PLANT REQUIREMENTS FOR MANUFACTURE OF PORCELAIN ENAMELWARE

TECHNICAL AIDS BRANCH
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FOREWORD

This brochure is one of a series of reports resulting from overseas technical inquiries on factory or commercial establishments, operation, management, and engineering. The report is designed to provide only a general picture of the factors that must be considered in establishing and operating a factory of this type. In most cases, plans for actual installations will require expert engineering and financial advice in order to meet specific local conditions.

Mention of the name of any firm, product, or process in this report is not to be considered a recommendation or an endorsement by the International Cooperation Administration, but merely a citation that is typical in its field.

Industrial reports prepared for ICA under special contract are customarily reviewed and edited before publication. This report, however, like other technical inquiry replies, has not been reviewed; it is the sole responsibility of the firm that prepared the report.

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For further information and assistance, contact should be made with the local Productivity Center, Industrial Institute, Servicio, or United States Operations Mission.

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PORCELAIN ENAMELWARE

Porcelain enamel is a hard, durable, glass-like coating on a metal base, produced by fusing a carefully compounded mixture of mineral substances to special grades of metal at temperatures around 1800°F (800°C). Both the fabrication of the metal parts and the application of the porcelain enamel thereto require highly specialised equipment and operating skills.

One of the many applications of this type of coating is in the manufacture of pots, pans, pails, kettles, and similar utensils commonly used in and around the home for cooking and cleaning purposes. These are made in a variety of sizes and shapes to meet the individual requirements of the many useful purposes for which they are used. This report will deal with the production of about thirty different commonly used kitchenware utensils, ranging in size from two to thirty inches in diameter, and in the over-all quantity of two to three million pieces per year.

According to currently available information, a plant of this type and size will cost at least three-quarters of a million dollars (US equivalent) if equipped according to US manufacturing standards. However, if the operations are less highly mechanised, and if they start with pre-shaped metal parts (instead of with sheet steel), the initial investment will be reduced by about two-thirds.

I - MANUFACTURING OPERATIONS

Three basic manufacturing operations are involved in the production of porcelain enamel kitchenware items. These are: (a) the fabrication of the metal parts from sheet metal and their subsequent preparation for enameling; (b) the preparation of the enameling compounds; and (c) the application of the enamel to the metal. Each of these may be divided into the several process steps as developed in the following paragraphs, and as illustrated in the schematic diagram (figure 1) at the end of this report.

1. Fabrication of Metal Parts

Sheet metal used as a base material for enamelware items must have certain special qualifications, many of which have been developed as the result of intensive research on the part of the enamel and steel industries. Several grades of enameling stock are available under recognised trade or brand names relating to the specific services to be rendered by

the part to be fabricated therefrom. In general, the following qualities are essential to successful enameling:

(a) Very low carbon content.
(b) Freedom from harmful gaseous or solid impurities.
(c) Resistance to sagging or warping at furnace temperatures.
(d) Good welding qualities.
(e) Good drawing and/or working qualities.
(f) Good surface texture.
(g) Uniformity of composition.

In addition to the quality of steel, the thickness of metal is also an important factor in the fabrication of porcelain enamelware. In general, if the metal is too thin, the part which is fabricated therefrom may not be sufficiently rigid to support the enamel coating, and the finished item will tend to chip or crack in handling or usage. On the other hand, if the metal is too thick, it will be more difficult to form the desired shapes, and the resulting production (and shipping) costs will become excessive. Small, inexpensive kitchenware items may be fabricated from as light as thirty-one gauge metal, but it is usually customary to start with thirty gauge material, and to work downwards to about twenty-two gauge as the size of the utensil increases. Table 1 shows the relationship between the numerical gauge values, the thickness of metal, and the weight of metal per square foot of sheet.

The first step in the fabrication of the metal part is to cut, or stamp, the flat blank from which the piece is to be shaped. This is usually in the form of a circle of appropriate diameter. In the cutting of this from the rectangular (or square) sheet of metal, there is an almost inescapable loss or scrap factor of twenty-two percent, based on the weight of sheet metal. Economic disposal of this scrap can be an important item in the over-all manufacturing costs, particularly if, as in the case at hand, the sheet steel is imported specifically for conversion into porcelain enamelware utensils.

