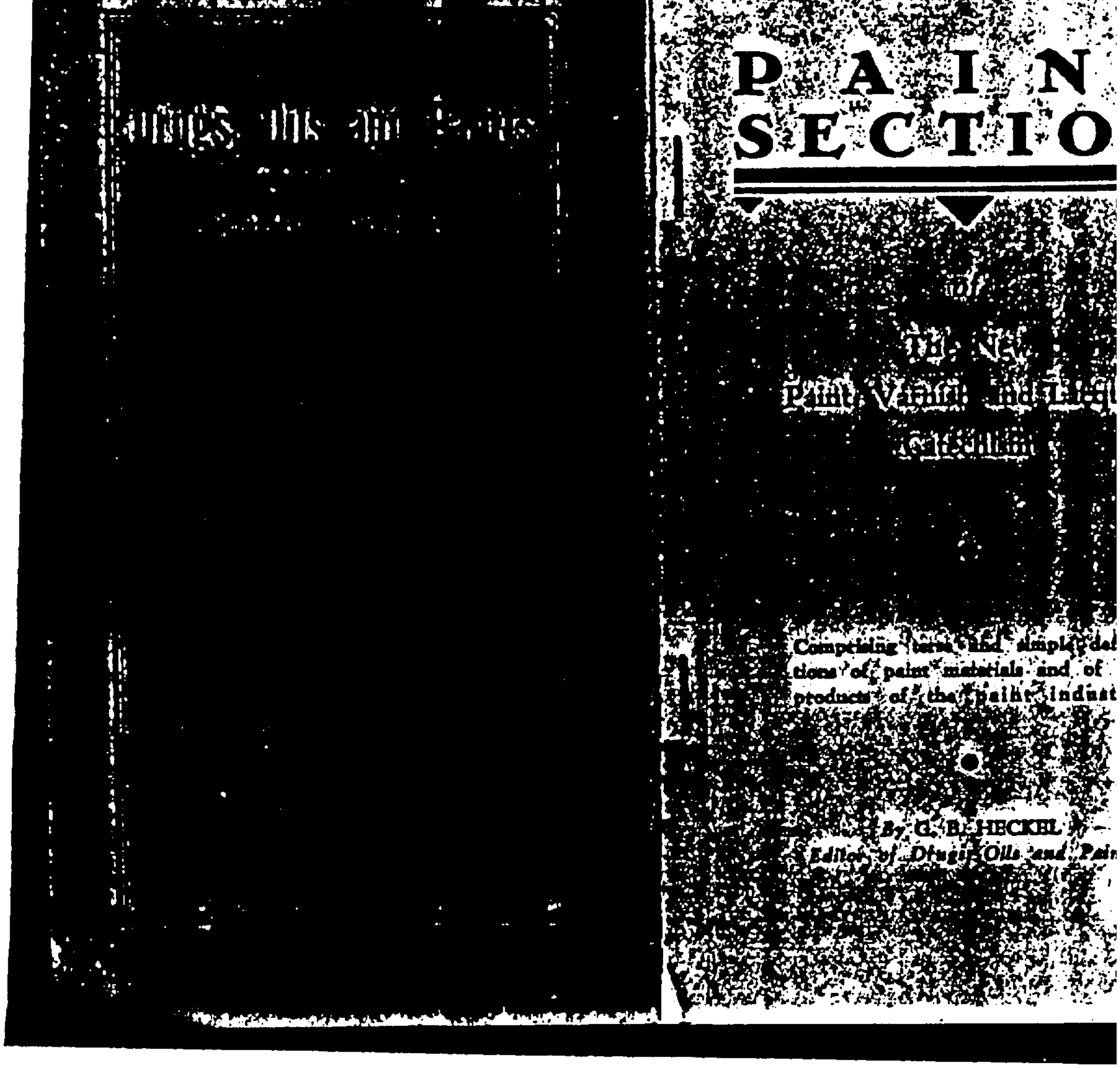
P A I N
S E C T I O
By G. B. HECKEL

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FOREWORD

Under the title "A Paint Catechism for Paint Men," the original "Paint Catechism" was first published in the columns of DRUGS, OILS AND PAINTS during May and June, 1907. It was described as "comprising terse, practical definitions of paint materials and answers to the questions met in the sale and use of paints."

In response to numerous requests it was immediately reprinted in booklet form, and 20,000 copies were sold in advance before it was off the press. Continued demand during the following years necessitated several reprintings, until by 1911, 250,000 copies had been sold.

In that year technical advance necessitated extensive revision. A third revision followed in 1917, a fourth (by James E. Heckel) in 1919, a fifth in 1922 and the sixth and last to this date, in 1925. Of each of these editions several reprintings were required. The total distribution to the present date has been nearly 1,000,000 copies.

All editions following the first, however, were issued on behalf of the Educational Bureau of the Paint and the Varnish Manufacturers Associations.

Exhaustion of the stock of the last edition and continued demand provides the opportunity for a seventh revision to bring the text abreast with the technical advance of the last nine years; and the Educational Bureau having been replaced by the Executive Committee of the National Paint, Varnish and Lacquer Association, the author, with the cordial assent of that Committee, resumes the responsibility.

