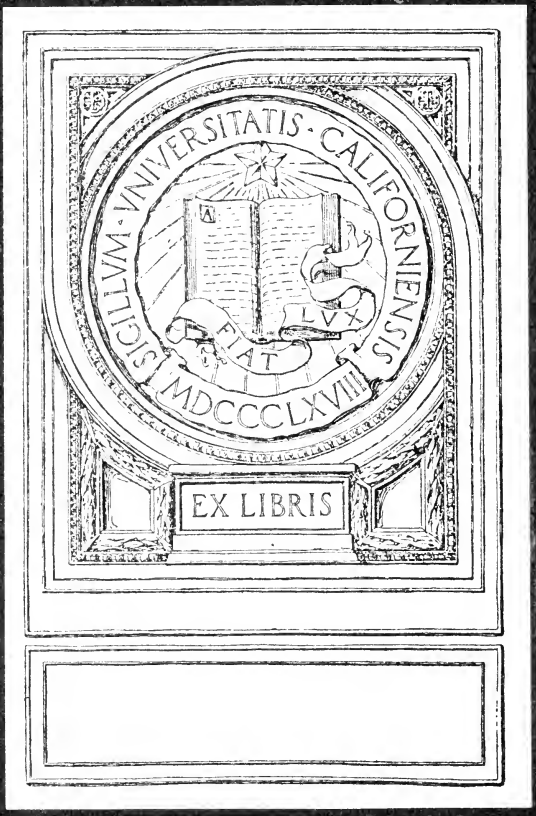
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VITREOUS ENAMELING OF IRON AND STEEL

ARTHUR D. LITTLE, Inc.
CHEMISTS AND ENGINEERS
CAMBRIDGE, MASS.

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READING LIST

ON

VITREOUS ENAMELING OF IRON AND STEEL

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A READING LIST ON VITREOUS ENAMELING ON IRON AND STEEL

The literature of the ceramic industry is very well covered up to the year 1906 by the Bibliography of Clays and the Ceramic Arts compiled by John C. Branner. The following reading list, therefore, begins with the year 1907. The articles listed deal more with the chemical principles involved than with mechanical methods. References are given to the abstracts printed in Chemical Abstracts or in the Journal of the Society of Chemical Industry. These abstracts are reproduced in part below, though where the abstract is long, or where the title indicates the scope of the article, abstracts are usually omitted. Reference to abstracts will enable the investigator to eliminate many articles as being unsuitable for his particular purpose. United States patents on enameling are omitted, as they are given in the second part of this pamphlet. Directions for ordering foreign patents may be found in Chemical Abstracts, vol. 13, no. 6 (March 20, 1919).

Books

Bollenbach, H. Keramische Rechentaflen zum Gebrauch in den Laboratorien der Ton-, Glas-, und Email Industrie. Halle: W. Knapp. 105 pages.

Brown, W. N. Art of enameling on metal. 2nd Edition. 1914. London: Scott, Greenwood and Son. 58 pages.

Chapin, H. M. How to enamel. 1911. Wiley.

Day, L. F. Enameling. 1908. Scribner.

Emailleindustrie. Dresden. IV, 255 pages.

Eyer, Ph. Anlagen und Einrichtungen e. Emailliewerke. Berlin: Keram. Rundschau. 44 pages.

Eyer, Ph. Emaille-Wissenschaft: In gemeinverstandl Auslegung. Dresden: Verlag "Die Glasshütte." 224 pages.

Fisher, A. Art of enameling upon metals. 1906. Lane. 38 pages, 26 plates.

Franchet, L. La fabrication industrielle des emaux et couleurs ceramiques. 1911.

Grampp, O. Practical enameler. 1909. William.

Griffin, H. R. Clay glazes and enamels, with a supplement on crazing, its causes and prevention, 1913. Randall and Co.

Grünwald, J. La technique de l'emaillerie moderne. Paris: H. Dunod et Pinat.

Grünwald, J. The raw materials for the enamel industry and their technical technology. Translated from the German by H. H. Hodgson. 1914. London: C. Griffin and Co. viii, 225 pages.

Grünwald, J. The technology of iron enameling and tinning. 1912. London: C. Griffin and Co. 138 pages.

Grünwald, J. The theory and practice of enameling on iron and steel with historical notes on the use of enamels. Translated by H. H. Hodgson. 1910. London: C. Griffin and Co. vii, 131 pages.

Havas, B. Uber Eisenblechemaille. 1910. (Dissertation of the Tech. Hochschule zu Karlsruhe.)

Landrum, R. D. Enamels. 1918. Cleveland: Harshaw Fuller and Goodwin Co. 106 pages.

Millenet, L. Manuel pratique de l'emaillage sur metaux. 1917.

Maryon, H. Metal work and enameling. 1913. London: Chapman and Hall. 342 pages.

Shaw, J. B. Enamels for sheet iron and steel. 1920. Washington: United States Bureau of Standards. Technologic Paper 165. 88 pages.

Staley, Homer F. Materials and methods used in the manufacture of enameled cast-iron wares. 1919. Washington: United States Bureau of Standards. Technologic Paper 142. 158 pages.

Turner, William. Transfer printing on enamels, porcelain and pottery.

ARTICLES IN PERIODICALS

1907

Chem. Fabrik Güstrow, Hillringshaus, and Heilmann. Manufacture of a white translucent enamel. German Patent 207,001. Aug. 6, 1907. *C. A.*, **3**, 2044. A small amount of cobalt oxide is added to the enamel material containing titanic acid with the view of covering the yellowish tint of the titanic flux.

Chem. Fabrik Güstrow. White clouded enamels. English Patent 12,583, May 30, 1907. *C. A.*, **3**, 587; *J. Soc. Chem. Ind.*, **27**, 810. Artificially produced titanates of alkaline earth or earth metals are used.

Klissner, J. Kiln for enameled articles, in which these do not come in contact with the flame. German Patent 203,296. Apr. 10, 1907. *J. Soc. Chem. Ind.*, **27**, 1204.

Rickmann and Rappe. Manufacture of an opaque enamel. German Patent 203,773, June 30, 1907. *C. A.*, **3**, 699; *J. Soc. Chem. Ind.*, **28**, 92. Cerium carbonate is ground with the previously melted enamel and burned on the metal plate.

Riddle, F. H. The type of enamel used for enameling cast iron sanitary ware. *Trans. Amer. Ceram. Soc.*, **9**, 645–61 (1907); *C. A.*, **2**, 1483; *J. Soc. Chem. Ind.*, **27**, 565. The most favorable composition was found to be: 0.4 PbO and BaO, 0.15 K_2O, 0.15 CaO, 0.05 ZnO, 0.25 Na_2O, 0.15 Al_2O_3, 1.0 SiO_2, 0.2 B_2O_3, 0.2 SnO_2.

Spitz, G. Process of detaching enamel from enameled objects. French Patent 370,986, Oct. 31, 1906. English Patent 5,273, Mar. 5, 1907. *C. A.*, **2**, 204; *J. Soc. Chem. Ind.*, **26**, 257. A solution of caustic soda or oxalic acid at 100° C. is used, either with or without a quantity of oxidizing medium.

1908

Act.-Ges. der Emailliewerke und Metallwaarenfabriken "Austria." Process for producing a metallic luster on enameled metallic surfaces. French Patent 388,761, Apr. 1, 1908. *J. Soc. Chem. Ind.*, **27**, 982.

Bock, B. Importance of fluorine in enamels. *Chem.-Ztg.*, **32**, 730–2 (1908); *C. A.*, **2**, 2718; *J. Soc. Chem. Ind.*, **27**, 900. Fluorine lowers the melting point of the enamels decidedly but has no influence on the opacity of the resulting enamel.

Bock, B. Note on white antimony enamels. *Chem.-Ztg.*, **32**, 446–7 (1908); *C. A.*, **2**, 2132; *J. Soc. Chem. Ind.*, **27**, 566. Dangers are pointed out, owing to the ready solubility and the poisonous character of the compounds of antimony. Slow cooling of frits in place of the rapid quenching is advised.

Bonzel, C. and P. Continuous furnace for burning enameled ware out of contact with flames. French Patent 392,285, July 13, 1908. *J. Soc. Chem. Ind.*, **27**, 1204.

Enameling of sheet iron hollow ware. *Keram. Rundschau*, **16**, 89–91, 135–9 (1908); *C. A.*, **2**, 1605. Various formulas are given in which zirconium is replacing tin.

Eyer, P. Advances in the preparation of enamel glazes (for iron). *Chem.-Ztg.*, **32**, 516–7 (1908); *J. Soc. Chem. Ind.*, **27**, 628.

Eyer, P. Tin oxide substitute. *Stahl u. Eisen*, **28**, 1097–9 (1908); *C. A.*, **2**, 3135. Tests of cryolite, which may replace about 12 per cent of tin, antimony, and arsenic oxides, bone ash, titanic acid and zirconium oxide.

Franchet, Louis. The enamels and ceramic colors of the Middle Ages and the Renaissance. *La Ceramique*, **10**, 142; *C. A.*, **2**, 2609. Various compositions are given.

Home office regulations for vitreous enameling metal or glass. Statutory Rules and Orders, 1908, No. 1258, Dec. 18, 1908. *J. Soc. Chem. Ind.*, **28**, 91.

Landau et Cie., and Rosenzweig, C. White enamel of great covering power. French Patent 389,483, Apr. 22, 1908. *C. A.*, **4**, 2720; *J. Soc. Chem. Ind.*, **27**, 983; *La Ceramique*, **11**, 100–1; *C. A.*, **3**, 364. Silicates of zirconium and beryllium are used in place of tin, etc. They are more refractory, more resistant to acids and are cheaper.