The blank piece, or circle, is then subjected to a series of drawing or spinning operations as required to shape the item into the desired form. This involves expensive dies and metal working machinery, the cost of which is better than fifty percent of the over-all plant investment. Also, special skills are required to produce items which will be satisfactory for subsequent enameling. For example, excessive or improper working will set up strains within the metal which will cause subsequent enameling defects, and although these strains can be largely relieved by annealing, excessive or improper annealing can also cause enameling defects. Similarly, improper selection and/or use of drawing compound can impart surface impurities to the metal, which, if not carefully and completely removed prior to enameling, can also cause defects in the finished goods.

Many of the porcelain enamel plants in the US (and possibly in other

countries) have excess production capacity with respect to the fabrication of these metal parts (or "black shapes" as they are otherwise known), and would, we are advised, welcome a non-competitive outlet for these. It is believed that the cost of such would compare favorably with the cost of producing them from imported sheet steel. Potential sources of supply in the US for "black shapes" can be obtained from the Porcelain Enamel Institute, 1145 - 19th Street, N.W., Washington, D. C.

2. Preparation of Metal Parts for Enameling

After the "black shapes" have been formed, fabrication is completed by forming a rim around the outside edges, and by welding on the appropriate handles, ears, and other appurtenances commonly found on the finished items. This operation is not complicated, nor does it require expensive machinery or highly specialized skills. Furthermore, shipment of the "black shapes" from the source of supply to the porcelain enamel manufacturer will be greatly simplified if the articles are not rimmed or finished with handles, ears, and other appurtenances, and the import tariff should be materially lower than for the more highly fabricated pieces. Consequently, it is recommended that manufacturing operations start with the unrimmed "black shapes" which would be stored in "nests", pending subsequent fabrication.

Perhaps the most critical step in the preparation of the metal parts for enameling is the cleaning and pickling operation. All dirt, grease, oxide scale, and other extraneous matter must be completely removed from the surfaces which are to be enameled, and the cleaned parts must be dried and stored under conditions which prevent subsequent oxidation and rusting. This is accomplished by a series of closely related operations, the first of which is usually complete immersion in a hot aqueous solution of detergent and alkali to loosen dirt and grease which is then rinsed off with hot (180°-200°F) water. Oxide scale is next removed by immersion in hot, dilute acid (6-8% H_2SO_4 at 140°-150°F), followed by a second hot water rinse, and the cleaned (pickled) surface is then given a thin protective coating of nickel by immersion in a carefully regulated solution of nickel salts (2-6 ounces per gallon; pH 5.8-6.2; temperature 160°-180°F) for three to ten minutes. The parts are then given a final rinse with hot water (to remove nickel residues), immersed in a hot alkaline solution to remove the last traces of acid residues, and allowed to drain dry in a current of hot (235°-250°F) air.

The metal parts thus prepared and cleaned are carefully inspected for flaws or defects in fabrication and for evidence of improper cleaning or pickling, and are stored (usually for short periods of time) under conditions not favorable to rusting (oxidation) of metal surfaces (no acid fumes, low humidity).

3. Preparation of Enameling Compounds

The basic enameling material, known as "frit", is prepared by pouring a

molten mixture of mineral substances such as cryolite, feldspar, quartz, silica, borax, tin and zirconium oxides into water to shatter the glass-like product into small particles. The compounding of the frit must be done under carefully controlled conditions, and the manufacturer of porcelain enamelware usually finds it advantageous to purchase this material from commercial sources of supply, some of whom are listed in Section III.

The frit must, however, be modified by further compounding prior to application to the metal. This compounding is always done by the manufacturer of the enamelware, and the modifying materials are known as "mill additions". These consist of substances such as water, clays, opacifiers, colors, gums, and electrolytes, which, exclusive of the water, average about 1% of the weight of the frit used. Compounding is done in a ball mill, and under conditions to produce the desired particle size and consistency of slurry, as required by the specific application. Enamels which are to be applied by dipping are not ball milled to as fine a particle size as those which are to be applied by spraying, and some enamels (or "slips" as they are commonly known) are ground to heavier consistencies than others.

The ground enamel slip, when milled to the proper characteristics, is aged for 24-48 hours to dissipate heat and air, and is then adjusted to the proper specific gravity and viscosity for application. Further adjustments may be made as required during the application of the slip to the metal.

4. Application of Enameling Compound to the Black Shapes

Kitchenware items require a minimum of two coats of enamel, the ground coat and the cover coat. The ground coat, which differs slightly in composition from the cover coat, and which is much darker in color, is applied directly to the cleaned, pickled and dried metal surface, and is usually fired at a higher temperature than the cover coat. Usually, one ground coat will suffice to produce the desired effect, but it may be necessary to apply more than one cover coat to completely mask the darker color of the ground coat, and to produce the desired surface texture on the finished item.