The history of "A Varnish Catechism for Varnish Men" is similar: In 1909 the author became Secretary of the National Varnish Manufacturers' Association, and in 1918, Secretary of the Sub-Committee on Varnish of Committee D-1, American Society for Testing

Materials. This fortuitous combination of circumstances prompted the preparation of a similar work for the Varnish Industry; and accordingly in 1918 appeared "A Varnish Catechism for Varnish Men," followed periodically by revised editions, the fifth and last of which was published in 1927. To this last edition a brief "Lacquer Section" was naturally added. The total distribution of the booklet to date is approximately 250,000 copies and practical exhaustion of the available supply necessitates another reprinting.

However, since the industries involved are by no means so separate and distinct as formerly and since the introduction of synthetic resins has revolutionized the technology of the varnish industry, not only does the "Varnish Catechism" require extensive revision, but for convenience it is obviously advisable to devote a separate section to the lacquer industry, to complete the series.

Each section, as it is completed, will be issued as a separate booklet, and on completion of the whole they will be combined in a single volume.

He gratefully acknowledges the assistance of James E. Heckel, Technical Editor of DRUGS, OILS AND PAINTS, in this revision.

THE PAINT SECTION

1. What is paint?

A mixture of opaque or semi-opaque substances (pigments, or finely divided metals, commonly known as "bronze powders") with liquids, suitable for application to surfaces by means of a brush or a spray painting machine or by "dipping," and solidifying ("drying") to form an adherent protective and/or decorative coating thereon.

2. What is the purpose of paint?

To protect or to decorate surfaces, or to serve both purposes.

3. What additional services does paint render?

It is a sanitary agency and a preventive of decay and corrosion. In white or light tints, it reflects and diffuses light, thus reducing the cost of interior illumination and eliminating eye strain.

4. What is House Paint?

Paint designed to protect and beautify the surfaces of materials used in the construction of buildings—especially of dwellings.

5. What is the best House Paint?

That which best and longest protects and beautifies the surfaces to which it is applied.

6. What materials are used in making House Paints?

Pigments, drying and semi-drying oils, volatile "thinners" and solvents, driers ("japans") and varnishes.

7. How may such pigments be classified?

As white "bases," inert or "reinforcing" pigments, natural earth colors, chemical colors or dyes, lake colors, etc.

8. What are the white colors?

White lead: the basic carbonate (of which there are several varieties), basic sulphate ("sublimed") white lead, zinc oxide ("American Process" and "French Process"), leaded zincs (containing definite percentages of lead sulphate, (5% to 35%), lithopone (of which there are four types), titanium dioxide (either pure or combined with definite percentages of barium sulphate or calcium sulphate?) and antimony oxide ("Timonox").

9. What is Basic Carbonate White Lead?

A compound of lead, carbonic acid (CO_2) and the elements of water (H_2O). Its chemical formula is 2 Pb CO_3Pb $(OH)_2$. The modern process of manufacture originated in Holland, hence the name "Old Dutch Process."

The American procedure may be outlined as follows: Lead is melted and cast into perforated disks, called "buckles," about six inches in diameter, which are placed in porcelain pots containing, in wells, about one pint of dilute 3% acetic acid (vinegar). These are placed in rooms holding several layers, or tiers, 600 to 1000 pots each. The pots are covered with boards and layers of tan-bark, placed between each tier. The rooms, technically called "stacks," are kept closed. During a period of about 120 days the heat and the carbonic acid gas generated by fermentation of the tanbark, together with the acid vapors, combine to transform the lead more or less completely into a white, flaky substance (basic lead carbonate).

This, after it is crushed, screened, floated, ground in water and dried, forms the white lead of commerce, and is either sold in the dry state to paint and color manufacturers, or ground in linseed oil and sold for general painting purposes.

The product may be regarded as a compound of lead carbonate (2 Pb CO_3) and lead dioxide (2 Pb O H_2O) the relative proportions of which vary according to conditions in different parts of the stack, these differences being compensated more or less completely when combined.

However, though Dr. S. P. Sadtler, in 1906, found the lead carbonate content of fifteen

13. What is Pulp Ground White Lead?

After washing and settling in tanks, the excess water is decanted. The residue is "pulp lead." Formerly this pulp was passed through a filter press and finally dried by heat. Later the preferential affinity of white lead for oil was utilized to displace the residual water in the "pulp." The moist pigment is agitated with oil in a special type of mixer and the displaced water is drawn off. The completeness of the displacement depends upon the energy and duration of the process. There is no appreciable difference in the products of the two processes, but the latter is by far the more economical.

