PAINTING RAILROAD CARS

By Glenn Guerra

The master painters considered themselves to be artists, and that is shown in this proposed badge submitted by T.H. Soley of the Lehigh Valley Railroad. This appeared in the February 1897 Railroad Car Journal.

I thought we would start a three part series here on paint. Talk about a hot topic! Paint color, and what is correct, can start some heated arguments. My point here is not to determine what is the right color, or to tell you how I paint my models; but to give some insight into paint, its use around the railroads, how we may be able to duplicate some of the finishes, and some information on color mixing. In this first article, we will start with some information on what paint is, and how the railroads used it. In the next article, we will discuss how to possibly duplicate some of this on our models. The last article will discuss some basics of color so we have some idea of what to add if we want to change a color.

In the railroad industry, there was a trade group called The Master Car and Locomotive Painters Association of the US and Canada. They were very prolific in their writing and, as a result, we have a good amount of information from them. In the 1890's, their official organ (newsletter) was the Railroad Car Journal magazine which can be found online at the Linda Hall Library. I worked for a number of years rebuilding railroad equipment at railroad museums, and studied paint quite a bit. The writings of the painters were a good resource for me. What follows is a little of what I have learned.

Vol. VII. No. 9 RAILROAD CAR JOURNAL 265

Railroad Paint Shop — Official Organ of the Master Car & Locomotive Painters' Association...

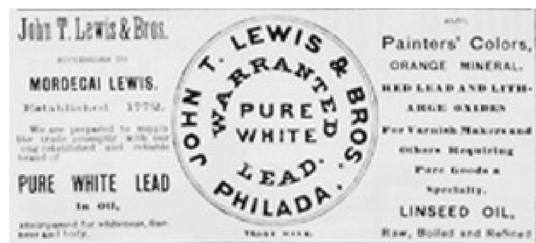
A Department Devoted to the Interests of Master Car and Locomotive Painters.

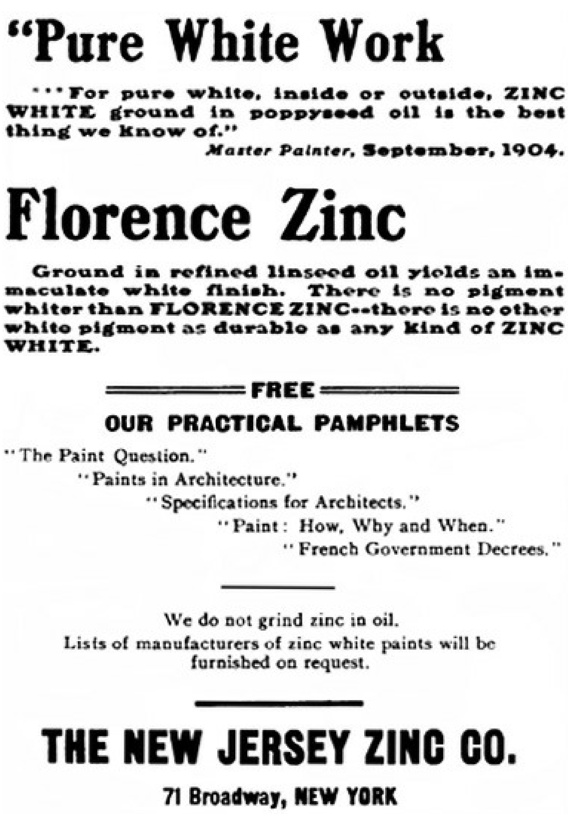
Edited by CHAS. E. COPP, General Foreman Painter, Car Department, Boston & Maine Railroad, Lawrence, Mass.

What Is Paint?

