a mirror, reflecting and diffusing the light so that the general illumination of the car is better than could be produced with brighter lights and a dark background.

The company has had considerable difficulty trying to find an enamel suitable for this work. Enamels that would stay white in the artificial light displayed a tendency to flake off and crack on account of the rapid changes in the temperature when the cars were taken from the open storage yard and run into the tunnel, as this remains at a constant temperature of 65 deg. regardless of climatic changes. On the other hand, white enamels that would



Hudson & Manhattan Painting—Typical Ceiling, Showing Cracks in Old Air-Drying Enamel

stand these rapid expansions and contractions without checking had a tendency to turn yellow under the continual artificial light.

In the search for a remedy to overcome this difficulty Mr. See noticed that the steel doors, which had been purchased complete and painted separately from the cars and not from the same manufacturer, did not deteriorate in appearance. Although the air-dried enamel on the vestibule sides alongside of the doors became discolored and cracked, the doors themselves retained their color almost indefinitely. An investigation brought out the fact that the doors had been baked in a kiln, and the result was, naturally, a trial of baking enamel.

An extensive test was made with small panels to find out whether baking enamels could be made to flow smoothly on the under surface of the metal when in a horizontal position. After this was completed the panels were placed in a light-proof box which was then given to the shop fireman with instructions to put it near the boiler for two hours and then put it out of doors for two hours. These rapid temperature changes were kept up for over a month, in the middle of winter. When the panels were removed from the box they were all found to be either darkened to a yellow or brown or else were more or less cracked. The test was carried still further by bending each piece through 180 deg. until the edges met. Although none of the panels came out of this very severe test in very good shape, it was definitely shown that the baking enamels were far superior to those of the air-drying type.

Experiments were then made to find out what tempera-

tures could be secured in a car without damage to the electric wiring, and it was demonstrated that 200 deg. Fahr. was not injurious. By suspending three extra equipments of electric car heaters from the hand rods this temperature was easily maintained, the consumption of power being at the rate of about 50 kw.

Three manufacturers have supplied enamels to the Hudson & Manhattan Railroad that have produced excellent results, but about the most thorough and comprehensive system which was tried was that of Flood & Conklin, of Newark. The details of this system of application are as follows:

After cleaning, the car is first heated to 200 deg. and allowed to remain at this temperature for one hour, as heating the clean surface before the application of the priming coat has been found by the manufacturers to be necessary to drive off moisture and to equalize as far as possible the injurious action of surface expansion and contraction.

After this the heat is shut off and the car is cooled down to about 115 deg., the priming coat being applied while the metal is hotter than the surrounding air to prevent condensation on the metal. The temperature is then raised again to 200 deg. and the enamel baked for three hours. The second and third coats are baked at 140 deg. for three hours and the last coat at 130 deg. for three hours. The first coat is the only one that is applied under heat, the others being applied with the air in the car cooled to about 70 deg.

In case the temperature of 200 deg. specified as necessary for baking on the priming coat cannot be obtained either through lack of facilities for heating or through other unusual conditions it is possible to obtain satisfactory results by baking the first coat at 165 deg. temperature for four hours.

The condensed list of instructions for applying the different coats issued for use in the paint shop on the Hudson & Manhattan Railroad is as shown in the accompanying table:

INSTRUCTIONS FOR APPLICATION OF BAKING ENAMEL			
GREEN BAKING ENAMEL			
	Deg.	Hours	
No. 1 brown metal primer.....	200	3	
No. 2 green baking enamel.....	140	3	
No. 3 green baking enamel.....	140	3	
No. 4 clear baking varnish.....	130	3	
WHITE BAKING ENAMEL			
No. 1 metal priming enamel.....	200	3	
No. 2 flat white.....	140	3	
No. 3 high-gloss baking enamel.....	140	3	
No. 4 high-gloss baking enamel.....	130	3	

NOTE.—After cleaning car thoroughly, heat car 200 deg., put heat down to from about 110 deg. to 115 deg. and apply priming coat. Sand between all coats. All coats after priming coat applied at ordinary painting temperature, 70 deg. to 80 deg.

The preparation of the surface of the metal before the application of the baking enamel is one of the most important features of the process. On the Hudson & Manhattan Railroad it has been found that the most satisfactory results are obtained by scraping off the old enamel by hand to remove the bulk of the covering. The surface is then gone over with a standard form of varnish remover carefully applied so that all of the old enamel is removed from the pores of the metal surface. This procedure leaves a surface which is absolutely free from paint, but in order to remove every trace of the varnish remover the surface is carefully rubbed again with waste and gasoline, thus freeing the pores of the metal from any foreign material which might serve as starting points for flaws in the paint film.

The heating of the metal prior to the application of the priming coat and the method of applying the priming coat at the high temperature of about 110 deg. are also important features necessary to assure permanency for the coats of enamel. It will be noticed from the preceding instructions for application that each coat following the primer is put on at a lower temperature so that no possibility exists

for renewed chemical action in the priming coat after it has been covered by the enamels.

As shown by the accompanying illustration, the high temperatures are obtained by hanging three equipments of electric heaters inside of the car, the temperature being controlled by a man who watches a thermometer inside of the car through one of the windows, the current being turned on and off from the heaters in accordance with the changes in temperature. The doors and windows are, of course, closed tight and all ventilators are covered with several thicknesses of newspaper pasted to the roof surface by layers of tar. This is shown in the illustration of the exterior of the car.

COSTS

The cost of application may be said in general to be about equal to that of high-grade painting. It is, however, impossible to make use of cheap materials with the baking process nor is it desirable to have the enamel applied carelessly. The results are, however, superior in general to those obtained with the best grade of air-dried enamels, for, as has been previously mentioned, the surface of the baking enamel is very much harder and more flexible than it is in a case of air-dried material.