14. What is "Sublimed" or Basic Sulphate White Lead?

"This product is so named because it is obtained by a sublimation process or 'fume' process from lead sulphide (galenite or 'galena') ores by a process analogous to that used to produce American zinc oxide and leaded zincs. The product is obtained directly as a very fine, impalpable white powder, without grinding. Chemically, it is different from ordinary white lead, being apparently a basic sulphate of lead and * * * has approximately the following constitution:

Lead sulphate	77%
Lead oxide	15%
Zinc oxide	8%

"It exceeds in the fineness of the particles the ordinary grades of white lead, and is at least equal to them in whiteness, body, covering power and wearing qualities. It differs from ordinary white leads in being less poisonous, and resists the blackening action of the sulphur compounds of sewer gas and of fuel gas to a much greater degree."—*Ladd.*

"The lead sulphate and lead oxide are chemically combined in sublimed white lead, forming the true basic sulphate (approximately $Pb_3 S_2 O_9$). This chemical combination of the sulphate and oxide into the basic compound explains the high degree of opacity which this

pigment possesses. Its physical structure is entirely different from the ordinary lead sulphate, which has no pigment value, because it is crystalline and transparent in oil. The zinc oxide present is caused by the presence of a small amount of zinc sulphide (sphalerite) in the ore used in its manufacture."—*Hughes.*

15. What are the Characteristics of Basic Sulphate White Lead?

"Like all pigments produced by sublimation process, sublimed lead possesses in its ultimate particles a fineness far superior to that of pigments otherwise produced. On account of the extreme fineness of its particles it does not settle out of liquid mixtures. Being an oxysulphate, it resists the discoloring action of hydrogen sulphide and other harmful gases in the atmosphere longer than does any other lead pigment. It is uniform in composition."

It reacts less strongly than the basic carbonate with the "drying oils." When used alone, it "chalks" rather more freely than corroded white lead. It is used by some manufacturers to introduce lead into the paint film and counteract the tendency to "crack."

16. What is Sublimed Blue Lead?

A sublimation product closely allied to sublimed white lead, the process of manufacture being similar, of somewhat different composition and color. A characteristic analysis follows:

	Per cent.
Lead sulphate	52.92
Lead oxide	37.48
*Carbon	2.25
Zinc oxide	2 to 4
Lead sulphite	1 to 1½

*The carbon comes from the fuel of the furnace.

17. What are the Characteristics of Sublimed Blue Lead?

Being a "fume" product, its spreading power in oil is high (more than twice that of red lead). Its lead content is as high as that of other lead pigments. It remains well in suspension and brushes well, having better "tooth" than most lead pigments. It is practically "inert" to linseed oil and is not affected by atmospheric gases. Official tests place it high among the class of "rust-inhibitors."

18. What is Zinc Oxide?

Zinc Oxide (ZnO) is a combination of one atom of zinc with one atom of oxygen. It is produced by two methods, one known as the "French" and the other as the "American" process. In the French process, the vapor of metallic zinc (or "spelter") is burned in a current of air and the product of combustion, zinc oxide, is collected in closed chambers. In the American process, ores of zinc mixed with powdered anthracite are reduced and volatilized in a closed furnace, having perforated grate bars, and the resultant zinc oxide, after being blown through a series of cooling flues, is collected in fabric bags.

19. What are the Characteristics of Zinc Oxide?

In particle size it is one of the finest of all white pigments and in color one of the whitest. A pound of dry zinc oxide occupies about 50.77 cubic inches, while a pound of basic carbonate white lead, in the same condition, occupies only 14.69 cubic inches. In consequence of its extreme fineness it requires more oil than most other white pigments to fit it for use with a brush. In one hundred pounds of zinc oxide paint ready for use there are about 46 lbs. of oil and 54 lbs of pigment, while the proportions in a corroded white lead paint of similar consistency are about 73 lbs. of pigment to 27 lbs of oil. Zinc oxide is unaffected in color by any gases present in the atmosphere, has no visible effect upon any pigment with which it may be mixed, and is non-poisonous.

20. What are Leaded Zincs?

Oxides of zinc produced from ores of zinc which contain in association a certain proportion of lead sulphide ores. In the process of

manufacture the lead sulphide is transformed into basic lead sulphate ("sublimed white lead") and intimately united with the zinc oxide. These pigments are made with definite percentages of basic lead sulphate, ranging from about five to about thirty-five per cent., according to the purposes for which they are to be used. The recognized grades contain respectively under five per cent. ten per cent., twenty per cent., and thirty-five per cent. of basic lead sulphate.

21. What are the Characteristics of Leaded Zincs?

In fineness they are similar to other zinc oxides, in whiteness slightly inferior. Their opacity and "body" in paint are measurably greater on account of the contained lead sulphate. Practically all western zinc ores contain some lead.

22. What is Zinc Sulphide?

The chemical formula of this pigment is ZnS. It is most readily produced by passing hydrogen sulphide gas through a solution of zinc sulphate, or by mixing the sulphate solution with a sulphide (such as sodium), and washing the precipitate. It is an important constituent of lithopone, to which the latter owes most of its pigment properties.

23. What are the Characteristics of Zinc Sulphide?

The pure pigment is intensely white and its hiding power is high in comparison with most other white pigments. It is used in both interior and exterior finishes.

24. What is "Lithopone"?

Lithopone is available in four distinct types: Barium Lithopone, Calcium Lithopone, "Titanated" Lithopone and High Strength Lithopone. They are all co-precipitated compounds of either barium sulphate or calcium sulphate with zinc sulphide. It is produced by mutual precipitation from aliquot solutions of barium sulphide, and zinc sulphate, or of calcium sulphide and zinc sulphate.