The most commonly used procedure for applying both ground and cover coats is to dip the metal parts into a tank or vat containing the enamel slip, which is regulated to such a consistency that excess material will drain from the part by gravity. A modification of this is to use a heavier consistency slip, and to mechanically shake off the excess material. This latter is called "slushing". It is usually customary to work for a dry coat of 0.003 inches thickness, which is equivalent to a weight increase (after firing) of 18-20 grams per square foot of surface. In cases where the cover coat is to differ in color on the inside and outside of the finished piece, or where certain decorative effects are to be obtained, the cover coat may be applied by spraying.

Each coat of enamel must be dried and fired before another coat can be applied. Drying should be done as soon as possible after excess slip has been removed by draining (or shaking), and at a uniform rate over inside and outside surfaces. Usually this is accomplished by suspending or supporting the pieces in a current of circulating hot (300°F) air which has been filtered to remove dust, dirt, and other extraneous matter which might tend to adhere to the sticky enamel surfaces. The rate of drying must be carefully controlled, particularly at the start of operations, since too rapid drying at the surface will frequently cause the enamel to tear or curl.

When the coated ware is thoroughly dry, irregularities (in enamel coating) are removed by brushing. In some instances, the outer edges of the ware are, at this point, rimmed with a black colored enamel which, if applied, must also be dried before the firing operation. The dried ware is then loaded onto specially designed racks of heat resistant steel which provide maximum support (to prevent warpage at firing temperatures) with a minimum of contact with enameled surfaces, and fired to fuse the enamel to the metal (in the case of the ground coat), or to previously fired coats (in the case of the cover coat). The firing temperature of the ground coat is usually higher (1500°-1600°F) than that for the cover coat (1450°-1560°F), but there are ground and cover coat formulations available which can be fired at the same temperature, and for approximately the same length of time.

In general, the firing operation must be carefully controlled with respect to temperature and time, and the furnace atmosphere must be of an oxidizing nature and free from contaminating gases such as sulfur fumes, carbon dioxide and water. The manufacturer of enamel frit will usually recommend the firing cycle most favorable to his particular product, but minor variations therefrom are to be expected in the individual operations, and these must be worked out by the enameler on the basis of conditions which are peculiar to the heat capacity of the furnace, the type of enamel used, the gauge of metal in the "black shapes", weight of firing charge, and other comparable factors.

Ground coat enamels undergo a definite color change during firing, and the experienced enameler will often use this as a guide in controlling the firing cycle. Similarly, cover coats develop both gloss and opacity during firing, and the resulting change in appearance also has a direct relationship to correctness of firing conditions. However, these visual control measures are only approximate at best, and should be used as supplements to, rather than substitutes for, adequate instrumentation and laboratory control.

When the firing cycle is complete, the ware is removed from the furnace, allowed to cool in the racks, and then inspected for enameling defects. Minor flaws may be repaired by a "touch-up" procedure, followed by a refiring, but major defects usually require a complete stripping of previously applied enamel and reworking of the piece. Ware which meets quality

control standards is made ready for further enameling or finished product storage, whichever the case may be.

II - PLANT REQUIREMENTS

In setting up the plant requirements for the operations described above, it has been assumed that production will be limited to standard utensils ranging downwards in size from about thirty inches in diameter, and in total quantity of two to three million pieces per year. It has further been assumed that the production cycle will start with "black shapes" which have been preformed at the source of supply, and have been imported as semi-fabricated merchandise.

Most of the equipment required for the above process is standard throughout the industry, and can be obtained, either new or secondhand, from established sources in the US and in other countries. Some of these sources (in the US) are suggested in Section III, but a more complete listing may be obtained from the Porcelain Enamel Institute or from the Enameled Utensil Manufacturers Council, Keith Building, Cleveland 15, Ohio.

The most costly single piece of equipment, and the most critical, is the enameling furnace. This may be either a batch-type unit costing about $50,000, or a continuous furnace which will cost in the neighborhood of $125,000. The latter requires less direct labor for its operation, and has certain other advantages which, in spite of the higher initial cost, have favored its almost universal adoption by US industry, even for production schedules substantially less than those being considered here. However, the box, or batch-type, furnace is much less dependent upon skilled labor for its successful operation and maintenance, and is recommended for areas where mechanization has not yet been developed to the level commonly found in US industrial centers.