Paint is a combination of a binder, which forms the protective film, and fillers. The binders come in two broad categories: those that set up by chemical reaction, and those that set by the solvent evaporating. This is an important difference when choosing a paint, or varnish for that matter. The paints that set up by chemical reaction cannot be used after they have set. Paints and varnish that set up by solvent evaporation can be made liquid again by applying the solvent. Prior to the advent of epoxy and urethane paints, the common binders for paints were oils. Linseed oil was most common, but fish oil, soybean oil, tung oil, and others have been used. The vegetable oils set by an oxidation reaction and by polymerization. Both reactions are non reversible. The reactions can be controlled by the additives to the oil, but we will cover that later. Around 1920, there were a lot of advances made in modifying the oil binder. Alkyd resin was developed from linseed oil, and made a stronger film. In addition, it added a gloss to paint. This, in effect, was the pigmented varnish made in a new and much cheaper way. The solvent binders are things like lacquer, shellac, and other gums dissolved in alcohol or volatile solvents. The films of these products can be varied by the solvents used. So, without getting too technical, the thing to remember here is that there are two basic binders for paints. Next are the additives.

Additives for paint, and this includes the pigments, are what gives the paint binder its durability, as well as its color. The UV light from sunlight is very destructive. Take a piece of wood and cover part of it. Then, place it in the sunlight for a few hours. Even in that short amount of time, the sun will start to discolor the wood. Sunlight also attacks the paint binders. The fillers and the pigments block the sun from the binder, and prolong the integrity of the film. In addition, additives aid in the chemical reactions of oil based binders to give the film hardness or flexibility. Chrome and manganese aid in the oxidation reaction. This will make the surface of the film hard; but can seal the film so it can stay soft under the surface, which may not be desirable. Lead can aid in the polymerization of the film, and will make the film strong. There is a balancing act going on in the manufacture of oil paint to get the properties of the paint matched to what it is to do. As an example, a paint that would be formulated for wood, which has large dimensional changes with the seasons and humidity, may be too soft for metal. Another additive for oil paint is varnish. Oil varnish is a combination of a hard resin and oil. To mix the two, the manufacturer needs to melt the resin and heat the oil so they will mix. A lot of resin in the oil will form a hard finish suitable for indoors, like trim and furniture. Less resin, and the film will be pliable for external use, as in spar varnish. The reason I mention these varnishes here is that enamel paint is pigmented varnish, and that is why it has the high gloss. As mentioned earlier, alkyd resin is similar to the tree gums and resins that were used in oil varnish. This then became a cheaper gloss paint than varnish enamel. Some paints are formulated so that the fillers fall out as the sun attacks the film. These are called chalking paints. The advantage is that the old paint will be gone when you go to apply the new paint. No scraping. Now that we have some basic information on paint, let's get to the pigments.

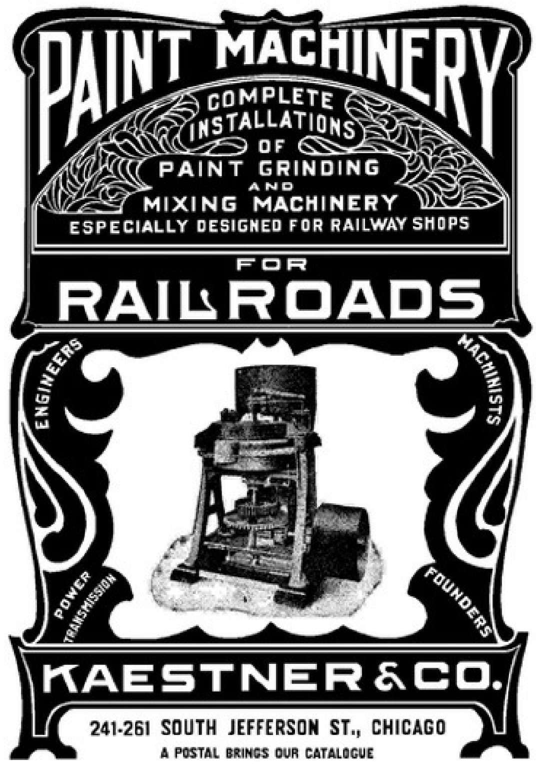




This ad for zinc white pigment appeared in the Railway Master Mechanic magazine in 1901. Note that they do not make paint, only pigment. Many people were mixing their own paint at this time.