In preparing *"High Strength" Lithopone*, containing 50% to 60% zinc sulphide, zinc chloride is added to the sulphate solution to increase the proportion of zinc sulphide precipitated. "Titanated" lithopone is produced either by heating the lithopone and titanium dioxide together in muffles, or separately, with subsequent mixing. It contains usually about 15 per cent. TiO_2. After precipitation the lithopone is washed and strongly sintered, ground and bolted.

25. What are the Characteristics of Lithopone?

The earlier lithopones were photogenic,—darkening in sunlight and bleaching in the dark—due to the presence of metallic impurities. All modern lithopones are "light resistant." They are used extensively in "flat wall paints," exterior house paints, industrial finishes, etc., the type of lithopone being selected according to the intended use of the product. The annual consumption of lithopone now exceeds that of any other white pigment.

26. What are the Titanium Pigments?

Primarily titanium dioxide (TiO_2). The pure oxide is obtained chiefly from ilmenite, a mineral containing approximately 47 per cent. iron and 53 per cent. titanium dioxide. While deposits are found in various parts of the United States, the chief commercial sources of supply are Travancore Beach, India, and Norway. By chemical treatment the iron is removed and the pure dioxide precipitated. This pure oxide is marketed under various trade names. "Reduced" grades (usually designated as "B" or "C") containing either barium sulphate (blanc fixe) or calcium sulphate, are also consumed in large quantities.

27. What are the Characteristics of Titanium Pigments?

Extreme fineness of particle, low specific gravity (3.75 4.25), brilliant whiteness and density of color, acid and alkali resistance, inertness to all paint, varnish and lacquer ingredients. They are extensively used in industrial finishes, lithographic metal coatings, nitrocellulose lacquers, enamels, etc.

28. What is an "Inert" or "Reinforcing" Pigment?

Properly speaking any pigment which does not react chemically with any of the components of a paint is an "inert pigment." In this sense titanium dioxide, carbon black, lamp black, graphite, chromic oxide (true "chrome green"), etc., are all inert pigments. The term, however, is usually applied to certain white or colorless natural pigments which are legitimately added to paints for various technical purposes: especially to provide the solid base on which dyes are precipitated (as in the chemical lake colors), to dilute the chemically active pigments in the paint film (as where moderate percentages of barytes or silica may be added to white lead, zinc oxide, etc.) to reduce excessive spreading rate (thus increasing the thickness of the paint film) or to give it the desired "tooth" (as when barytes or silica is added to white paint bases). It will be noted that in the lithopones, certain of the inert pigments are components of the pigments themselves.

Note: The inert pigments have also been used extensively to adulterate the more expensive pigments.

29. What Inert Pigments are in Common Use?

Barium sulphate ("barytes," blanc fixe or "permanent white") silica (*silex*, diatomaceous earth), magnesium silicate (asbestine, talc), alumina (china clay, precipitated alumina, feldspar, kaolin, alumina hydrate), calcium sulphate (gypsum, terra alba, "burnt

It is held by those who use it to make a "smoother" paint and to retard settling better than other inerts. The asbestiform varieties (chrysolite, "asbestine") are generally held to strengthen the paint film materially. Magnesium silicates are believed to be of special value in fire-retardant roof paints.

36. What is "Alumina"?

Aluminum Oxide (Al_2O_3). Its most familiar forms are corundum, emery, ruby, sapphire. Aluminum sulphate ("alum") under certain circumstances, precipitates aluminum trihydrate (aluminum hydroxide, "hydrated alumina"), which is used as a mordant in dyeing and as a base in the manufacture of chemical colors and lakes. The silicates of aluminum, --china clay, kaolin, feldspar, etc.—are commonly, though incorrectly, called "Alumina," and therefore are included here under that heading. They are complex hydrated silicates. One of these is kaolin, which is decomposed feldspar. For use it is washed and "floated."

Another type, Pyrophyllite (Al_2O_3. $4SiO_2$ H_2O) is also a well-known "inert."

37. What are the Characteristics of Aluminum Silicate?

"Inertness" and practical absence of color —though in this the clays are inferior to barytes and silica while feldspar is about the same—impalpable fineness in the case of kaolin and appreciable "tooth" in the case of feldspar; micro-tubular and crypto-acicular form in the case of pyrophyllite. Otherwise the pigment is comparable in its properties to magnesium silicate.

Being one of the cheapest of the "inerts" it is specified in station paints, freight car paints, etc. by some large consumers.

38. What is Calcium Sulphate?

The hydrated sulphate of the metal calcium ($CaSO_4$. $2H_2O$). Familiar as "gypsum," alabaster, selenite, plaster of Paris (the latter dehydrated by heating). In contact with water it rehydrates and "sets." A similar

phenomenon is familiar in Portland cement. Completely dehydrated, however, it loses this property. For use as an inert pigment it is carefully ground to avoid heating and consequent dehydration, and bolted.

39. What are the Characteristics of Calcium Sulphate?

Inertness, medium softness, colorlessness and ease of manipulation. Its solubility in water (one part in 500) impairs its value in some formulas. If completely hydrated it is *comparable to other "inerts."* The late Dr. C. B. Dudley, of the Pennsylvania Railroad, gave it full preference.