Many furnaces in this country are electrically heated, but gas and oil fired muffle furnaces are also commonly used. The actual choice will depend largely upon local conditions relating to industrial heating (firing) costs and, to a lesser extent, upon personal preferences of the enameler. Design details can be varied to meet the individual requirements, and it is recommended that prior to making an actual selection of the furnace, or the method of heating, the services of a competent enameling engineer be engaged to establish the type of furnace best suited to operate under local conditions relating to cost and caliber of labor, fuel costs, and other factors.

The following tabulation lists the major pieces of equipment which will be required to manufacture porcelain enamel kitchen utensils from the imported "black shapes". Approximate sizes and floor space requirements are indicated wherever appropriate, and an estimate has been made as to their respective costs. This latter, however, is more an indication of the order of magnitude than of actual cost, and should be checked against current prices after the plant specifications have been more firmly established.

Black Shape Processing and Storage (3,000 square feet)

4 - 10 KVA spot welders	$ 2,000	
1 - double seamer (folder)	1,000	
10 - hand trucks	1,300	
workbenches, storage racks, and other miscellaneous items	1,000	$ 5,300

Cleaning and Pickling (1,500 square feet)

8 - 7 feet x 4 feet x 4 feet steel tanks with steam coils, for cleaning, rinsing, and drying ware	5,000	
3 - 7 feet x 4 feet x 4 feet acid-proof tanks with steam (lead) coils, for pickling, acid rinse, and nickel flash	3,000	
1 - 1,000 pound capacity pickle room hoist and monorail	1,000	
5 - 72 inches x 40 inches monel pickle baskets	3,000	
1 - 125 horsepower boiler (4 feet x 4 feet foundation)	30,000	
pumps, motors, blowers, and accessories	5,000	47,000

Mill Room (1,300 square feet)

1 - 3,000 pound capacity ball mill (with driving gears)	9,000	
1 - 4,000 pound capacity ball mill (with driving gears)	10,000	
1 - 300 pound capacity ball mill (with driving gears)	3,000	
1 - 1,000 pound capacity mill room hoist and monorail	2,000	
1 - 2,000 pound capacity scale	500	
4 - weighing hoppers	500	
1 - dial water meter	100	
miscellaneous accessories	1,000	26,100

Beading and Dipping (2,000 square feet)

4 - drainer machines (dipping wheels)	2,000	
5 - 5 feet x 5 feet x 30 feet (high) vertical driers	7,500	
9 - dip or slush tanks	1,000	
5 - beading wheels	500	
miscellaneous accessories	1,000	12,000

Drying and Furnacing (2,000-3,000 square feet)

1 - 70 feet x 8 feet x 6 feet steam heated drier	$12,000	
1 - box-type furnace with tools	50,000	$62,000

Finished Ware Storage (3,500 square feet)

1 - 150 feet roller conveyor system	1,000	
1 - 50 feet belt conveyor system	250	
hand trucks, storage racks, and miscellaneous equipment	2,500	3,750

Control Laboratory (500 square feet)

1 - GE Thickness Gauge	200	
1 - Hunter Reflectometer	300	
1 - laboratory furnace (gas or electric)	750	
1 - small scale (balance)	200	
benches, glass ware, and other accessories	2,000	3,450

Power and Maintenance

3 - 500 KVA transformers	9,000	
power tools and accessories	10,000	19,000

Total Estimated Cost of Equipment	$178,600
Allowance for Contingencies	35,000
Engineering and Design	10,000
Total Plant Cost (Exclusive of Installation)	223,600

III - SUGGESTED SOURCES OF SUPPLY FOR RAW MATERIALS AND PROCESSING EQUIPMENT

The following is a partial list of commercial sources of supply in the US for certain of the raw materials and processing equipment described in Sections I and II. It is to be noted, however, this does not constitute, in any way, a recommendation or endorsement of the individual firms thus mentioned, nor does it imply these are the only firms in the US who would be in a position to supply the items named. A more complete listing can be obtained by consulting standard commercial directories, or by directing specific inquiry to the Porcelain Enamel Institute, located at 1145 - 19th Street, N.W., Washington, D. C.; or to the Enameled Utensil Manufacturers Council, Keith Building, Cleveland, Ohio.