Common Pigments Used Around The Railroads

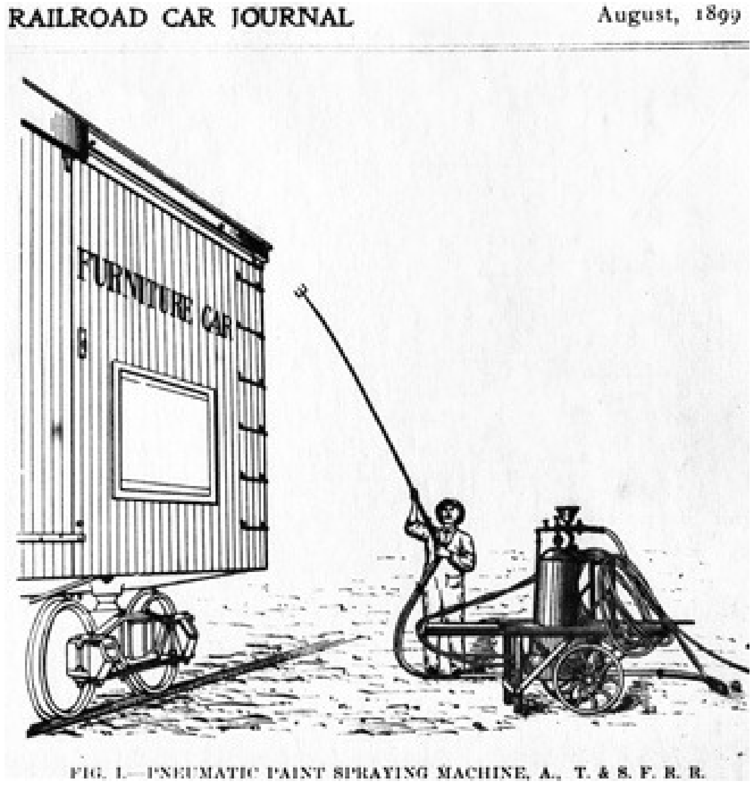
It's worth the time to look into what some of the common pigments are, and how they are used. Let's start with the whites. Lead white was almost the universal white pigment prior to 1900. Lime was the other common white, as in whitewash. Lime not used in oil paint because it is basic, and that will attack the film. One benefit of lead white is that it aids in the polymerization of the oil. White is technically not a color in the art world, and we will get into that in another article. Lead white is not a brilliant white, but has more of an egg shell appearance. Zinc white started to appear around 1900, and is a very bright brilliant white. Both of these pigments are relatively inexpensive, and were used extensively in white paints. Another lead based pigment that was used was red lead which is red in color. The next group I would like to talk about vary quite a bit in color, but are all the same compound, so they should be covered together. These pigments are rust, earth tones, or iron oxides, take your pick of name. They are yellow ocher, raw sienna, burnt sienna, mineral red, and red ocher. What makes them different in color is the lattice bond that iron oxide forms with water. Also, it makes a difference which iron oxide you have, Fe_2O_3 or Fe_3O_4. Lets start with Fe_2O_3, the common brown rust on all of our stuff. Take a close look at something rusty with an area that collects water. The rust will be lighter in the area that collects the water. The reason that some of the rust varies in color is important to know when talking about these pigments. The rust molecule, Fe_2O_3, and water molecule, H_2O, have an attraction to each other, and can bond in a lattice called an ionic bond. The attraction is similar to a static electric attraction, and the molecules do not combine. The more water in the lattice, the lighter the color will be. The lattice bond is stable, and therefore, the color does not change readily. The color can change with the addition or subtraction of water in the lattice, but this takes some effort. By roasting the pigment, you are providing enough energy to drive the water off. Adding water to the lattice to make the color lighter is very difficult. The strength of the lattice bond makes these pigments relatively colorfast. These pigments are as follows: yellow ocher is the lightest, followed by raw sienna. If raw sienna is roasted, it forms burnt sienna, and you will start to get a reddish color. Less water in the lattice, and you get mineral red, indian red, and red ocher, which are all basically the same. The iron oxide pigments are



Railroads made some of their own paint using machines like these. The C&NW had seven of these machines. The ad appeared in Railway Master Mechanic magazine in 1901.