40. What is Calcium Carbonate?

One atom of calcium combined with one *molecule of the carbonic acid radical* ($CaCO_3$). Familiar in nature as limestone, marble, Mexican onyx, crystalline calcite, satin spar, stalactite, Paris white, chalk, etc. The most familiar commercial form is "whiting," the best of which is known as "Paris white," "cliffstone Paris white" and "bolted whiting." It is formed through long ages, similarly to diatomaceous earth, from the shells of minute foraminifera inhabiting prehistoric oceans. The best varieties are obtained from the chalk cliffs on the east coast of England—hence the name "cliffstone." The chalk is coarsely ground in water with "edge-runner" mills, then with flat stone mills, floated in water, thoroughly dried, and carefully reground to avoid heating. Finely ground marble dust, etc., is often offered for sale as "whiting."

41. What are the Characteristics of Calcium Carbonate?

Each of the various forms has its definite properties. Whiting, partly because of its peculiar structure, tends to hold pigments in suspension and will neutralize any traces of free mineral acid in oil or pigments. It "spreads" well and is regarded as especially useful to neutralize acid residues in the chemical iron oxides, bleached barytes, etc.

Another type, known as "white mineral primer," is made from marble dust, calcite etc., finely ground and water floated. It has a crystalline structure and is comparable in properties to other inerts of similar structure.

The most recent type of calcium carbonate pigment, already mentioned, is described as "treated calcium carbonate," ("Surfex") and apparently has polar properties which differentiate it from other forms.

Regarding calcium carbonate in general it is worthy of note that "old time putty" made of linseed oil and whiting alone has been known to endure, without apparent deterioration, for half a century.

42. What are "Earth Colors?"

Colored minerals occurring as natural deposits, which are utilized as pigments, either in their natural state, after proper treatment, such as grinding and purification or, after further oxidation by calcination in open furnaces, etc. The principal varieties are the more or less pure iron oxides, the mineral browns ("Prince's mineral," etc.), ochres, umbers, siennas, pure hematites (ferric oxide —Fe_2O_3) variously designated as rouge, light red, Indian red, red oxide, purple oxide, Persian Gulf oxide, Spanish oxide, etc. *Ochre* and *sienna* both consist of ferric hydroxide ($Fe(OH)_3$) permeating an earthy base (clay) and containing small percentages of manganic dioxide (MnO_2) in the case of the siennas. The *umbers* are similar in composition to the siennas, excepting that the content of manganese is materially higher (10 to 12 per cent. or over). Their color is dark brown with a tinge of green. They are mined in many countries, including the United States, but the best grades—"Turkey umbers" —come from the island of Cyprus. Heating in an open furnace changes the color of the ochres to red, of sienna to a rich red-brown (*"burnt sienna"*), of umber to a warmer and darker brown. (*"burnt umber"*).

The most brilliant *"red oxides"* come from the Persian Gulf and from Spain. "Prince's mineral" and similar "brown oxides" are supposed to contain large percentages of iron carbonate, which is converted to the oxide in open furnaces. The natural oxides, as pigments, range in color from warm brown to brilliant scarlet.

Brilliant red oxides (rouge, colcothar, etc.) are also obtained by subjecting ferrous sulphate ($FeSO_4 \cdot 7H_2O$—"copperas") to high heat in open furnaces. Sulphuric acid (H_2SO_4) is obtained as a byproduct of this process.

In this class also belong the "*Mapico*" *reds, yellows and blacks*, which are distinguished by *uniformity* of color, *fineness* of particle size and color density.

Closely allied to these oxides is *Venetian Red* which, like them, is a chemical and not an earth color, but both serve similar purposes. It is produced by precipitating the iron oxide from copperas with lime in water suspension, drying the combined precipitate and furnacing in open furnaces. The resultant product is an intimate mixture of finely divided iron oxide and calcium sulphate, the depth of color being determined by the percentage of oxide. Pigments similar in color are also produced by grinding highly colored red oxides with inert bases, such as gypsum. The earth colors in general are quite stable and find wide application.

43. What are "Chemical Colors"?

Chemical colors are pigments produced by chemical action of one substance (usually in solution) upon another, resulting in the precipitation of a colored compound. Following are the principal chemical colors in common use: The various *Prussian or cyanide blues (Chinese blue, Antwerp blue, Milori blue, bronze blue, etc.)*, made by precipitation of a solution of a soluble salt of iron (ferrous) by a solution of potassium or sodium ferrocyanide, and subsequent oxidation of the precipitate (which is at first white in color and i its color. (It is an excellent "inhibitor" or retardent of corrosion on steel surfaces.)

Red Lead and *Orange Mineral*, as well as *Litharge* are oxides of lead, and while not classed as chemical colors belong here. The first-named is produced by further oxidation of litharge at a low heat in an open furnace. *Orange Mineral* is usually produced by oxidation from lead carbonate instead of pig lead, and is therefore amorphous in structure. This makes it much easier to hold in suspension, while its color is lighter and more brilliant. These lead oxides form a cement with linseed oil and tend to harden in the can. Freshly mixed, they form an excellent protective coating for metal surfaces. A fully oxidized red lead has, however, been introduced which is free from this objection, and the addition of certain substances in small percentages delays this action. Fine grinding impairs the color. Litharge is used almost exclusively as a "drier."