Recovery and utilization of enamel wastes. *Rev. chim. ind.*, **19**, 160; *C. A.*, **2**, 2718.

Staley, H. F. The compounding of frits. *Trans. Amer. Ceram. Soc.*, **10**, 113–23 (1908); *C. A.*, **2**, 3392.

Vollkommer, Joseph. Furnaces for the enameling industry. *Iron Age*, **82**, 648–9 (1908); *C. A.*, **2**, 2981.

Vondracek, R. Enameling of iron. *Sprechsaal*, **41**, 475–7, 493–5, 507–8 (1908); *J. Soc. Chem. Ind.*, **27**, 1020.

Woog, P., and Delage, M. Process of enameling in one stage. French Patent 401,543, July 29, 1908. *J. Soc. Chem. Ind.*, **28**, 1130. An acetylene flame is directed onto the spot where the enamel is required and the finely ground enamel is also projected on the same spot.

1909

Bock, B. Fixation materials in enamel making. *Chem.-Ztg.*, **33**, 109 (1909); *C. A.*, **3**, 1450. Fixation materials are those substances which have the effect of holding the fine enamel glass particles in suspension, thus preventing their settling to the bottom of the mass after fusion. These include clay; insoluble magnesium salts; soluble, neutral salts, such as ammonium chloride (volatile), alkali carbonates and sulfates (partly volatile), and borax (non-volatile).

Colin, G., et Cie. Process of enameling cast iron articles and especially pots and cooking utensils. French Patent 411,630, Apr. 14, 1909. *J. Soc. Chem. Ind.*, **29**, 951. The interior of the pots is polished and then oxidized into a layer of magnetic oxide of iron, to which the enamel is applied by the wet process and as liquid as possible.

Enequist, Erik. The chemistry of opaque glass and enamel. *Chem. Eng.*, **10**, 54; *C. A.*, **3**, 2865.

Fletcher, D. Enameling muffles. English Patent 25,692, Nov. 8, 1909. *J. Soc. Chem. Ind.*, **29**, 1383.

Frink, R. L. The chemistry of opaque glass and enamel. *Chem. Eng.*, **10**, 128–9 (1909). A criticism of the work of Enequist.

Grünwald, Julius. Annealing and pickling of the finished iron articles before enameling. *Stahl u. Eisen*, **29**, 137–40 (1909); *C. A.*, **3**, 878; *J. Soc. Chem. Ind.*, **28**, 204.

Grünwald, Julius. Cast iron enamels. *Stahl u. Eisen*, **1909**, 137; *Sprechsaal*, **43**, 485–7 (1910); *C. A.*, **5**, 168.

Grünwald, Julius. Enameling and the function of clay in the enamel. *Sprechsaal*, **42**, 287–9 (1909); *C. A.*, **3**, 1674; *J. Soc. Chem. Ind.*, **28**, 600. A general discussion.

Grünwald, Julius. Note on the technology of the enameling industry. *Oesterr. Chem. Ztg.*, **11**, 271; *C. A.*, **3**, 2364. The density of certain enamels is given, with and without water. Certain analytical methods are also given.

Hartmann, A. Zircon enamel. *Z. anorg. Chem.*, **1909**, 178–227; *Keram. Rundschau*, **19**, 118–28 (1911); *C. A.*, **5**, 1981.

Lesmuller, A. Process for making glass and enamels opaque. German Patent 218,316, April 1, 1909. *J. Soc. Chem. Ind.*, **29**, 420. Oxides of tin, silicon, lead, titanium, zirconium or thallium are fused with boric acid derivatives and the fused mass exposed to the action of steam or acid vapors while it cools and the solid product subsequently melted with the enamel.

Mayer, M., and Havas, B. Expansion coefficient of sheet iron enamels. *Chem.-Ztg.*, **33**, 1314; *C. A.*, **4**, 1092.

Mayer, M., and Havas, B. The coefficient of thermal expansion of sheet iron enamels. *Sprechsaal*, **42**, 497–9 (1909); *C. A.*, **3**, 2494; *J. Soc. Chem. Ind.*, **28**, 1199. Six different enamels were studied.

Mayer, M., and Havas, B. The function of fluorine compounds in enamels. *Sprechsaal*, **42**, 460–1 (1909); *Chem.-Ztg.*, **33**, 758 (1909); *C. A.*, **3**, 2740, 3001; *J. Soc. Chem. Ind.*, **28**, 835. Fluorine is a good opacifier and permits the tin oxide to be decreased to 3 per cent and still maintain excellent covering power.

Orton, Edward, Jr. Notes on the testing of enameled sheet steel wares. *Trans. Amer. Ceram. Soc.*, **11**, 320–41 (1909); *C. A.*, **3**, 2741; *J. Soc. Chem. Ind.*, **28**, 1130.

Shaw, Joseph B. The allowable limit of variation in the ingredients of enamels for sheet steel. *Trans. Amer. Ceram. Soc.*, **11**, 103–52 (1909); *C. A.*, **3**, 2740; *J. Soc. Chem. Ind.*, **28**, 1130. A discussion of the manufacture of sheet steel enameled ware, followed by an investigation of fitting ground and top coats to a particular Bessemer steel. It is replete with details and explanations.

1910

de Back, A. Method and apparatus for recovering iron and steel from waste enameled articles. English Patent 3375, Feb. 11, 1910. *J. Soc. Chem. Ind.*, **29**, 1390. The articles are first pressed together to crack the enamel and the enamel then scraped off.

Cavanaugh, J. A. Large electric enameling oven. *Elec. World*, **56**, 685–6; *C. A.*, **5**, 29.

Cheney, Merritt B. The limits of composition of enamels for cast iron. *Trans. Amer. Ceram. Soc.*, **12**, 543–7 (1910); *C. A.*, **5**, 362.

Goldschmidt, Th. Removing enamel and recovering the iron. German Patent 242,055, April 2, 1910. French Patent 418,971, Aug. 1, 1910. *C. A.*, **6**, 2157; *J. Soc. Chem. Ind.*, **30**, 92.

Grünwald, J. Cast iron enamels. *Stahl u. Eisen*, **30**, 1201–6 (1910); *J. Soc. Chem. Ind.*, **29**, 951.

Grünwald, J. The stiffening of wet ground enamels. *Sprechsaal*, **43**, 594–7 (1910); *C. A.*, **5**, 168; *J. Soc. Chem. Ind.*, **29**, 1251. The reagents recommended are ammonium chloride or carbonate, magnesium oxide and borax.

Hillringhaus and Heilemann. Zirconium oxide as a clouding agent in enamels and glasses. *Z. anorg. Chem.*, **66**, 436; *C. A.*, **5**, 167.

Holcroft, Harold. The principles of vitreous enameling of cast iron for industrial purposes. *J. Soc. Chem. Ind.*, **29**, 121–5 (1910); *C. A.*, **4**, 1227. Four methods are discussed.

Landau et Cie, and Rosenzweig. White enamel. French Patent 417,078, June 13, 1910. *J. Soc. Chem. Ind.*, **29**, 1383. A substitute for tin oxide is prepared by heating zirconium and calcium nitrates in the proportions necessary to give 70 per cent zirconium and 30 per cent calcium.

Landau, Kreidl, Heller and Co. White enamels. German Patent 274,860, June 11, 1910. *C. A.*, **8**, 3107. Discusses the use of zirconium compounds.

Landrum, R. D. The manufacture of enameled ware. *Trans. Kansas Acad. Sci.*, **22**, 76–80; *C. A.*, **4**, 1532. A brief but interesting description.

Landrum, Robert D. Methods of analysis for enamels and enamel raw materials. *Trans. Amer. Ceram. Soc.*, **12**, 144–74 (1910); *Glasind.*, **26**, **27**, **28**; *C. A.*, **4**, 258; *J. Soc. Chem. Ind.*, **29**, 1310.

Mayer, M., and Havas, B. The function of the ground enamel. *Sprechsaal*, **43**, 727–9 (1910); *C. A.*, **5**, 1981.

Muffle kilns for iron enameling and other industrial purposes. *Stahl u. Eisen*, **1910**, No. 36; *Keram. Rundschau*, **18**, 495–7, 507–9, 520–3 (1910); *C. A.*, **5**, 580.

Shaw, J. B. Testing sheet steel enamels. *Trans. Amer. Ceram. Soc.*, **12**, 463–93 (1910); *C. A.*, **5**, 168; *J. Soc. Chem. Ind.*, **29**, 1310.

Sonntag, S., and A. Enameled metal ware. German Patent 239,252, Aug. 13, 1910. French Patent 419, 433, Aug. 17, 1910. English Patent 19,233, Aug. 16, 1910. *C. A.*, **6**, 2155; *J. Soc. Chem. Ind.*, **29**, 1383. The cleaned surface is wetted with water to which a glutinous substance has been added and the enamel powder sifted on.

Tafner, H. Fluorite and its function in enamels. *Sprechsaal*, **43**, 36–7 (1910); *C. A.*, **5**, 773; *J. Soc. Chem. Ind.*, **29**, 213. Enamels containing calcium fluoride do not represent stable compounds as fluorine continues to be given off on heating.

Underhill, D. Enameled cast iron sanitary ware. *Foundry*, **36**, 17; *C. A.*, **4**, 2668. A good general survey of the entire field.

Weiss, Ludwig. Zirconium oxide as a clouding agent in enamels and glasses. *Z. anorg. Chem.*, **67**, 456; *C. A.*, **5**, 168.

1911

Coethen. The training of engineers for enamel works at Friedrich-Polytechnicum. *Glashütte*, **41**, 309–10; *C. A.*, **5**, 2711.

Colin, L. V. Enameling. English Patent 17,270, July 28, 1911. *C. A.*, **7**, 407.