1. Possible Sources of Semi-Fabricated Black Shapes

Columbian Enameling & Stamping Company, Terre Haute, Indiana
Federal Enameling & Stamping Company, Pittsburgh 30, Pennsylvania
Fletcher Enamel Company, Dunbar, West Virginia
Jones Metal Products Company, West Lafayette, Ohio
Lisk-Savory Corporation, Canandaigua, New York
United States Stamping Company, Moundsville, West Virginia
Vollrath Company, Sheboygan, Wisconsin

2. Manufacturers of Enamel Frit

Chicago Vitreous Enamel Product Company, Cicero 50, Illinois
Ferro Corporation, Cleveland 5, Ohio
The O. Hommel Company, Pittsburgh 30, Pennsylvania
Ingram-Richardson, Incorporated, Frankfort, Indiana
Pemco Corporation, Baltimore 24, Maryland

3. Process Equipment Suppliers

Abbe Engineering Company, New York, New York
Armco Steel Company, Middleton, Ohio
Baker Perkins Company, Saginaw, Michigan
Barrows Porcelain Enamel Company, Cincinnati, Ohio
Bettinger Corporation, Waltham, Massachusetts
A. J. Bolland Company, St. Louis, Missouri
Brill Equipment Company, New York, New York
Consolidated Products Company, New York, New York
Erie Enameling Company, Erie, Pennsylvania
Fletcher Enamel Company, Dunbar, West Virginia
Patterson Foundry & Machine Company, East Liverpool, Ohio
Vitreous Steel Products Company, Cleveland, Ohio