Paris Green, (also called Schweinfurt green, emerald green, etc.), though poisonous, used to some extent because of the brilliance and permanency of its color, is lead aceto-arsenate $Cu(C_2H_3O_2)_2 \cdot 3Cu(AsO_2)_2$. It is produced by boiling basic copper acetate with arsenic. *Verdigris* basic copper acetate, $Cu(C_2H_3O_2)_2 \cdot 2H_2O$), is an artist's color rather than a paint pigment.

44. What are Lake Colors (or Color Lakes)?

Primarily a combination of an organic dye with a mineral salt, produced by mutual precipitation from solution—(as illustrated in the production of lithopone by mutual precipitation of solutions of barium sulphide and zinc sulphate). The principal mineral bases are alumina hydrate, clay, fullers' earth, bentonite, etc. The *Alizarine Lakes* are true chemical combinations of the organic pigment with the mineral base. They are extensively used because of good color and fastness. The *Hansa Yellows*, *Para Reds*, *Toluidine Reds* and "*Toners*" are used largely in the pure form, but are also obtainable in the reduced form, precipitated on the "inert," or incorporated with it by grinding. *Para Red* is precipitated from solutions of diazotized paranitraniline by beta-naphthol. The product is *Para Toner*, used principally as a solid color, because it is not "light-fast" when used for tinting. When precipitated with an inert in suspension, the product is *Para Red Lake*. The difference between *Toluidine Lake* and *Toluidine Toner* is similar.

45. What are Carbon Blacks?

With the exception of a few iron oxide and dye blacks, all black pigments are practically pure carbon, though the name is commercially used to designate specifically the blacks produced from natural gas. The list comprises *Lamp Black*—(soot from incomplete combustion of oil), *Gas Black* (Carbon Black), —soot from incomplete combustion of natural gas; *Graphite*—a natural product, also produced artificially in the electric furnace ("Acheson Graphite"); *Bone Black* and *Ivory Black* (the latter a superior bone black), *Drop Black* (so called because formed with gum into large "drops,") *Vine Black*, etc.,—are all produced by carbonizing animal or vegetable matter. They contain mineral salts which modify their tone. Of them only lamp black and carbon black are of importance as paint pigments.

46. What are the Characteristics of the Carbon Blacks?

With the exception of those of direct organic origin they are practically pure carbon and therefore, chemically inert. Lamp and carbon blacks are amorphous, though certain types of the latter ("Spectra Blacks") show micro-reflecting facets. The particles size is very small, the specific gravity low and the tinting strength and oil absorption very high. The spreading rate of a pure carbon black paint is extraordinary, consequently it is usually reduced by admixture with an inert pigment

50. Are the Same Proportions of Drier Used in All Paints?

No. Some pigments themselves act as driers. Such, in order of drying strength, are red lead and other lead oxides, lead carbonate, iron oxides (of which the umbers are "strongest"), and some of the chemical colors, like the chromes, containing lead. The chemical colors have generally little drying power and carbon black none. The percentage of driers added is, therefore, adjusted to the formula.

51. For What Purpose are Driers Added to Paint?

For convenience alone, to avoid exposure of the wet film to rain etc., to avoid adherence of dust, insects, etc., and to permit the application of the necessary additional coats within a reasonable time.

52. Do Driers Prolong the Life of Paint?

By no means. The final destruction of good paint being primarily due to progressive oxidation, anything which hastens oxidation shortens its "life." Therefore, the proportion of drier should be limited to its practical necessity.

53. What is "Kettle Boiled Oil"?

A term formerly used to designate linseed oil in which the "driers" had been incorporated by boiling in open kettles, in contradistinction to oils to which the drying salts in solution were added without heating. The process was subject to great abuse through adulteration. Specially treated oils, with definite properties, have almost completely replaced it, though the term "boiled oil" is still used by manufacturers to designate some of these special products. "Stand Oils"- polymerized at moderate temperatures in an atmosphere of carbon dioxide- belong in this group.

54. What are Volatile "Thinners"?

Certain liquids which form clear solutions with the oils used in paints, but on exposure evaporate rapidly and more or less completely. They comprise turpentine ("gum turpentine"—"wood turpentine"- "spirits of turpentine") alcohol (methyl and ethyl), benzol, naphtha ("benzine," "mineral spirits"), benzol and allied coal tar distillates, etc. Some of them are used more generally in varnish removers, bronzing liquids, etc., than in paints

55. What are the Characteristics of the Volatile Thinners?

Of those commonly used in paints, "*Gum Turpentine*" is a distillate from the sap of several species of pine, the residual product being rosin. *Wood Turpentine* is turpentine distilled from pine wood waste, stumps, roots, etc., by two processes — one similar to that used for "Gum Turpentine," with water; the other by direct heat in retorts. There is no important difference between "Gum" and "Wood" Turpentine, excepting that the latter is *more uniform in composition* and properties. Another type, recovered from the waste liquors of paper mills—finds little application in the paint industry.