Cox, John H. Comparison of commercial ground coats for cast iron enamels. *Trans. Amer. Ceram. Soc.*, **13**, 531–49 (1911); *C. A.*, **5**, 3892; *J. Soc. Chem. Ind.*, **30**, 1386.

Deutsche Stahhottich Ges. Subsequent enameling of rough places and weld-

ing of enameled articles. German Patent 251,059, Sept. 5, 1911. *C. A.*, **7**, 235.

Eyer, Ph. How much of the heat applied to enamel firing and melting ovens is useful? *Glashütte*, **41**, 931–2; *C. A.*, **6**, 415.

Franchet, L. Preparation of Grecian black enamel with natural ferroso ferric oxide. *Compt. rend.*, **152**, 1097–1100 (1911); *J. Soc. Chem. Ind.*, **30**, 622.

Green enamels for galvanized iron. *Glashütte*, **41**, 604–6, 649–51 (1911); *C. A.*, **5**, 3503.

Grünwald, J. The chemical technology of enamel raw material. *Glashütte*, **40**, **41**, **42**. In 42 installments. See under Books, also.

Grünwald, J. The use of zirconia in the enameled iron industry. *Sprechsaal*, **44**, 72–3 (1911); *C. A.*, **5**, 2163; *J. Soc. Chem. Ind.*, **30**, 210.
Doubt is expressed as regards the efficiency of zirconium oxide as an opacifier.

Havas, B. The function of the ground enamel. *Sprechsaal*, **44**, 72–3 (1911); *C. A.*, **5**, 2163.

Landau et Cie, and Rosenzweig, C. White enamels. English Patent 10,418, Apr. 29, 1911. French Patent 429,665, May 12, 1911. *C. A.*, **6**, 2986; *J. Soc. Chem. Ind.*, **30**, 1213; *La Ceramique*, **14**, 204. A part of the silicate of either the natural or artificial silicate of zirconium is removed by warming with alkali carbonate or hydroxide, which product is very suitable for rendering enamels opaque.

Landau, Kreidl, Heller and Co. White enamels. German Patent 283,504. June 23, 1911. *C. A.*, **9**, 2579. Addition to German Patent 274,860.

Landau, Kreidl, Heller and Co. White enamel with metal hydroxides as clouding agents. German Patent 289,102. Oct. 3, 1911.

Landrum, R. D. Resistance of sheet enamels to solution by acetic acids of various strengths. *Trans. Amer. Ceram. Soc.*, **13**, 494–501 (1911); *C. A.*, **5**, 3886; *J. Soc. Chem. Ind.*, **30**, 1386.

Mayer, M., and Havas, B. The coefficient of expansion of enamels and their chemical composition. *Sprechsaal*, **44**, 188–91, 207–10, 220–2 (1911); *C. A.*, **5**, 2163; *J. Soc. Chem. Ind.*, **30**, 543.

Mayer, M., and Havas, B. Reactions during the fusion of iron enamels (containing fluorine). *Sprechsaal*, **44**, 6–8 (1911); *C. A.*, **5**, 2163; *J. Soc. Chem. Ind.*, **30**, 930.

Meyer, A. Enameling or glazing plates of iron, steel, etc. German Patent 266,161, July 9, 1911. *C. A.*, **8**, 809.

Meyer, A. Enameled or glazed plates of iron or steel. German Patent 272,355, July 9, 1911. *C. A.*, **8**, 2612.

Minneman, Johannes. An investigation on art enameling on metals. *Trans. Amer. Ceram. Soc.*, **13**, 514–30 (1911); *C. A.*, **5**, 3890; *J. Soc. Chem. Ind.*, **30**, 1386.

Olsberger and Altenbekener Eisenhüttenwerke C. Kropff. Enameled cooking utensils. German Patent 244,389, Mar. 2, 1911. *C. A.*, **6**, 2304.

Rickmann, R. White pigments for enamels, etc. German Patent 283,204, Dec. 5, 1911. *C. A.*, **9**, 2444. Substances containing antimony are used.

Roenelt, T. J. Process of enamel stripping by heating with alkaline compounds. French Patent 434,301, Sept. 16, 1911. *J. Soc. Chem. Ind.*, **31**, 336. Potassium cyanide is used, sprinkled on the enamel heated to just redness. The enamel may be lifted off after half a minute.

Schott, E. A. Muffle oven for enamel works and other industrial purposes. *Stahl u. Eisen*, **31**, 310 (1911); *C. A.*, **5**, 2315.

Staley, H. F. The cause and control of the mottling of enamels on metals. *Trans. Amer. Ceram. Soc.*, **13**, 489–93 (1911); *C. A.*, **5**, 3890.

Tostmann, C. The function of the ground enamel. *Keram. Rundschau*, **19**, 5–6 (1911); *C. A.*, **5**, 1670. The claim is reasserted that in ground enamels on cast iron the cobalt oxide is reduced to cobalt.

Various processes for decorating enameled ware. *Glashütte*, **41**, 811–3, 839–40, 864–6; *C. A.*, **6**, 142.

Vondrácek, R. The function of the ground enamel. *Sprechsaal*, **44**, 115; *C. A.*, **5**, 2163.

Vondrácek, R. The enamel industry. *Sprechsaal*, **44**, 264–7 (1911); *C. A.*, **5**, 3503. A general review of the industry for 1910.

Waldes and Co. Enameling tools, etc. German Patent 242,850, Jan. 29, 1911. *C. A.*, **6**, 2157.

Zahn, O. Enameling muffles. *Keram. Rundschau*, **19**, 30–2 (1911); *Stahl. u Eisen*, **31**, 308–10 (1911); *C. A.*, **5**, 1671. A criticism of previous work on enamels.

1912

Akt. Ges. Porzellanfabr, Weiden Gebr. Bauscher. Method of enameling vessels. French Patent 451,332, Dec. 4, 1912. *C. A.*, **7**, 3210.

Brown, R. E. Replacement of tin oxide by antimony oxide in enamels for cast iron. *Trans. Amer. Ceram. Soc.*, **14**, 740–55 (1912); *C. A.*, **7**, 232; *J. Soc. Chem. Ind.*, **31**, 1129. A different type of enamel is required if antimony is used.

Dupont, P. Enameling bath tubs. German Patent 269,524, Sept. 26, 1912 *C. A.*, **8**, 2469. Heating of the tub is effected by electric means.

Enameling on metal. *Keram. Rundschau*, **20**, 79; *C. A.*, **6**, 3504.

Eyer, Ph. Natural history of enamel defects. *Keram. Rundschau*, **20**, 233–5, 243–5, 252–5. *C. A.*, **6**, 3505.

Goldschmidt, Th. Frits useful in the manufacture of enamels or glasses. French Patent 439,609, Feb. 1, 1912. *La Ceramique*, **16**, 12; *C. A.*, **7**, 1959; *J. Soc. Chem. Ind.*, **31**, 723.

Haschek, K. Decorating enameled metal products. German Patent 275,560, Dec. 28, 1912. *C. A.*, **9**, 852.

Heilmann, E. Opaquing substances for white enamels. English Patent 26,498, Nov. 18, 1912. *C. A.*, **8**, 1652; *J. Soc. Chem. Ind.*, **33**, 259. Mixtures of magnesium oxide and aluminium oxide or of aluminium oxide and zinc oxide, calcined to form a spinel.

Kralapp, E. Furnaces for the preparation of fritted enamels. *Keram. Rundschau*, **20**, 261–3; *C. A.*, **6**, 3505.

Kretzer, H. Process for the manufacture of clouded glasses, enamels, and similar products and of clouding agents allowing the carrying out of this process. French Patent 444,440, May 30, 1912. English Patent 12,749, May 30, 1912. *J. Soc. Chem. Ind.*, **31**, 1129.

Landau, Kreidl, Heller and Co. Clouding agent for white enamel. English Patent 11,754, May 17, 1912. *C. A.*, **7**, 3649.

Landau, Kreidl, Heller and Co. Alkali containing clouding agent for white enamels. German Patent 283,792, Aug. 24, 1912. *C. A.*, **10**, 262. Metal compounds, other than those of tin, are used.

Landau, Kreidl, Heller and Co. Clouding agents for white enamels. English Patent 16,787, July 18, 1912. *C. A.*, **8**, 410. Zircon is partially disintegrated by heating with sodium hydroxide or carbonate and the soluble silicates and surplus alkali removed with water. The combined alkali is partly removed by treating the mass with ammonium or metallic salts and the product then heated until the water of hydration is removed.

Landau, Kreidl, Heller and Co. Clouding white enamels. English Patent 19,849, Aug. 30, 1912. *C. A.*, **8**, 562.

Landau, Kreidl, Heller and Co. Iron enamels. German Patent 282,348, Aug. 10, 1912. *C. A.*, **9**, 2301. Method of directly enameling iron in white.

Landau, Kreidl, Heller and Co. Manufacture of white enamels. French Patent 429,665. First addition. June 6, 1912. *J. Soc. Chem. Ind.*, **31**, 1181. See English Patent 6,787.

Landau, Kreidl, Heller and Co. Opaquing agents for white enamels. English Patent 1,136, Jan. 15, 1912. *C. A.*, **7**, 2460.

Landau, Kreidl, Heller and Co. White enamels. Swiss Patent 62,594, July 8, 1912. *C. A.*, **8**, 2236. Alkali containing hydroxides of the known metal compounds, used heretofore as obscuring agents, are here employed for that purpose.

Landau, Kreidl, Heller and Co. White enamels. English Patent 29,382, Dec. 20, 1912. *C. A.*, **8**, 2046. The amount of water of hydration contained in the hydrated oxide used as the opaquing agent is varied in inverse proportion to the per cent of alkali used.