IV - ILLUSTRATIONS

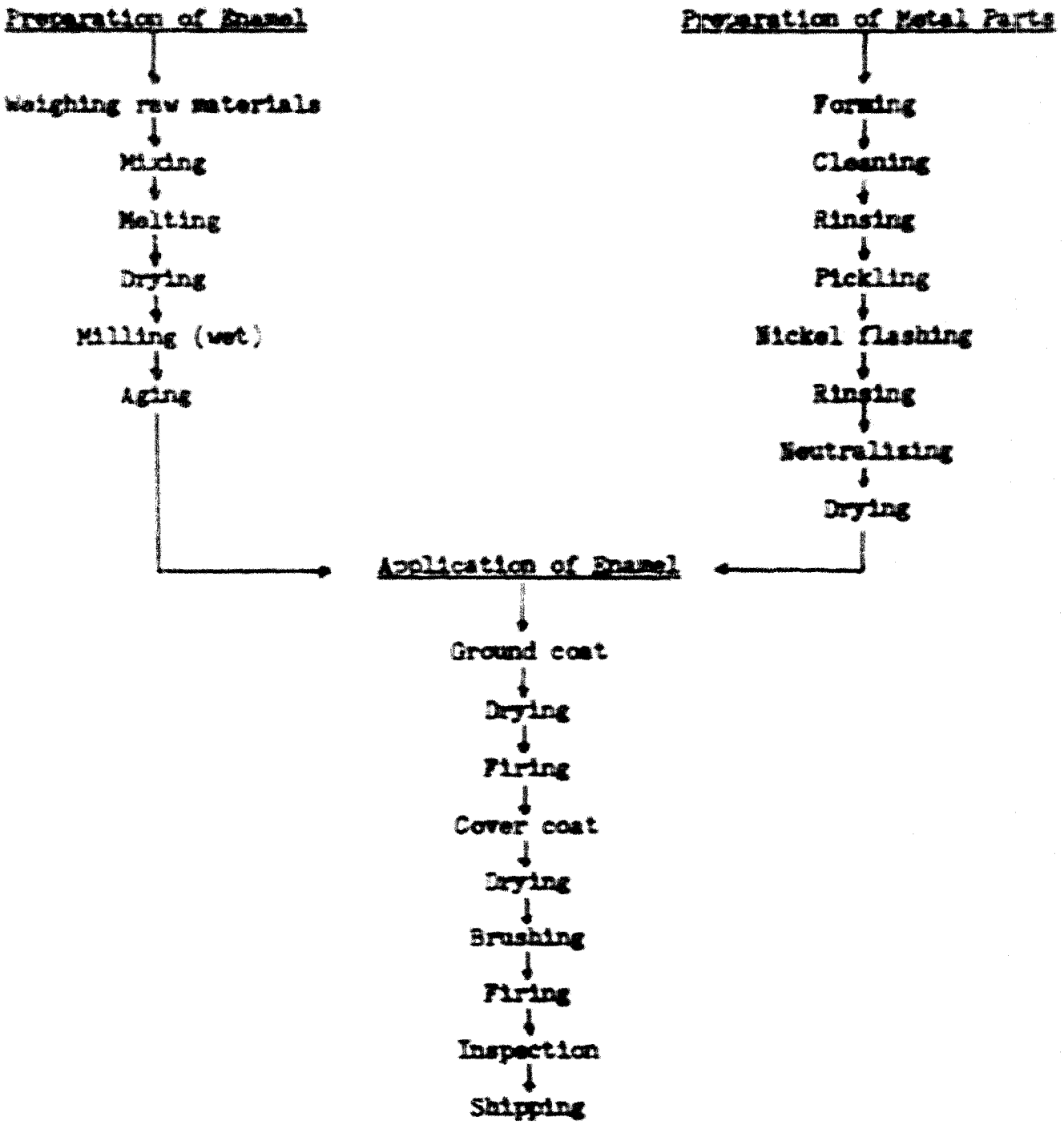


Figure 1 - Flow Sheet for Production of Porcelain Enamel Kitchenware

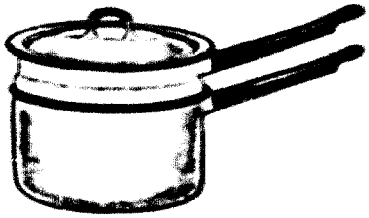
BASINS, AMERICAN SHAPE

Deep—Seamless—Wide Top rim with hole for hanging. Flat bottom.

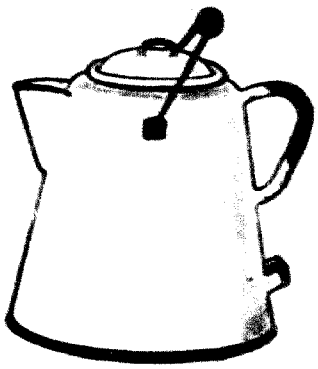
Stock Number	Actual Capacity Quarts	Dimensions Diameter	Height	Packing	Weight Per Doz	Price Per Doz
20	2.10	10-3/4	2-11/16	2 Doz	8 Lbs	
28	2.71	11-1/8	3	2 Doz	10 Lbs	
30	3.55	11-7/8	3-1/4	2 Doz	11 Lbs	
32	3.84	12-5/8	3-1/4	2 Doz	13 Lbs	
34	4.63	13-1/4	3-3/8	2 Doz	15 Lbs	
36	5.81	14-3/16	3-1/2	2 Doz	16 Lbs	
38	7.00	15	3-3/4	2 Doz	17 Lbs	
40	8.31	15-3/4	4-1/8	2 Doz	19 Lbs	
50	19	21-5/8	4-3/4	1 Doz	43 Lbs	
60	24.76	23-5/8	5	1 Doz	55 Lbs	

BOILER, DOUBLE

Rounded Bottom Inset—Seamless; easy grip handles with holes for hanging—close fitting cover for top or bottom, percussion welding.



Stock Number	Actual Capacity Quarts	Dimensions Diameter	Height	Packing	Weight Per Doz	Price Per Doz
1 Inset	1.05	5-11/16	3-5/8	1/2 Doz	18 Lbs	
1 Btm	1.05	5-11/16	3-1/4			
1½ Inset	1.36	6-3/8	3-3/4	1/2 Doz	22 Lbs	
1½ Btm	1.45	6-3/8	3-9/16			
2 Inset	1.88	7-1/4	3-7/8	1/2 Doz	26 Lbs	
2 Btm	2.19	7-1/4	4-1/8			



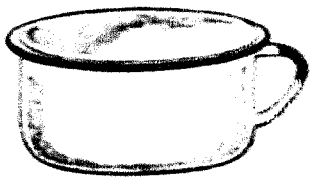
BOILER, COFFEE & WATER KETTLE

Seamed Bottom—handy tip handle—heavy wire bail with wood grip handle. Ideal for serving large groups or picnicing.

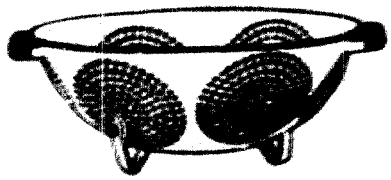
Stock No.	Actual Capacity Quarts	Cu. In.	Dimensions Diameter	Height	Packing	Weight Per Doz	Price Per Doz
35	6	35	9-1/4	8-1/4	1/3 Doz	30 Lbs	
53	10	53	10-3/8	10-3/8	1/3 Doz	36 Lbs	

CHAMBER

Deep Straight Side with roll top flange—Heavy welded handle—Seamless—Easy to clean.