"*Benzine*," "Naphtha," etc., are among the lighter distillates from petroleum. In modern practice, the "fractions" are carefully controlled as to boiling point, distillation range, specific gravity, etc. The "*fractions*" used in the paint industry range from 0.703 to 0.808 in specific gravity.

"*Mineral Spirits*" are petroleum fractions of higher boiling point, therefore evaporating more slowly. The variety available for specific uses covers a wide range.

Benzol or, properly, *Benzene*, is a distillate from coal tar. There are several "fractions" in the series (benzene, "solvent naphtha," toluol, xylol, etc.) of which "Benzol," and "Solvent Naphtha," are the only two ordinarily found in paint. The first is that fraction

63. What is the Most Desirable Mode of Disappearance?

Obviously by "normal wear"; and it is one of the chief objects of the honest paint manufacturer and of intelligent paint technologists that their products shall meet this requirement.

64. How is this Accomplished?

First, by careful selection of raw materials and unremitting laboratory control to insure uniformity in physical and chemical qualities; second, by constant chemical research for means of improvement; and lastly, by experience with large scale exposure tests of products under intensified natural conditions—such for instance as exposure in hot, humid or dry climates, and the "accelerated weathering machine." Paint manufacture is one of those industries which, within a few years, has developed from routine traditional practice to a highly specialized technical industry and is still in process of rapid development.

65. What is the Cause of Blistering?

Heat vaporizing moisture under a paint film. Only comparatively new films are subject to this defect. Incompletely dried lumber would appear to be the chief cause. It may be partially due to the chemical action of sunlight on the oil vehicle, segregating glycerine. The blister may disappear, but the film remains brittle and permanently detached.

66. What is Flat Wall Paint?

That type of interior paint designed to produce a lustreless washable finish on interior surfaces especially on plaster, etc. The vehicle is usually a China wood oil varnish, modified by soya oil (because of its colorlessness), with a large volume of mineral spirit, while the pigment is usually lithopone, with the addition of titanium pigment, zinc oxide, or zinc sulphide, or all three.

67. What are the Merits of these Finishe[s?]

Being washable, they are more sanit[ary] than wall paper and, being more durable, a[re] in the end, more economical.

68. What are Casein Paints?

Improved types of the products former[ly] known as "water paints." The "binde[r]" in these products is casein (from milk) wi[th] a non-toxic preservative. The pigments, var[y]ing according to intended use, may be pu[re] "cliffstone Paris white" (whiting), or othe[r] white "inert" pigments, with zinc oxide, zin[c] sulphide, lithopone, titanium pigment, etc. They furnished as a dry powder to which the user adds water; as a paste to which addi[]tional water is added by the user; or as a *Plastic Paint* intended for decorative relief effects. In the case of these latter, the vehicle is designed to produce a plastic rathe[r] than a fluid product. These newer products have largely supplanted ordinary kalsomine. They are all obtainable in white or tints.

69. What are the Uses of Casein Paints?

Largely for interior wall coatings, in dwel[]lings, factories, public buildings, etc.; fo[r] priming coats (on plaster especially) unde[r] oil paints and enamels, as an opaque coat between the first coat and the third coat o[f] oil paints, etc. Some types are especially adapted to the illumination of industrial buildings, tunnels and road "underpasses," etc. The "plastic" types are used principally for "texture" decoration.

70. What are "Mill Whites"?

White paints of the enamel type for use on interior wall surfaces of industrial plant[s], office and school buildings, etc., to augment illumination, thereby reducing hazard, pro[]moting physical comfort and reducing cost of illumination. They include a "primer" and a finish the first to level the surface and insu[re] adhesion; the second to insure reflection and diffusion of light. They are usually offered in three types of finish "glossy," "semi-flat" and "flat." Some manufacturers also furnish measured quantities of a limited range of colors, the addition of which will produce agreeable tints. The pigments used are selected from the denser whites—lithopone, zinc oxide, zinc sulphide, titanium pigment, titanium dioxide, sublimed white lead, etc., with an inert pigment. The vehicle is usually an ester gum-China wood oil varnish.

71. What is Cement Paint?

Formerly the name applied only to paints designed to protect and embellish cement, concrete or plaster surfaces; more recently it has been used also to designate paints containing Portland cement. It was devised to replace ordinary oil paints, which do not adhere well to surfaces of this type. Some of these paints may be safely applied to moist cement, etc.

72. How may Cement or Plaster Surfaces Be Prepared for the Application of Oil Paints?

By preliminary treatment with zinc sulphate solution in the proportion of eight ounces to one gallon of water. By chemical action of the zinc salt with the "free lime," (calcium oxide or hydroxide) the lime is transformed to calcium sulphate (gypsum) and the zinc salt into zinc hydroxide, neither of which reacts with the oil acids. Paints are, however, obtainable, which require no preliminary treatment of the surface.

73. What are "Sealers"?

Coatings devised to fill the pores of unduly absorbent surfaces, in preparation for painting. By preventing the absorption of oil from the paint they not only reduce the number of coats required, but insure a stronger film.