Landau, Kreidl, Heller and Co. White enamel. French Patent 438,908, Jan. 11, 1912. First addition, Jan. 18, 1912. French Patent 450,228, Sept. 7, 1912. English Patent 29,382, Dec. 20, 1912. *C. A.*, **7**, 3210; *J. Soc. Chem. Ind.*, **31**, 643; **32**, 489, 753. Compare the above patents by the same firm.

Landrum, R. D. A comparison of ten white enamels for sheet steel. *Trans. Amer. Ceram. Soc.*, **14**, 489–509 (1912) *C. A.*, **7**, 230; *J. Soc. Chem. Ind.*, **31**, 1129.

Landrum, R. D. Enamels for sheet steel. *J. Ind. Eng. Chem.*, **4**, 561–4 (1912); *Chem. Eng.*, **16**, 141–3 (1912).

Landrum, R. D. The necessity of cobalt oxide in ground coat enamels for sheet steel. *Trans. Amer. Ceram. Soc.*, **14**, 756–67; *C. A.*, **7**, 232.

Rickmann, R. Testing of enamels containing antimony. *Z. angew. Chem.*, **25**, 1518–19 (1912); *J. Soc. Chem. Ind.*, **31**, 775. The sample is boiled for half an hour with 4 per cent acetic acid or 2 per cent tartaric acid. The antimony in solution is titrated with permanganate. The meta-antimonates are not attacked by this treatment.

Rickmann, R. Coloring agents for white glasses, glazes and enamels. English Patent 27,954, Dec. 4, 1912.

Rickmann, R. The use of antimony compounds for the production of white enamel. *Sprechsaal*, **45**, 115–7 (1912); *La Ceramique*, **15**, 134; *C. A.*, **6**, 1348, 2679; *J. Soc. Chem. Ind.*, **31**, 231. Antimony oxide should be avoided, but the antimonates are not injurious to health.

Rickmann, R. White covering for enamels. French Patent 451,238, Dec. 2, 1912. English Patent 27,954, Dec. 4, 1912. *C. A.*, **7**, 3210; *J. Soc. Chem. Ind.*, **32**, 604. Antimony is heated to redness with saltpeter and an alkaline hydroxide.

Schuler, A. J. Process for dulling enamels. English Patent 28,679, Dec. 12, 1912. *J. Soc. Chem. Ind.*, **33**, 81.

Shaw, J. B., and Shaw, Lucian. Determining the cost of enameled sheet steel cooking utensils. *Trans. Amer. Ceram. Soc.*, **14**, 510–5 (1912); *C. A.*, **7**, 230.

Staley, Homer F. The cause and control of crazing in enamels on cast iron. *Trans. Amer. Ceram. Soc.*, **14**, 516–45; *C. A.*, **7**, 230; *J. Soc. Chem. Ind.*, **31**, 1129.

White enamel with zirconium silicate base. *La Ceramique*, **14**, 204; *C. A.*, **6**, 1665. The natural silicate of zirconium, extracted with hydrochloric acid, and then with 4 parts of sodium hydroxide at 500–600 gives a product that is bulky and superior to tin oxide.

Zahn, O. Burning furnace for enameling. German Patent 263,518, Sept. 27, 1912. *C. A.*, **8**, 227.

1913

Advantages of the portable muffle furnace in glass, porcelain and enamel works. *Diamant*, **35**, 485–6; *C. A.*, **7**, 3003.

de Back, A. Removing enamels from waste enamel ware. English Patent 77, Jan. 1, 1913. *C. A.*, **8**, 2235.

Berge, A. Leadless enamels and faience with reduced content of tin oxide. *Sprechsaal*, **46**, 17–9(1913); *J. Soc. Chem. Ind.*, **32**, 142. Instead of dispensing with tin oxide, it is reduced to a minimum by fritting with sodium phosphate.

Bertrand, M. S. V. Enamels of sodium borosilicate. *La Ceramique*, **16**, 113–4; *C. A.*, **7**, 2841.

Chem. Fabrik Güstrow, Hillringhaus, and Heilmann. Opaquing agent for white enamels. English Patent 11,749, May 20, 1913. *C. A.*, **8**, 3622. This consists of titanic acid and zirconium oxide.

Davidson, T. R. Cleaning of metal articles preparatory to the application. of a coating of enamel or the like. English Patent 16,554, July 18, 1913 *J. Soc. Chem. Ind.*, **33**, 355. Concentrated sulfuric acid is used to carbonize the grease, and the pieces are then allowed to stand in water, where the diluted acid further cleans the articles.

de Haen, E., Chem. Fabrik List G. m. b. H. Enamel and glazes. German Patent 289,317, Jan. 14, 1913. *C. A.*, **10**, 2792. Zinc sulfide is used as a substitute for the oxide.

Deleuil, S. L. Enameling metal plates. French Patent 456,959, Apr. 22, 1913. *C. A.*, **9**, 137. The plates, after immersion in the bath, are freed from excess by rapid turning.

Eyer, Ph. The assumed reduction of antimonic to antimonous compounds in enamels. *Glashütte*, **43**, 266, 327–8; *C. A.*, **7**, 3004. This does not take place.

Eyer, Ph. Design and equipment of an enameling plant. *Keram. Rundschau*, **20**, 433–5, 447–9, 538–40; **21**, 24–7, 47–9; *C. A.*, **7**, 2102.

Eyer, Ph. The melting of enamels. *Ill. Ztg. Blechind.*, **1912**, 640; *C. A.*, **7**, 2459.

Eyer, Ph. Quartz and clay in enameling. *Glashütte*, **43**, 662–3; *C. A.*, **7**, 3647 .

Eyer, Ph. Scientific enameling. *Glashütte*, **42**, 8–43, No. 12 (1912–1913); *C. A.*, **7**, 3004. An exhaustive treatise.

Frissell, N. E. Enameling process for cast iron sanitary ware. *Foundry*, **41**, 220–3; *C. A.*, **7**, 3209.

Goldschmidt, Th. Removing enamel and recovering the iron, etc. French Patent 418,971. First addition, May 5, 1913. *J. Soc. Chem. Ind.*, **32**, 1072.

Havas, B. Manufacture of zirconium oxide. German Patent 262,009. May 5, 1913. *C. A.*, **7**, 3650.

Hirsch, W. Furnace for enameling. German Patent 283,869, Feb. 1, 1913.

Honigmann, L. Enamel for sheet metal and other hard surfaces. French Patent, 465,574, Dec. 1, 1913. English Patent 28,398, Dec. 9, 1913. *C. A.*, **8**, 3495; *J. Soc. Chem. Ind.*, **33**, 355. The use of metallic silver.

Importance of powdered coal in enamel works. *Glasshütte*, **43**, 1004–6; *C. A.*, **8**, 1194. The relative value of 3 varieties of charcoal and coal are discussed.

Influence of sulfur dioxide used as a disinfectant upon sheet steel enamel. *Keram. Rundschau*, **21**, 380; *C. A.*, **8**, 224. Dry or water-laden sulfur dioxide is without effect upon perfect ware, but on ware exhibiting crazing defects, yellow spots are formed in the defective spots of the enamel. If the ware itself is wet, however, the sulfur dioxide fumes exert vigorous effect, due to sulfuric acid formation.

Kentonwski, L. A muffle furnace for enameling large cast iron kettles. *Stahl u. Eisen*, **32**, 2179–80; *C. A.*, **7**, 2102.

Krause, H. Enamels. *Electrochem. Z.*, **20**, 113–6, 143–5, 176–9; *C. A.*, **8**, 805. Historical and descriptive article.

Landau, Kreidl, Heller and Co. Covering masses for white enamels. French Patent 456,335, Apr. 4, 1913. *C. A.*, **8**, 2047; *J. Soc. Chem. Ind.*, **32**, 945.

Landau, Kreidl, Heller and Co. Manufacture of white enamels. *La Ceramique*, **16**, 9–10; *C. A.*, **7**, 1961.

Landau, Kreidl, Heller and Co. Opaquing agents for white enamels. English Patent 17,998, Aug. 17, 1913. *C. A.*, **9**, 363. Highly basic compounds or complexes of aluminium, tin, titanium or zirconium, containing a small proportion of the radicals not refractory to heat.

Landau, Kreidl, Heller and Co. White, particularly zircon, enamels. French Patent 462,587, Sept. 16, 1913. German Patent 286,038, Oct. 25, 1912. English Patent 17,998, Aug. 7, 1913. *C. A.*, **8**, 3106; *J. Soc. Chem. Ind.*, **33**, 314, 921.

Landau, Kreidl, Heller and Co. White enamel. French Patent 463,623, Oct. 14, 1913. *J. Soc. Chem. Ind.*, **33**, 355; *C. A.*, **8**, 2788.

Landau, Kreidl, Heller and Co. White enamel. Austrian Patent 4,677,009, June 13, 1909. *C. A.*, **7**, 3209.

Landau, Kreidl, Heller and Co. White enamel. French addition, 17,112 to Patent 438,908, Jan. 18, 1913. *C. A.*, **8**, 411. Each hydrate unit gives its highest effect with a certain alkali amount which must be ascertained emperically.

Landau, Kreidl, Heller and Co. White enamels and opacifiers for white enamels. *La Ceramique*, **16**, 238–40; *C. A.*, **8**, 224. The opacifying effects of the metallic oxides are influenced by combinations with small amounts of phosphoric acid. Combining water of hydration and alkali or alkaline earths to the above phosphate further favorably influences the opacifying effect.

Landau, Kreidl, Heller and Co. White enamels of a zircon base. *La Ceramique*, **16**, 61–2; *C. A.*, **7**, 2671; *La Ceramique*, **17**, 52–3; *C. A.*, **8**, 2233.