On the Hudson & Manhattan Railroad the cost of application of a car interior is shown in the accompanying table.

COST OF BAKING ENAMEL ON HUDSON & MANHATTAN RAILROAD.			
WHITE WORK			
Heat at 0.6 cent per kw-hr.....	Material	Labor	
Connecting heaters		\$3.60	
Removing paint from ceiling.....		1.00	
First ceiling coat, 1½ qts.....		7.00	
Sanding same	\$1.38	1.25	
Second ceiling coat, 1½ qts.....		0.75	
Sanding same	1.38	1.25	
Third ceiling coat, 2 qts.....		0.60	
Fourth ceiling coat, 2 qts.....	1.84	1.35	
	\$6.44	\$18.15	
GREEN WORK			
Removing paint from sides.....		\$15.00	
First coat green, 2½ qts.....	\$2.30	1.75	
Sanding		0.80	
Second coat green, 2 qts.....	1.84	1.80	
Sanding		1.50	
Third coat green, 4 qts.....	3.70	1.75	
Sanding third coat		0.75	
Fourth coat, 2½ qts.....	2.30	2.00	
	\$10.14	\$25.35	

These costs apply to a car 41 ft. long between bulkheads, 8 ft. 10 in. wide over the sills, the roof being of the monitor-deck type with ventilators spaced between alternate carlines. The cost of material for baking enamel in general appears to be about one-half of that for air-drying enamel. This is due to the fact that the baking enamel covers about twice as much surface with a given volume as air-drying enamel, the costs of the two per gallon being the same. On the Hudson & Manhattan Railroad the ceiling of the car has an area of approximately 400 sq. ft. and it has been found through considerable experience that approximately 1 gal. of air-dried enamel is required for each white ceiling coat. When baking enamel is used, however, as will be seen by referring to the list of material given in the statement of costs, only 1¾ quarts of enamel is used for the average white ceiling. As the costs of the two classes of enamel are exactly the same, this makes the baking enamel, at least for white coverings, equal to about half of that for the air-dried material.

APPLICATION TO WOODEN CARS

While the use of baking enamel on the Hudson & Manhattan Railroad applies only to all-steel cars, since that company operates no wooden cars of any description, it has been demonstrated in the automobile industry that baking enamel can be applied to wood with perfect satisfaction and without injury to the wood. In fact, on the Hudson & Manhattan cars the wooden sashes are treated exactly as if they were made of steel, except that the old paint, having become thoroughly hardened, is not removed before the application of the new enamel.

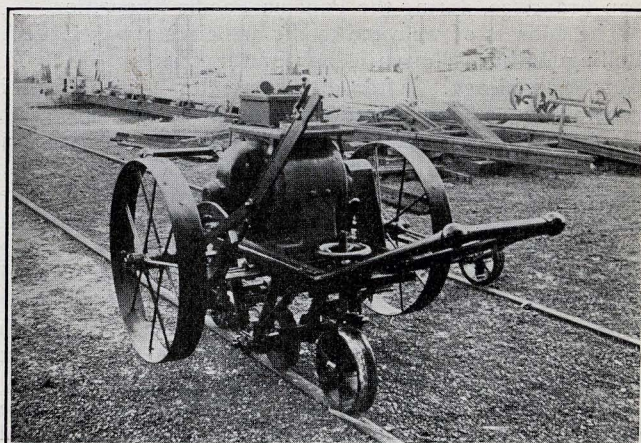
In applying the enamel to new or cleaned wooden cars,

it is only necessary to use an oil primer to fill the pores of the wood and provide a proper surface for the enamel coats. It is possible, as has been proved by experiment, to apply the enamel to clean wood with only three coats, the oil primer being considered as the first coat, and yet produce a satisfactorily smooth white surface. In the case of an old wooden car upon which the paint had become thoroughly dry and hard with age it would be quite practicable to apply baking enamel over the old paint after a thorough rubbing down.

The removal of baking enamel may be effected with any varnish remover capable of removing air-drying enamels. The surface is, however, harder, and for that reason the varnish remover has to be applied with more care as the chemical reaction takes a longer time to do its work. Standard removers will, however, serve for the purpose of removal in a commercially practical manner.

PORTABLE RAIL GRINDERS USED BY THE OMAHA & COUNCIL BLUFFS RAILWAY

The engineering department of the Omaha & Council Bluffs Street Railway has built a portable rail grinder of novel design. Heretofore all joints on both new and old track have been ground by hand. The portable grinder, as shown in the illustration, is provided with two sets of wheels, three for use on the track and two when it is desired to wheel it about on the pavement. Either set of wheels may be put in service by releasing the dog and shifting the



Omaha & Council Bluffs Portable Rail Grinder

large lever beside the motor from front to back or the reverse. Two of the wheels for use on the track may be easily detached, thus reducing the weight of the device and permitting it to be moved about a paved street with less effort.

The grinding mechanism includes a 5-hp motor, which the company considers too large but which was available for this purpose, a rheostat and a single-pole knife switch. The motor is connected to the 2-in. x 10-in. emery wheel by a set of sprockets and chain, which also serve to reduce the motor speed at the grinding tool. Energy is supplied to the motor through a flexible cable and pole connection to the trolley wire. The depth of the cut may be adjusted by a hand wheel and screw, the lower end of which forms the fork carrying the permanently attached wheel used in moving the grinder along the track. The grinder is operated by two men who push it back and forth over the work. One man, however, has complete control of the machine and regulates the cutting and the speed of the motor. It has been successfully operated on track where a three-minute headway is maintained, as only forty seconds is required for two men to remove it to clear a car.