74. What is Aluminum Paint?

Aluminum pigment consisting of finely divided aluminum particles in flake form suspended in a suitable vehicle, usually of the long oil varnish type. Its chief uses are in painting structural steel such as bridges and tanks, interiors of industrial buildings and as a priming coat and finishing coat for wood. The aluminum pigment is obtainable either in the paste or powder form. Aluminum paints, owing to the shape of the metal particles, have the unique property of "leafing"—the tiny flat plates rising to the surface of the vehicle and forming there a practically complete metallic layer.—*W. B. Roberts.*

75. What are Ship Bottom Paints?

Special products designed to prevent corrosion and "fouling" with marine life. To serve this dual purpose, in many cases, an anti-fouling coat is applied over an anti-corrosion primer. In others, the two are combined in a single paint. Adamson, who has made the most exhaustive study of the subject to this date, found a compound of coal tar, rosin, coal tar naphtha, manganese linoleate, Venetian red, zinc oxide, silica and bees wax the most effective of the anti-corrosive paints tested; and a similar formula, with the bees wax and the manganese linoleate omitted and pine oil, asbestine, cuprous oxide and mercury oxide added, he rated as the best anti-fouling paint of those tested. He also found satisfactory a combination anti-corrosive and anti-fouling paint containing yacca gum, alcohol, a special pine oil, petroleum spirits, zinc oxide, silica, blanc fixe, Paris green and mercuric oxide (See DRUGS, OILS AND PAINTS, September, 1934 March 1935, inclusive). For wood vessels in fresh water copper in any form prevents fouling. Recent investigations have also indicated the effectiveness of phenolic resin varnishes with zinc chromate as anti-corrosive coatings.

76. What is Zinc Dust?

Metallic zinc in finely powdered form. In the production process a slight film of zinc oxide forms on each particle. Mixed with special vehicles, being electro-negative to iron, it is highly efficient as a rust inhibitor; and as a priming coat on metal under other paints, it has proved equally efficient in preventing the cracking and scaling due to rapid changes of temperature.

77. What are "Industrial Paints"?

Coating designed for use in the multifarious products of industry. The range is very wide—from automobile to agricultural machinery and implements—and in each case the paint is designed for its specific purpose, usually under specifications of test requirements.

78. In View of all the Foregoing, what is the True Test of Paint Value?

Service. The conditions, physical, chemical and technical, governing the behavior of paint in any given case are so numerous and so obscure that it is hopeless for anyone but an expert to attempt to comprehend them. House paint is designed to cover a wide range of conditions and the better grades of prepared paints meet the average conditions with remarkable success. As between the many competing products, naturally, it is to the record of success rather than the composition of the paints that the consumer must look for enlightenment. There is always a reason—usually there are many reasons—why a certain paint under certain conditions meets or fails to meet the requirements; but these reasons are usually obscure and technical and quite beyond the range of common knowledge. It may be taken as axiomatic that no paint obtains permanent popularity except on the basis of substantial merit. Success begets success, and nothing could be more conducive to increased sale of a given paint in any locality

than the ocular demonstration of its value on painted buildings. It is this practical demonstration of superior convenience, economy and durability which caused the consumption of prepared paint to expand from the humble beginnings of the industry in the late fifties to its vast proportions of the present day.

SUMMARY

The inescapable conclusion from all that has preceded is that *paint manufacturing* is a progressive industry, dependent upon the knowledge and skill at the command of the manufacturer. At the time when the first edition of this "Catechism" was published, in 1907, manufacturing practice was based largely on tradition, modern technical science having not yet been born. During the period intervening the subject has received intensive study from trained specialists and the use of a multitude of devices for the measurement and evaluation of raw materials and finished products has become almost universal. The measurement of such cryptic properties as surface tension, electric charges, catalytic action, absorption and adsorption, reflective and refractive indices, have become routine practice with all advanced manufacturers—especially raw material manufacturers, whose technical salesmen disseminate technical information throughout the entire industry. As a result the industry has largely "cut loose" from ancient tradition involving the classic method of "trial and error."

At the present day all paint products have been improved, though we still have with us the "selfish minority" who promise everything and furnish less than nothing, in that their products, failing quickly, necessitate the expense of removal. Wherefore the old dictum "a responsible name on a sealed can is everywhere a guarantee of quality," still holds good.

Modern paint products of this qualification give better and more economical service than ever before; but the end is not yet. With horde of scientists constantly seeking to improve the old and discover the new, continual progress, entailing constant change, is inevitable. Even that ancient "back-bone" of the industry, linseed oil, is assuming more and more, the rôle of a raw material for the production of "special oils" with definite properties for definite purposes, and it behooves all manufacturers to keep themselves in step with this progress.

As the paint of today is radically different from the paint of yesterday, so the paint of tomorrow will differ from that of today. Those who have the responsibility for the selection and application of these therefore owe it to themselves as well as to their clients to keep themselves in touch with this development—it is a responsibility inherent in the service they offer. The scientist is abroad in the land and in his eyes nothing is valid that cannot be proved—he is no respecter of trade traditions, no matter what their age or ancestry.

"Try all things. Hold fast to that which is good"—until something better displaces it!

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