Meyer, A. Enamel. English Patent 2,155, Jan. 27, 1913. *C. A.*, **8**, 2611.

Meyer, A. Enameling. English Patent 2,279, Jan. 28, 1913. *C. A.*, **8**, 2612. Coats of enamel of increasing fusibility are applied over the anti-oxide layer.

Michel, R. Iridescent enamel. French Patent, Addition 17,326 to 455,064, Feb. 7, 1913. *C. A.*, **8**, 2046. Glass or enamel ware, immediately after production, is exposed at a suitable temperature to metal bromide vapors.

Nailler, Raymond F. Art of enameling or the coating of iron and steel with glass. *Am. Soc. Mech. Eng.*, **35**, 1479–92 (1913); *Sci. Am. S.*, **76**, 338–9; *Met. and Chem. Eng.*, **11**, 695–8; *Iron Trade Rev.*, **53**, 678–80; *Iron Age*, **92**, 843–4 (1914); *Foundry*, **42**, 7–10; *Eng. Mag.*, **46**, 603–5 (1914); *C. A.*, **8**, 805. Deals with the fundamentals of sheet steel and cast iron enamels.

Removing enamels. *Glashütte*, **43**, 326–7; *C. A.*, **7**, 3004. The use of sodium hydroxide at 180° with 12 atmospheres pressure is suggested.

Schuler, A. J. Process for dulling enamels. Canadian Patent 146,740, Mar. 18, 1913. *C. A.*, **7**, 1792. A silicious material is mixed with the covering mass and burned in a furnace on the article to be enameled.

Schuler, A. J. Roughening of enamels. *La Ceramique*, **16**, 239–40; *C. A.*, **8**, 224. Quartz, feldspar or kaolin is mixed with a cover compound of earths or silicates and salts before application to the object.

Shaw, J. B. Process of making sanitary ware. *Trans. Amer. Ceram. Soc.*, **15**, 467–481; *C. A.*, **8**, 807.

Stanley, H. F., and Fisher, G. P. Leadless enamels. *Trans. Amer. Ceram. Soc.*, **15**, 620–7; *C. A.*, **8**, 805; *J. Soc. Chem. Ind.*, **33**, 80. Four good lead-free enamels were produced.

Weiss, L. Opaquing agents for enamels. French Patent 459,999, June 23, 1913. English Patent 14,632, June 24, 1913. *C. A.*, **8**, 2932; **9**, 136; *J. Soc. Chem. Ind.*, **32**, 1157. Fluorides or double fluorides of tin, antimony, titanium, zirconium are used. The effect is increased by the presence of hydroxides of the alkalies and alkaline earths or of silicon compounds.

Westfalische Stanz- und Emailliewerke Akt. Ges. vorm. J. and H. Kerkamm. Enamel glazes on iron. German Patent 289,103 Sept. 11. 1913. *C. A.*, **10**, 2511; *J. Soc. Chem. Ind.*, **35**, 424. Metal powder or dust is added to the ordinary enamel glaze.

Westfalische Stanz- und Emailliewerke Akt. Ges. vorm J. und H. Kerkamm. Enamel glazes on iron. German Patent 290,054, Nov. 4, 1913. *C. A.*, **10**, 2792. Water soluble metallic compounds which decompose at the enemeling temperature are used.

Zahn, O. Muffle furnace for enameling. German Patent 267,801, Feb. 27, 1913. Addition to German Patent 263,518.

Zahn, O. Process and firing oven, more especially applicable to enameling. French Patent, 460,104, July 7, 1913. *J. Soc. Chem. Ind.*, **33**, 25.

1914

Baumann, Gebr. Apparatus for clouding enamels. German Patent 286,037, Apr. 22, 1914. *C. A.*, **10**, 1701.

Berge, A. Enamel glazes free from lead and tin. *Sprechsaal*, **47**, 339–41; *C. A.*, **8**, 3493; *J. Soc. Chem. Ind.*, **33**, 647. Antimony compounds are used as a substitute for the more costly tin oxide in producing opacity. Formulas are given.

Berndt, M. The status of cobalt in ground coat of sheet steel enamel. *Keram. Rundschau*, **1914**, 262; *Silikat-Z.*, **2**, 160–1; *C. A.*, **8**, 3847.

Denmead, W. A. Hints on experimental enamel making. *Trans. Amer. Ceram. Soc.*, **16**, 445–53; *C. A.*, **8**, 3711. Practical guide for the production of enamels maturing at 700–1000°.

Dichanz, G. Securing enameled metal plates to each other. German Patent 286,774, Nov. 13, 1914. *C. A.*, **10**, 1587.

Don'ts relative to enameled iron ware. *Metal Work*, **82**, 410–1 (Sept. 18, 1914).

Eyer, Ph. Use of sodium silicofluoride in enamel glazes and in the glass industry. *Glashütte*, **44**, 205–7(1914); *C. A.*, **8**, 2468.

Eyer, Ph. White clouding materials for enamels. *Glashütte*, **44**, 247–9, 268–9; *C. A.*, **8**, 2469.

Haber, F. Zirconium oxide replaces stannic oxide in the enamel industry. *J. Ind. Eng. Chem.*, **6**, 326 (Apr., 1914).

Kraze, F. The technic of iron enamels applied dry. *Sprechsaal*, **47**, 535–8, 545–6 (1914); *C. A.*, **9**, 957.

Linke, Wilh. The plan and management of a modern enameling factory. *Glashütte*, **44**, Nos. 14–52; and **45**, Nos. 1–36; *C. A.*, **10**, 513.

Manufacture of gray enameled ware. *Iron Age*, **94**, 10–3 (July 2, 1914).

Musiol, C. Process of enameling sheet iron and cast iron articles by means of enamels free from boric acid and composed of silicates of aluminium, soda, and lime, containing fluorine. French Patent 473,395, June 12, 1914. *J. Soc. Chem. Ind.*, **34**, 493.

Nagel, Oskar. Some American enameling ovens. *Chem.-Ztg.*, **38**, 801–2; *C. A.*, **8**, 3105.

Shaw, J. B. Fluorides as opacifiers. *Trans. Amer. Ceram. Soc.*, **16**, 577–9; *C. A.*, **8**, 3713; *J. Soc. Chem. Ind.*, **33**, 1048.

Vondracek, R. Covering power of clouding agents for enamels. *Sprechsaal*, **47**, 341–2; *C. A.*, **8**, 3493; *J. Soc. Chem. Ind.*, **33**, 647. Water and alkali containing forms of the oxides of tin, zirconium and titanium are used. The increased covering properties are probably due to the oxides being in a state of a colloidal gel.

Welte, H. Support for the galvanic production of patterns in the ceramic and enamel industries. German Patent 283,081, Jan. 17, 1914. *C. A.*, **9**, 2444.

1915

Bartlett, C. W. Electrically heated enameling ovens. *Gen. Elec. Rev.*, **18**, 1130–6; *C. A.*, **10**, 679.

Bole, G. A., and Howe, R. M. Role of chlorides in the volatilization of ferric iron (from enamels). *Trans. Amer. Ceram. Soc.*, **17**, 125–9; *J. Soc. Chem. Ind.*, **36**, 879.

Electric enameling ovens. *Am. Machinist*, **43**, 598–600; *C. A.*, **9**, 2974.

Eyer, Ph. Antimonates. Enamel and glazes. English Patent 11,083, July 30, 1915. *C. A.*, **11**, 198; *J. Soc. Chem. Ind.*, **35**, 839. The production of antimonates is described.

Kardos, E. Method of removing enamel and like coatings from waste enamel and like ware. English Patent 100,118, Mar. 2, 1915. *J. Soc. Chem. Ind.*, **35**, 470.

Kraze, F. Saltpeter replacement in the enamel industry. *Keram. Rundschau*, **23**, 5–6; *C. A.*, **9**, 3341.

New opacifier for white iron enamels. *Keram. Rundschau*, **23**, 221–2; *C. A.*, **10**, 1416. Magnesium oxide and aluminium oxide, or zinc oxide and aluminium oxide.

Poste, Emerson P. The relative action of acids on enamels. *Trans. Amer. Ceram. Soc.*, **17**, 136–49 (1915); **18**, 762–6 (1916); *C. A.*, **11**, 282; *J. Soc.*

Chem. Ind., **36**, 879. Within a rather narrow limit in sizing, reasonable uniformity can be obtained in the loss in weight of a two-gram sample of frit ground to pass 20 mesh when exposed to a given solution.

Schaefer, J. Enamel and its use in the chemical industry. *Z. angew. Chem.*, **28**, I, 419–20; *C. A.*, **10**, 260. History of the industry and a general description of enamels and enameling methods.

Schroder, E. Muffle kiln for enamels. German Patent 296,457, Oct. 31, 1915. *J. Soc. Chem. Ind.*, **36**, 596.

Schwarzbach. A hint from enamel technology. *Diamant*, **37**, 525–6; *C. A.*, **10**, 960. To secure uniform and complete fusion the addition of borax, magnesium oxide, or ammonium chloride is recommended.

Staley, H. F. Antimony compounds as opacifiers in enamels. *Trans. Amer. Ceram. Soc.*, **17**, 173–89; *J. Soc. Chem. Ind.*, **36**, 879.

Tostmann, C. Saltpeter replacement in the enamel industry. *Keram. Rundschau*, **23**, 15 (1915); *C. A.*, **9**, 3341.

Using electric ovens for enameling. *Iron Trade Rev.*, **57**, 215 (July 29, 1915).

Vogel, H. The enameling of cast iron ware. *Keram. Rundschau*, **23**, 109–10; *Z. angew. Chem.*, **28**, Ref. 411; *C. A.*, **10**, 377; *J. Soc. Chem. Ind.*, **34**, 1145.