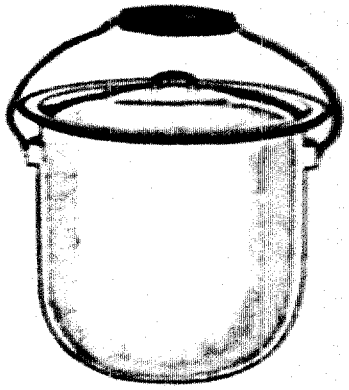
Stock Number	Actual Capacity Quarts	Dimensions Diameter	Height	Packing	Weight Per Doz	Price Per Doz
00	7½	5-9/16	3-1/4	2 Doz	7 Lbs	
7	1.56	7-1/4	2-3/4	1 Doz	9 Lbs	
9½	2.75	8-5/8	4-3/16	1 Doz	12 Lbs	
9	3.57	9-1/4	4-9/16	1 Doz	14 Lbs	



COLANDER

Footed with Side Handles—Small Piercing — Seamless Bowl — Welded foot and handles.

Stock Number	Actual Capacity Quarts	Dimensions Diameter	Height	Packing	Weight Per Doz	Price Per Doz.
8	2.31	8-15/16	4	1 Doz	11 Lbs	
28	4.33	11-3/16	4-15/16	1 Doz	17 Lbs	



COMBINET

Bulged side—Close fitting cover—Bead smooth rolled top edge—Deep seamless construction—Sanitary, easy to clean.

Stock Number	Actual Capacity Quarts	Dimensions Diameter	Height	Packing	Weight Per Doz	Price Per Doz.
10	7.25	9-3/4	8	1/2 Doz	30 Lbs	
12	9.91	10-7/16	8-3/4	1/2 Doz	36 Lbs	

CUP, FLARING

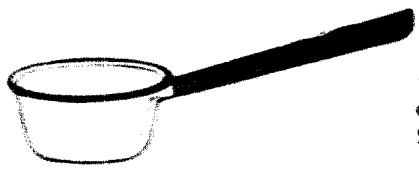
Easy grip handle—Seamless bowl shape.

Stock Number	Actual Capacity Quarts	Dimensions Diameter	Height	Packing	Weight Per Doz	Price Per Doz.
2	.30	4-3/16	2-1/16	3 Doz	3 Lbs	

CUP, STRAIGHT SIDE

Easy grip handle—Seamless deep shape.

Stock Number	Actual Capacity Quarts	Dimensions Diameter	Height	Packing	Weight Per Doz	Price Per Doz.
4	.45	3-7/8	3	3 Doz	4 Lbs	
4	1.06	5-1/4	4	3 Doz	8 Lbs	

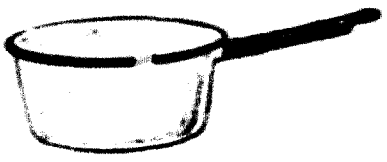


DIPPER, WINDSOR

Long Handle Hollow — Set at angle for easy pouring—Seamless bowl.

Stock Number	Actual Capacity Quarts	Dimensions Diameter	Height	Packing	Weight Per Doz	Price Per Doz.
10	.54	5-1/8	2-3/8	3 Doz	5 Lbs	

Figure 2 - Typical Porcelain Enamelware Units



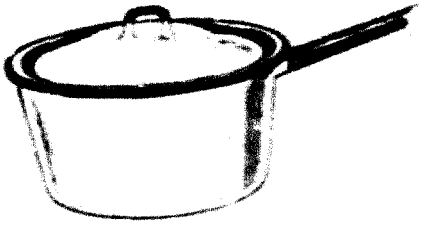
PAN, SAUCE

Windsor Shape—Deep nested, easy grip handle, hole for hanging.

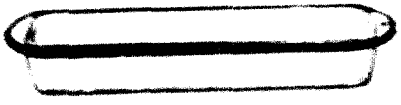
Stock Number	Actual Capacity Quarts	Dimensions Diameter	Dimensions Height	Packing	Weight Per Doz	Price Per Doz.
½	.54	5-1 8	2-3 8	2 Doz	4½ Lbs	
1	1.00	6-2 16	3	2 Doz	6½ Lbs	
1½	1.50	7-1 16	3-3 8	2 Doz	8½ Lbs	
2	2.00	7-11 16	3-5 8	2 Doz	9 Lbs	
3	3.00	8-11 16	4-3 8	2 Doz	12 Lbs	

PAN, SAUCE

Covered Windsor Shape — Nested Easy grip handle, hole for hanging.