C&NW paint lab in Chicago. Photo by Jack Delano, 1943 Library of Congress collection.

some of the most common pigments used in older paints because they were cheap and colorfast. Another pigment worth mentioning is Vandyke brown. This pigment is made from peat which is very young coal. One of the characteristics of Vandyke brown under the microscope is that the cell structure of the vegetation is still present. Vandyke brown is a very common railroad pigment as we shall see when we get to mixing paints. Chrome yellow is lead chromate, and was invented around 1820. It is a very bright yellow, and was found in bright yellow color paints. A very common blue was Prussian blue which is an iron derived pigment discovered around 1724. Chromium oxide was a green pigment found in mineral ores containing iron. Through a chemical process developed around 1838, the chromium was separated from the ore to make chromium oxide – a cheap and colorfast green pigment. The last pigment I should mention is lampblack, which again is not considered a color in the art world. There are many more pigments used in art, but these make up the base for almost all railroad paints prior to the streamline era with its color full trains. Now, let's move on to the application and composition of paints.



An illustration of painting a car with compressed air on the Santa Fe railroad in 1899.

Railroad Painting

The railroads tended to be self sufficient entities, and all the master painters had their own brew. This also means that like so many other issues regarding railroad practices, there is no definite date when things changed. The colors varied, as did the wearing qualities of the paint. Some railroads even went as far as buying pigment or ore and milling it themselves. This practice of mixing paint yourself was common, even in house painting, until the 1940's. Paint companies have been around for a long time, but the idea of going to

This photo was taken by Jack Delano in February, 1943 at the Proviso freight yard of the C&NW near Chicago. Not a lot has changed since 1899, has it? The photo is from the Library of Congress depression era photos collection. They are Farm Services Administration photos, and were taken during the depression through WWII. Many are in color, and are a valuable resource.

the store and getting a squirt of this, and a squirt of that in your paint, did not exist. You purchased the components from the paint company, and mixed them yourself. Pigments were sold dry, drying additives were sold separately, as was the oil. Paint was brushed on the cars; however, spraying came into being in the 1890's.

Torches like this, and even compressed air torches, were used to burn the paint off of passenger cars. There were reports in Railroad Car Journal of compressed air torches blowing up, and car shops burning down. This ad appeared in the February 1897 issue.

The color we all call freight car red was made of iron oxide with a small amount of fillers like calcium carbonate, gypsum, magnesium silicate, and other such fillers. As an example of the cheapness of iron oxide pigment, 1941 paint specifications from the C&NW called for 84% by weight of iron oxide, with the remaining pigments being fillers for their freight car red. In a 1910 history of the C&NW, they called for the paint to be made from ore mined in North Freedom, Wisconsin. As we have discussed earlier, iron oxide comes in a variety of colors. This was a way of controlling the color. It also means that the color varied quite a bit, ranging from a dark brown to a reddish brown. The paint of the era consisted of linseed oil and pigment which was applied with a brush. The iron work on a lot of cars in this era was "blacken off", as the painters would say, which consisted of oil and lampblack. Black freight cars did not come into being much until steel cars started to become common. The basic formula for freight car paint was pigment in oil with some filler and driers. This formula gave a flat finish similar to what we would call a heavy body stain that would be put on our house today. A 1941 paint specification for wood cars on the C&NW used this formula. For the steel cars, they added alkyd resin to the paint, giving the paint a semi gloss finish. Alkyd resin is a modified linseed oil that made the paint film stronger, and gave the paint some gloss. High gloss paints are gloss enamels which are basically pigmented oil varnishes. In the 1890's, the Santa Fe railroad used a paint sprayer that cut the time down from a day to five minutes. The sprayer was little more than a hose for applying the paint. A worker on each side of the car hosed the car down as it passed. This paint was flat, and had a look of what would be called a heavy bodied stain today. The paint "chalked" and wore off. Repainting consisted of brushing or hosing more on. Refrigerator cars were in a class of their own, and passenger car painting covers them better.