1916

Bickmeier, C. Continuous furnace for burning enamel ware. Canadian Patent 172,606, Oct. 17, 1916.

California sanitary enameled ware plant. *Metal Work*, **86**, 273–4 (Sept. 1, 1916).

Black enamels. Schnurpfeil's *Rev. Glass Works*, **2**, 137 (1916); *C. A.*, **10**, 2133. Five formulas are given.

Conover, W. R. Electric ovens and furnaces. *Am. Machinist*, **45**, 316–7 (1916); *C. A.*, **10**, 2543.

Danielson, R. R. The effect of variation in the composition of ground coats for sheet iron enamels. *Trans. Amer. Ceram. Soc.*, **18**, 343–62 (1916); *C. A.*, **11**, 283; *J. Soc. Chem. Ind.*, **36**, 717.

Heilmann, E. White enamels. Austrian Patent 72,232, Aug. 10, 1916. *C. A.*, **11**, 880. Mixtures of zinc and aluminum oxides or of magnesium and aluminum oxides are heated to form a spinel.

How enameled kitchen ware is made. *Iron Trade Rev.*, **59**, 1091–7 (Nov. 30, 1916).

Koepp, R., and Co. Enamels. English Patent 100,777, Feb. 18, 1916. *C. A.*, **10**, 2791; *J. Soc. Chem. Ind.*, **37**, 924A. Glass with low melting point is used to replace the usual fluxes.

Koepp, R., and Co. Manufacture of enamels. English Patent 101,221, Aug. 16, 1916. *J. Soc. Chem. Ind.*, **36**, 291. Enamels are clouded or rendered opaque by the addition of zirconium borate supersaturated with zirconia.

Koepp, R., and Co. Enamels. English Patent 101,802, Feb. 18, 1916. *C. A.*, **11**, 294; *J. Soc. Chem. Ind.*, **36**, 388. The use of natural borates is facilitated by the addition of large quantities of glass.

Koepp, R., and Co. Production of enamels. English Patent 107,392, Mar. 28, 1916. *J. Soc. Chem. Ind.*, **36**, 963. The addition of cobalt, nickel, manganese, copper or other oxide to an enamel greatly increases its adhesion.

Lotterhos, G. Enamels. Swiss Patent 72,174, Apr. 17, 1916. *C. A.*, **10**, 2511. Low melting glazes containing flux are used as a substitute for the fluxes containing boron.

Lynde, Charles C. Production of stamped and enamel ware. *Steel and Iron*, **50**, 211–5 (1916).

Poste, Emerson P. Heat transmission of enamel. *Trans. Amer. Ceram. Soc.*, **18**, 570–4; *C. A.*, **11**, 284; *J. Soc. Chem. Ind.*, **36**, 718.

Zinc sulfide as an opacifying agent. *Keram. Rundschau*, **24**, 5, 29 (1916); *C. A.*, **11**, 3106. Addition of not more than 5 per cent of zinc sulfide produces opaque enamels.

1917

Continuous enameling and stoving machine for small parts. *Engineering*, **103**, 410 (1919); *C. A.*, **11**, 2146.

Electric enameling ovens at Ford Plant. *Elec. Rev. West. Elec.* **71**, 407-409 (1917); *C. A.*, **11**, 3450. Detailed account of a modern large scale enameling installation.

Kretzer, H. Clouded enamels and glasses. Swiss Patent 73,471, May 1, 1917. *C. A.*, **11**, 3406. Silicon compounds of acid character are added to the enamel mass after melting and while grinding.

Later, E. P. Protective coatings; japans and enamels. *Foundry*, **45**, 139–40 (April, 1917).

Lotterhos, G. Enamel. Danish Patent 22,409, Sept. 3, 1917. *C. A.*, **12**, 413. Borax is replaced by glass containing easily fusible fluxes.

Poste, Emerson P. Enamel surfaces under the microscope. *Trans. Amer. Ceram. Soc.*, **19**, 146–59 (1917); *C. A.*, **12**, 523; *J. Soc. Chem. Ind.*, **37**, 513A.

Schaeffer, J. The use of zinc sulfide in white and luminous enamels. *Keram. Rundschau*, **25**, 75; *C. A.*, **12**, 2677; *J. Soc. Chem. Ind.*, **37**, 584. In sheet steel enamels of suitable composition zinc sulfide is an excellent opacifier in the absence of metallic oxides which tend to decompose it. The opacity is equal to that produced by stannic oxide, but the enamels are not so white nor brilliant.

Scott, W. S. The control of industrial heating units. *Elec. J.* **14**, 252–254 (1917); *C. A.*, **11**, 2618. An illustrated description of electrical units used in ovens for japanning and enameling.

Shaw, J. B. American clays for floating enamels. *Trans. Amer. Ceram. Soc.*, **19**, 339–60 (1917); *J. Soc. Chem. Ind.*, **37**, 512.

Verein Chem. Fabrik Landau. White enameling. Swedish Patent 41,858, Jan. 10, 1917. *C. A.*, **11**, 1735. The clouding agent is an anhydrous zirconium compound, poor in alkali, which is treated with salts of metals whose hydroxides or oxides themselves produce clouding effects.

Warge, K. Enameled metal articles. English Patent 116,361, June 11, 1917. *C. A.*, **13**, 79.

1918

Cast iron enameled ware. *J. Am. Ceram. Soc.*, **1**, 74–5 (1918); *C. A.*, **12**, 2117. Editorial.

Dreissen, Cl. G. Enamels and ceramic pigments. *Pol. Weekblad*, **1918**, Nos. 5, 6, 8; *Chem. Weekblad*, **16**, 865–6; *C. A.*, **13**, 2115. Review.

Frost, Leon J. The action of acetic acid solutions of different strengths on a sheet steel enamel. *J. Am. Ceram. Soc.*, **1**, 422–8 (1918); *C. A.*, **13**, 175; *J. Soc. Chem. Ind.*, **38**, 107A. Twenty to 25 per cent acid is the most corrosive.

Kreutzberg, E. C. How high grade enameling is done. *Iron Trade Rev.*, **63**, 1290–1 (Dec. 5, 1918).

Poste, Emerson P. The manufacture of enameled lined apparatus. *Chem. Met. Eng.*, **19**, 400 (Sept. 25, 1918); *C. A.*, **12**, 2676. Descriptive article of the general manufacturing operations.

Poste, Emerson P, and Rice, B. A. The effect of the degree of smelting on the properties of a frit. *J. Am. Ceram. Soc.*, **1**, 221–37 (1918); *J. Soc. Chem. Ind.*, **38**, 15A.

Shaw, J. B. Antimony oxide as an opacifier in cast-iron enamel. *J. Am. Ceram. Soc.*, **1**, 502–13 (1918); *C. A.*, **13**, 253; *J. Soc. Chem. Ind.*, **38**, 107A.

Staley, Homer F. The control of luster in enamels. *J. Am. Ceram. Soc.*, **1**, 640–7 (1918); *C. A.*, **13**, 775; *J. Soc. Chem. Ind.*, **38**, 140A.

Staley, Homer F. Enamels for cast iron. *J. Am. Ceram. Soc.*, **1**, 703–9 (1918); *C. A.*, **13**, 1000; *J. Soc. Chem. Ind.*, **38**, 176A.

Staley, Homer F. Ground coat enamels for cast iron. *J. Am. Ceram. Soc.*, **1**, 99–112 (1918); *C. A.*, **12**, 2117; *J. Soc. Chem. Ind.*, **38**, 15A.

Staley, Homer F. Preparation and application of enamels for cast iron *J. Am. Ceram. Soc.*, **1**, 534–55 (1918); *C. A.*, **13**, 253.

1919

Collins, W. D. Acid test on enamel ware. *J. Ind. Eng. Chem.*, **11**, 757–9 (1919); *J. Am. Ceram. Soc.*, **2**, 843; *J. Soc. Chem. Ind.*, **38**, 903A.

Danielson, R. R. Cleaning of sheet steel and iron for enameling purposes. *J. Am. Ceram. Soc.*, **2**, 883–94 (1919); *C. A.*, **14**, 1201.

Dupont, P. Enameling metal articles and furnace therefore. English Patent 114,618. *J. Soc. Chem. Ind.*, **37**, 700A.

Poste, E. P. The manufacture of enameled lined apparatus. *J. Am. Ceram. Soc.*, **2**, 944–76 (1919); *C. A.*, **14**, 1744.

Poste, E. P. Relative action of acids on enamels. II. *J. Am. Ceram. Soc.*, **2**, 32–43 (1919); *C. A.*, **13**, 1136; *J. Soc. Chem. Ind.*, **38**, 287A. Twenty per cent acid has the maximum effect. Citric and tartaric acids are more active than acetic acid.

Schorry, V. S. Magnesia as an opacifier (of enamels). *J. Am. Ceram. Soc.*, **2**, 447–80 (1919); *J. Soc. Chem. Ind.*, **38**, 635A.

Springer, L. What precautions should be taken in replacing soda or potash (in glasses and enamels). *Sprechsaal* **52,** 362–3 (1919); *C. A.*, **14,** 809; *J. Soc. Chem. Ind.*, **38,** 902A.

Treischel, Chester. The cause and control of blistering in sheet-steel enamels. *J. Am. Ceram. Soc.*, **2,** 774–81 (1919); *C. A.*, **14,** 107. Experiments show that hydrogen has much to do with this.

Vielhaber, L. Fuel consumption of muffle kilns in the enameling industry. *Keram. Rundschau*, **27,** 293–4 (1919); *C. A.*, **14,** 811; *J. Am. Ceram. Soc.*, **3,** 83–5 (1920); *J. Soc. Chem. Ind.*, **38,** 862A.

1920

Landrum, Robert D., and Frost, Leon J. Titanium enamels. *J. Am. Ceram. Soc.*, **3,** 316–21 (1920); *C. A.*, **14,** 2688. The good qualities resulting from the use of titanium seem to more than offset the bad ones and it seems possible to overcome some of the difficulties and develop enamels of very substantial practical value.

Lindemann, W. C. The electric cleaning of metals for enameling purposes. *J. Am. Ceram. Soc.*, **3,** 252–5 (1920). The electric cleaning process is superior to the older scaling or burning off method.

Metallic coating for the rust proofing of iron and steel. Bureau of Standards, *Circ. No.* **80**; *J. Am. Ceram. Soc.*, **2,** 844.

Shaw, J. B. Fish scaling. *J. Am. Ceram. Soc.*, **3,** 489–97 (1920); *C. A.*, **14,** 2689. Chemical composition has very little bearing on the subject of fish scaling. It is probably due to a number of contributory causes, which are discussed.

UNITED STATES PATENTS RELATING TO ENAMELS WITH SPECIAL REFERENCE TO ENAMELS FOR IRON AND STEEL

The following pages contain a list of the United States patents relative to enamels, with special reference to those for iron and steel for the period 1900–1920. These are arranged chronologically. Wherever possible reference is given to Chemical Abstracts, where a more complete abstract of the patent may usually be found. Reference is also made (the figures in parentheses), to the Official Gazette of the U. S. Patent Office, where the more important, if not all, the claims of the patents are printed. Printed copies of patents are furnished at 10 cents each by the Commissioner of Patents, Washington, D. C.

640,844. Charles H. Watermann. Process of enameling. Jan. 9, 1900. (**90**, 279).

645,393. Edward C. Hoelscher and John Clifford. Enameling table or machine. Mar. 13, 1900. (**90**, 2076).

645,517. Christian A. Sievert. Enameling table. Mar. 13, 1900. (**90**, 2121).

658,833. Edward Dithridge. Enameling table for bath tubs. Oct. 2, 1900. (**93**, 45).

663,601. William C. Degelman. Apparatus for enameling bath tubs. Dec. 11, 1900. (**93**, 1911).

663,618. Wilbur Topping. Composition for enameling metal ware. Dec. 11, 1900. (**93**, 1996).

The formula used was: 61 parts borax, 71 parts feldspar, 44 parts quartz, 15 parts fluorspar, 14 parts soda, 11 parts saltpeter and water.

664,321. Josiah Hughes and James F. McGowan. Ornamental enamel ware. Dec. 18, 1900. (**93**, 2285).

Variegated enamel ware, the surface of which comprises a body having incorporated and fused therein an enameling material of different color.

669,567. Charles H. Watermann. Apparatus for enameling surfaces of refractory material. Mar. 12, 1901. (**94**, 1999).

674,506. Joseph H. Hines. Process of enameling metal surfaces. May 21, 1901. (**95**, 1509).

679,300. William A. Dunpal. Enameling metal. July 30, 1901. (96, 854).

A thin finish coat is applied to a burned ground coat and while this is still wet, a second thin coat of a contrasting color is applied.

684,979. Edward Dithridge. Manufacture of enamels (apparatus). Oct. 22, 1901. (97, 638).

691,268. William Jankowsky. Enameling metal ware. Jan. 14, 1902. (98, 365).

Iron or steel is coated with a suitable primary coating (alkali carbonate) and an enamel coat containing a suitable percentage of primary or acid salt capable of decomposing the film.

700,021. Edward Dithridge. Enameling fork for bath tubs. May 13, 1902. (99, 1542).

707,490. Carl H. Zwerman. Enamel sifting apparatus. Aug. 19, 1902. (100, 1732).

708,363. George W. Ketcham. Art of enameling metal ware. Sept. 2, 1902. (100, 2115).

The cleaned article is coated with a thin layer of cohesive and non-corrosive metal and an enamel then applied which, upon heating, will coact with and only partially oxidize and permeate the coating metal.

709,530. Daniel Wieser. Manufacturer of enameled metal plates. Sept. 23, 1902. (100, 2460).

The plates are coated with a mixture of zinc white and oil varnish, dried, then coated with a greasy lacquer color, dried and rubbed.

710,443. Paul Dupont. Machine for mechanically enameling baths or other metal objects. Oct. 7, 1902. (101, 19).

716,106. Rudolf Rickmann. Manufacture of white or light-colored enamels. Dec. 16, 1902. (101, 2460).

Sodium antimoniate is fused with the enamel.

721,155. Hubert Claus. Enamel machine. Feb. 24, 1905. (102, 1565).

733,831. Samuel H. Frisk. Work holder for enameling. July 14, 1903. (105, 446).

758,325. Thomas M. Sunan. Manufacture of enameled ware. Apr. 26, 1904. (109, 2307).

The cleaned article is coated with an enamel carrying metallic bodies, a non-metallic hydroxide added and heated to flux and set the enamel.

759,351. Edward L. Dawes. Enameling device. May 10, 1904. (110, 380).

762,547. Henry C. Milligan. Process of enameling steel ware. June 14, 1904. (110, 1860).

Steel is pickled, washed, dried, immersed in an acid solution and coated while wet with alkaline liquid enamel, dried and fused.

771,507. Thomas L. Strong. Apparatus for drying enameled ware. Oct. 4, 1904. (112, 1080).

774,478. John S. Jobe. Enameling kiln. Nov. 8, 1904. (113, 420).

774,491. Charles F. Pfalzgraf. Enameling metal. Nov. 8, 1904. (113, 425).

779,655. Julius F. Kenkel. Manufacture of enamel ware. Jan. 10, 1905. (114, 388).

The plate is coated with a preparation of enamel, burned, the plate then slushed in an enamel preparation and the enamel evenly distributed by a blast of air.

793,659. Otto L. Heintz. Enameled ornament. July 4, 1905. (117, 14).

804,010. Julius F. Kenkel. Enameling. Nov. 7, 1905. (119, 203).

An iron or steel article which has a fundamental coat composed of clay and an oxidizing agent and a separately applied glaze coat covering the fundamental coat and forming therewith a mottled finish.

806,153. Walter J. Kohler. Process of making speckled enameled ware and the product thereof. Dec. 5, 1905. (119, 1293).

The process consists of mixing a comparatively small amount of comminuted carborundum with dry pulverized enameling material of one color (different from the carborundum), putting the mixture on the article to be coated with enamel, and then subjecting the article to such heat as fuses the enameling material but less than sufficient to fuse the carborundum.

808,542. Joseph H. Hines. Process of enameling. Dec. 26, 1905. *J. Soc. Chem. Ind.* **25**, 1220 (119, 2458).

After cleaning the metal is coated with an alkaline material, the enamel is then applied, a coloring coat applied and burned, and a second coat of enamel applied and burned.

808,744. Otto L. Heintz. Enameled ornament. Jan. 2, 1906. (120, 57).

826,628. Samuel H. Thurston. Process of enameling metal and the resulting product. July 24, 1906. (123, 1061).

The process consists in first forcibly beating one metal into and upon the other systematically and continuously until the particles or molecules of the coating metal are driven into the metal being coated and incorporated with the particles at and beneath the surface of the same.

843,985. Wm. Atkinson and Joseph Smith. Enameling metals. Feb. 12, 1907. *C. A.*, 1, 919. (126, 2390).

Also English patent 12,554. May 30, 1906. *C. A.*, 1, 938.

A flux of white opal cullett 130, sodium bicarbonate 20, and boric acid 12 parts is ground in water to a fine powder, applied to the article and burned.

862,285. Charles R. Schmidt. Method of enameling. Aug. 6, 1907. *J. Soc. Chem. Ind.* **26**, 1009, (129, 2175).

The article to be enameled is heated in a rotating enameling chamber or furnace containing dry enamel material.

866,821. Arthur R. Speer. Method of enameling the interior of sheet metal vessels. Sept. 24, 1907. (130, 1092).

868,078. William A. Dunlap. Enameled ware. Oct. 15, 1907. (130, 1772).

869,155. Grace M. Banning. Metal enameling. Oct. 22, 1907. (130, 2321).

906,628. Everett D. Holley. Enamel ware. Dec. 15, 1908. (137, 1528).

932,839. Rudolph Weimer. Substitute for tin oxide for enameling metal ware. Aug. 31, 1909. *C. A.*, 3, 2554. (145, 1165).

The boiled, roasted and ground product of Sb oxide 70, NaOH 28, $NaNO_3$ 22, kaolin 10 and barytes 10.

971,641. George L. Rice and Benjamin W. Gilchrist. Enameling metallic articles. Oct. 4, 1909. *C. A.*, 5, 31. (159, 49).

A coating containing a magnetic material and sulfur is deposited upon the article electrolytically and the enamel is applied to this.

994,162. Edgar L. Hull. Producing flat watch dials, enameled on one side. June 6, 1910. *C. A.*, 5, 2540. (167, 22).

Both sides are enameled and the enamel then removed from one side by the action of HF.

995,724. C. Rosenzweig. White enamel for glazed goods. June 20, 1910. *C. A.*, 5, 2711. (167, 625).

A glazing mass and a silicate of Zr, Th, Gl, La, or Yt.

996,226. Charles W. Ebeling. Enameling table. June 27, 1911. (167, 832).

1,001,511. J. H. Danver. Making mottled or colored enamels. Aug. 22, 1911. *C. A.*, 5, 3898. (169, 890).

1,017,360. D. A. York and J. A. Tinker. Enameling steel, etc. Feb. 13, 1912. *C. A.*, 6, 920. (175, 424).

1,024,405. K. Kreidl. Making a filler for white enamel. Apr. 23, 1912. *C. A.*, 6, 1666. (177, 987).