Passenger cars in the wood era were an elaborate process that took weeks to do. To start, the bare wood was primed with 2 coats of oil, lead white, and fillers. The whole car was "rubbed down" (sanded) and "knifed off", which was filling the nail holes and other imperfections with a putty made of white lead. The car was again primed and sanded. Two coats of color were added, and more sanding was followed by two more coats of color. The car was then lettered and varnished. The varnish used was a spirit varnish. Oil varnish was very expensive, and not suited to this application. What made spirit varnish good was that once a year when the finish was touched up, all that was needed was to apply more varnish. The solvent in the varnish softened up the varnish on the car, and the two coats merged as one. The application of the varnish changed the look of the color on the car, and successive applications of varnish changed it still further. After about five years, this paint was worn out, and the car needed repainting. Unlike the freight cars whose paint wore off, the passenger cars needed to be stripped. This was accomplished by "burning off", much like a heat gun today for removing paint. This, and the spontaneous combustion of paint rags, burned down a lot of car shops. In the late 1890's, the D&H railroad started to experiment with the two step paint process which was a self glossing enamel paint on secondary cars. The sleepers, diners, and observation cars were still done the old way. The master painters really took them to task for such a cheap and inferior job, "It just don't look right!", was the cry. At the same time, the

Chicago, Milwaukee & St. Paul Railway. *B. and Painted.*

PAINT AND VARNISH RECORD.

Received at W. Milwaukee Shop, 6-13-1898. *Left Shop, 8-6-1898.* *Passenger Car No. 92.*

	KIND OF WORK.	Whole or Part.	DATE.	LABOR & COST. Hours.	LABOR & COST. Dollars	LABOR & COST. Cents.	M'TERI'L. Dollars	M'TERI'L. Cents.	KIND OF MATERIAL USED.	REMARKS.
OUTSIDE BODY.	Paint burnt off.........	Part.	....	41	8	47		41	Gas.	New sheathing on lower part applied
	Scrubbing..............	......	....	....	....			....		
	Priming..................	Deck and Whole	7.9	18	3	60		96	15¾ Lbs. Formula: 1 part dry min., 1 part dry lead. Paste, 3 p. oil, 1 p. turp.; Thinner, 1 p. oil, 1 p. turp.	
	Sandpaper..............	"	....	6	1	26		06	⅝ qu. sandpaper.	
	Priming	"	7.13	10	2	20	1	15	16¼ Lbs. Formula: 1 part dry min., 1 part dry lead, 1 p. oil, 1¼ p. turp.; 7 p. turp., 1 p. jap.	
	Sandpaper..	......	....	....	....			....		
	Putty	Whole.	7.15	44	11	04		55	5¾ Lbs. Formula: Putty.	
	Rubbing down.........	"	....	56	11	20		54	6 qu. sandpaper.	
	Color, deck and reputty	"	7.22	14	2	80	1	35	13¾ Lbs., Formula: Body color.	
	"	"	....	3		60		05	½ lb. putty.	
	"	"	7.25	10	2	00		96	8 lbs. body color.	
	"	Deck.	....	6	1	20		36	3 lbs. oil body color.	
	Color and varnish......	Whole.	7.26	12	2	40	2	88	12 Lbs. Formula: 2 parts Valentine rubb. varnish, 1 p. paste body color, ⅛ p. turp.	
	Lettering and orn.	"	....	36	5	64	2	66	8 books gold leaf, ⅛ pint size, 1 lb. orn. color, 1 lb. waste.	
	Varnish	"	7.30	15	2	94	4	00	1¹⁸/₃₂ gal. Degolyer Rock body varnish.	
	"	"	8.1	10	2	10	3	80	1⁹/₃₂ gal. " " "	
	"	......	....	....	....			....		
	"	......	....	....	....			....		
	"	......	....	....	....			....		
	"	......	....	....	....			....		
	Sash paint..............	Whole.	....	126	26	16	2	22	2 qu. sandp., 2¾ lbs. filler, 1 lb. waste, 1 lb. putty, 10 lbs. paint, ⁶/₃₂ gal. Val. Rubb., ¹¹/₃₂ gal. Mur. Ry. Body Var.	
	"	......	....	....	....			....		
	Cleaning glass..........	Whole.	....	19	3	72		10	Material.	
	Glazing........	Part.	....	43	8	84	6	15	9-10×18.8-18×20 glass, 22-6⅜×18¼ cut glass, 6 lbs. putty.	
	Blinds, varnish........	Whole.	....	72	11	34	2	37	3 qu. sandp., 1 lb. paint, ¹⁴/₁₆ gal. Mur. Ry. B. Var.	
INSIDE.	Washing..........	Whole.	....	26	4	17		75	Washing material.	
	Filling and putty	Part.	....	40	8	03		98	8¼ lbs. filler, 8¼ lbs. waste, ⅛ lb. walnut putty.	
	Sandpaper.............	"	...	51	10	13		54	6 qu. sandpaper.	
	Stain and shellac......	"	....	56	11	20	7	31	3¾ lbs. stain, 3⁷/₁₆ gal. shellac.	
	Varnish..................	"	....	12	2	40	2	43	¹¹/₁₆ gal. Murphy interior varnish, ¹⁸/₃₂ gal. ceiling varnish.	
	Paint, New Ceiling, etc.	......	....	82	17	26	7	30	19¾ lbs. bronze, 67¼ lbs. various paints, 1 lb. waste.	
	" " "	......	....	....	....			....		
	Polishing................	......	....	....	...			....		
	Cleaning up............	Whole.	....	2		36		1²	Material.	
	Roof, Paint, New Roof	Whole.	7.14, 7.15, 8.5	14	2	80	1	90	9 lbs. red lead, 28¾ lbs. roof paint.	
	Irons under Car, Paint.	"	....	3		60		18	4¾ lbs. Asph. black.	
	Trucks and Platf. Paint	"	....	15	3	00	1	20	17¾ lbs. truck paint, 1 lb. putty, 1 lb. waste.	
	" "	......	....	....	....			....		
	" "	......	....	....	....			....		
	Platf. Rails, Paint.....	Whole.	....	9	1	80		30	2 lbs. railing paint.	
	Cost.................			848	172	20	34	18	Total Cost: $223.52.	

In this report, we can see some of what went into painting a passenger car in the wood car era. This is also an illustration of why some railroads were experimenting with enamel paint to save time in painting the cars.

CB&Q was also experimenting with enamel paint. By the time the steel cars started to appear, enamel paint was here to stay; and better spraying equipment made the job simpler. What came next was lacquer paint. This looked like the save all. It covered well, dried fast, and was able to be sprayed. It also had the ability to be touched up by spraying on another coat since lacquer is a finish that sets by the solvent evaporating. This is similar to spirit varnishes. The problem was that these early lacquers did not hold up. They tended to get gummy and sticky. I worked on an interurban car that was painted in 1915 with some of this paint on it. You could stick your fingernail in the paint. So, the railroads were still using enamel paint, and putting up with the slow drying time. The automobile industry was not as complacent, and the early lacquers were improved for their use. A 1927 article in Master Mechanics magazine described the new paint shops of the Pennsylvania Railroad in Wilmington, Delaware. They had installed drying ovens, and were using Dupont lacquer paint. The article credits the advances made by the auto industry for making the paint better. Lacquer could be formulated to give a high gloss, and a whole car could be painted in one day. The lacquer dried fast and, as a result, the cars could be painted outdoors with little problem from dust. The lacquer paint seems to have only been used on passenger cars. Freight cars still needed the thicker film of the oil paints, and finish was not a big concern on freight cars. The enamel paints came back with the advent of formulas that gave better drying time and harder finishes.

Here we have some information on paint, paint pigments, and paint processes. Different paints used on railroad cars gave different looks to the cars. The all wood cars had no gloss to them, and in good builders photos you can see the grain in the wood. In later day cars, the paint had some gloss to it. In the next issue, we will cover some thoughts on duplicating these finishes on models. In addition, I will have some comments from different modelers on how they achieved their results.