Zirconium silicate and sodium hydroxide.

1,033,821. George R. Meyercord. Process of decorating enameled metal. July 30, 1912. (180, 1162).

1,055,678. G. Spitz. Removing the enamel from scrap enameled metal. Mar. 11, 1913. *C. A.*, 7, 1593. (188, 379).

1,065,401. G. Spitz. Removing the enamel from enameled goods. June 24, 1913. *C. A.*, 7, 2845. (191, 862).

1,072,047. Walter L. Shepard. Process of making enameled articles. (194, 129).

1,091,492. H. G. Essayan. Enamel for metals. Mar. 31, 1914. *C. A.*, 8, 1861. (200, 1130).

Heating a mixture of 2 per cent silver, 8 per cent copper and 8 per cent lead, melted together with 82 per cent sulfur and powdering the product.

1,101,455. I. Kreidl. Composition for rendering white enamels opaque. June 23, 1914. *C. A.*, 8, 2932. (203, 1194).

Hydrated alkali zirconate, stannate, or titanate, combined with silica.

1,104,107. T. R. Davidson. Pickling metal to prepare it for enameling. July 1, 1914. *C. A.* 8, 3102. (204, 742). Also German patent 277,834. July 22, 1913.

Immersed in conc. sulfuric acid at 90–150 degrees, then washed with water at 65 and then at 100 degrees.

1,104,266. M. Mayer and B. Havas. White opaque enamel. July 21, 1914. *C. A.*, **8**, 3106. (**204**, 896).

Contains spinel and preferably small amounts of zirconium, titanium stannic or silicon oxide as opaquing material.

1,104,679. I. Kreidl. Opaque enamel. July 21, 1914. *C. A.*, **8**, 3106. (**204**, 940).

Contains colloidal zirconium oxide.

Reissue 13,791. I. Kreidl. Making an opaque material for white enamels. Aug. 25, 1914. *C. A.*, **8**, 3494. (**205**, 1291).

Natural zirconium silicate is heated with 4 times its weight of sodium hydroxide to 500–600 degrees, washed, dried, and heated to a glowing temperature.

1,117,197. I. Kreidl. White enamel. Nov. 17, 1914. *C. A.*, **9**, 136. (**208**, 682).

The opaquing material is formed of zirconium oxide combined with silica and about 3–4 per cent of alkali metal.

1,118,898. P. Eyer. Enamel glazing. Nov. 24, 1914. *C. A.*, **9**, 136 (**208**, 1314).

1,119,905. C. A. W. Vollrath. Enamel for coating machine. Dec. 8, 1914. *C. A.*, **9**, 239. (**209**, 381).

Finely comminuted colored glass in addition to the ordinary enamel to form a speckled coating.

1,123,760. I. Kreidl. Making a material for opaquing white enamel. Jan. 5, 1915. *C. A.*, **9**, 701. (**210**, 193).

1,124,380. O. Zahn. Muffle furnace for enameling. Jan. 12, 1915. *C. A.*, **9**, 701. (**210**, 454).

1,126,621. A. de Back. Recovering iron and steel from waste enameled articles. Jan. 26, 1915. *C. A.*, **9**, 592. (**210**, 1327).

1,128,691. I. Kreidl. Opaquing materials for enamels, glass, etc. Feb. 16, 1915. *C. A.*, **9**, 1103. (**211**, 797).

Hydrates zinc oxide containing 2–7 per cent combined alkali and a few per cent of water, varying inversely as the amount of alkali.

1,129,300. I. Kreidl. White enamel. Feb. 23, 1915. *C. A.*, **9**, 1103. (**211**, 1047).

The opaquing agent consists of zirconium oxide combined with a small amount of alkali.

1,140,105. Charles Bickmeier and Daniel A. Liston. Continuous-burning furnace for burning enamel ware. May 18, 1915. *J. Soc. Chem. Ind.* **34**, 717. (**214**, 914).

1,150,467. J. Weber. Opaquing composition for use in vitreous enamels. Aug. 17, 1915. *C. A.*, **9**, 2701. (**217**, 871).

Hydrates stannic oxide containing about 10 per cent water and 3–5 per cent of alkali.

1,150,772. I. Kreidl. Opaquing material for white enamels. Aug. 17, 1915. *C. A.*, 9, 2701. (217, 976).

Alkaline compound of zirconium formed by treating with acid and washing to remove part of the combined alkali.

1,153,748. C. Baezner. Opaque enamel or glazing composition for use on sheet iron, etc. Sept. 14, 1915. *C. A.*, 9, 3343. (218, 528).

1,178,469. H. G. Higley. Enameling iron. Apr. 4, 1916. *C. A.*, 10, 1587. (225, 320).

The iron is immersed in a bath prepared from dilute sulfuric acid, ferric oxide and an enamel composition.

1,181,944. J. Weber. Coloring enamels. May 2, 1916. *C. A.*, 10, 1701. (226, 286).

Neutralized anhydrous calcium stannate is used as an opaque coloring.

1,196,342. Alfred de Back. Method of recovering iron, steel, and the like from waste enameled articles. Aug. 29, 1916. (229, 1393).

1,196,243. Alfred de Back. Apparatus for disintegrating metal articles. Aug. 29, 1916. *J. Soc. Chem. Ind*, 35, 1012. (229, 1393).

1,197,618. Arthur W. Forbes. Enameling apparatus. Sept. 12, 1916. (230, 352).

1,203,409. R. Rickmann. White opaque enamels. Oct. 31, 1916. *C. A.*, 11, 93. (231, 1446).

Small proportion of potassium antimoniate is added.

1,205,845. H. A. Biggar. Enameling composition for use on metals. Nov. 21, 1916. *C. A.* 11, 198. (232, 869).

A mixture of various asphalts, rosin, Portland cement, etc., is used.

1,220,253. M. Meyer and B. Havas. Opaque white enamels. Mar. 27, 1917. *C. A.*, 11, 1735. (236, 937).

A mixture of titanium oxide and zirconium oxide is used for opaquing white enamels.

1,230,958. K. Warga. Coating aluminium with vitreous enamel. June 26, 1917. *C. A.*, 11, 2323. (239, 989).

1,239,112. H. Kretzer and A. Cappel. Opaque enamels. Sept. 4, 1917. *C. A.*, 11, 3407. (242, 126).

The opacifying agent, *e. g.*, a compound of Zr, Ti, Si, Al, Zn, or alkaline earth metal, is added to the other ingredients of the enamel after they have been at least partially ground in a wet mill, together with substances which precipitate colloids, such as ammonium chloride, magnesium sulfate, or chloride, or sodium sulfate.

1,249,937. P. Eyer. Ground enamel. Dec. 11, 1917. *C. A.*, 12, 414. (245, 469).

Ore containing cobaltic oxide, freed from sulfur and arsenic, is used to color the enamel.

1,256,455, 1,256,456. P. Eyer. Enamel for iron. Feb. 12, 1918. *C. A.*, 12, 986. (247, 433).

White enamel for glass consisting of ruby glass, clay, cryolite and sodium carbonate.

1,268,778. John F. Dodge and Harry C. Allen. Enameling apparatus. June 4, 1918. (**251**, 200).

1,272,917. R. D. Cooke. Removing enamel from metal surfaces. July 16, 1918. *C. A.*, **12**, 1917. (**252**, 670).

Treated first with HCl (10 per cent) at 70 degrees and then with 25 per cent NaOH at 70 degrees.

1,273,632. William Lindsay. Enameling powder distributer. July 23, 1918. (**252**, 887).

1,281,762. Frank J. Carpenter. Enameling apparatus. Oct. 15, 1918. (**255**, 508).

A plurality of contracting members for engaging the rims of articles to be enameled attached to a rotating shaft.

1,285,862. Stefan Wiester. Enamel oven. Nov. 26, 1918. (**259** 729).

1,290,060. Albert J. Boland. Enameling furnace. Jan. 7, 1919., (**258**, 11).

1,290,580. W. J. Kohler. Marking enameled ware. Jan. 7, 1919. *C. A.*, **13**, 780. (**258**, 136).

1,311,487. G. H. Benjamin. Enameling kiln. July 29, 1919. *J. Am. Ceram. Soc.*, **2**, 852. (**264**, 772).

1,313,834. I. Rennerfelt. Electric furnace. Aug. 19, 1919. *C. A.*, 13 2642. (**265**, 424).

The furnace is adapted to melting enamels in crucibles.

1,314,831. F. Preusser. Opaque enamels. Sept. 2, 1919. *C. A.*, **13**, 2478; *J. Am. Ceram. Soc.*, **2**, 927. (**266**, 71).

Relatively low content of the usual opacifying agents, such as tin or zinc oxide is used by suitable mixing with other auxiliary ingredients.

1,314,861. P. Eyer. Clouding composition for enamels. Sept. 2, 1919. *C. A.*, **13**, 2748; *J. Am. Ceram. Soc.*, **2**, 927. (**266**, 71).

Zirconium borate supersaturated with zinc oxide is used as a clouding material in enamels.

1,316,018. R. D. Cooke. Enameling sheet metal ware. Sept. 16, 1919. *C. A.*, **13**, 2986. (**266**, 306).

Sheet steel is coated with oil and subjected to a drawing operation, the ware then is heated to remove the oil which produces a thin oxide coating on the metal, the enamel is then applied and baked.

1,332,058. C. Musiol. Enamel for metals. Feb. 24, 1920. *C. A.*, **14**, 1204; *J. Am. Ceram. Soc.*, **3**, 513. (**271**, 629).

Triple silicate of Al, Na, and Ca mixed with fluorides and coloring substances.

1,335,279. Paul Dupont. Enameling and annealing furnace. Mar. 30, 1920. (**272**, 804).