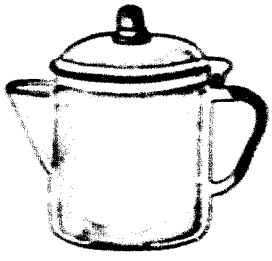
Stock Number	Actual Capacity Quarts	Dimensions Diameter	Dimensions Height	Packing	Weight Per Doz	Price Per Doz
20	2.00	7-11 16	3-5 8	1 Doz	16 Lbs	
30	3.00	8-11 16	4-3 8	1 Doz	20 Lbs	



PAN, STOVE

Rolled rim—Deep flat bottom. Extended rim for handles.

Stock Number	Actual Capacity Quarts	Dimensions Diameter	Dimensions Height	Packing	Weight Per Doz	Price Per Doz
12	2.16	11-9	3 x 8¾ x 1¾	1 Doz	12 Lbs	
14	2.95	13-3 16	3 x 9-1 8 x 2	1 Doz	12 Lbs	
16	3.76	15-11 16	3 x 9¾ x 2-5 16	1 Doz	17 Lbs	



PERCOLATOR

Hinge Cover — Enamel Inset — Constructed to make rapid percolation and full flavored coffee.

Stock Number	Actual Capacity Quarts	Cups	Dimensions Diameter	Dimensions Height	Packing	Weight Per Doz	Price Per Doz
6	1.27	6	5	4-3 4	1 2 Doz	18 Lbs	
8	1.65	8	5	5-5 8	1 2 Doz	20 Lbs	
Loose Cover							
60	1.27	6	5	4-3 4	1 2 Doz	18 Lbs	
80	1.65	8	5	5-5 8	1 2 Doz	20 Lbs	

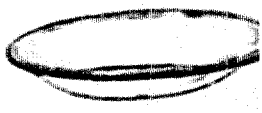
PLATE, DINNER

Wide flare edge—Flat bottom.

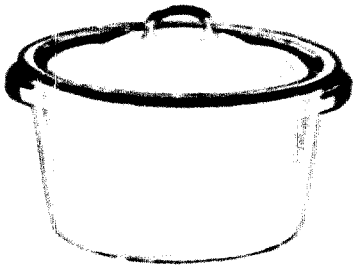
Stock Number	Actual Capacity Quarts	Dimensions Diameter	Dimensions Height	Packing	Weight Per Doz	Price Per Doz
9	.42	8-7 8	1 4	3 Doz	5 Lbs	

PLATE, SOUP

Deep Shape—Wide flare edge—Flat Bottom.



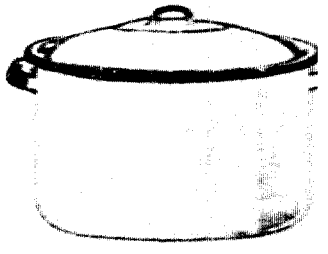
Stock Number	Actual Capacity Quarts	Dimensions Diameter	Dimensions Height	Packing	Weight Per Doz	Price Per Doz
9	.73	8-3 4	1-3 8	3 Doz	5 Lbs	



POT

Windsor Shape—Enamel clo fitting cover—Nested to redu freight costs and warehou space.

Stock Number	Actual Capacity Quarts	Dimensions Diameter	Dimensions Height	Packing	Weight Per Doz	Price Per D
2	1.86	7-11 16	3-5 8	2 Doz	13 Lbs	
3	3.00	8-5 8	4-1 2	1 Doz	18 Lbs	
4	4.00	9-3 4	4-5 8	1 Doz	21 Lbs	
6	6.00	10-3 16	6-1 16	1 Doz	25 Lbs	
8	8.00	10-15 16	7-1 16	½ Doz	30 Lbs	
10	9.18	11-3 16	7-5 8	½ Doz	34 Lbs	
12	11.50	11-3 4	8-3 4	½ Doz	37 Lbs	



POT

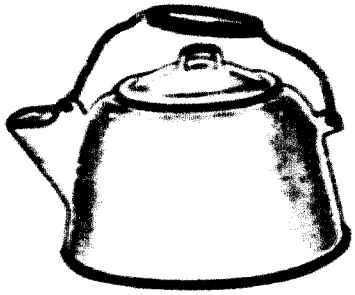
Straight Side—Enamel Cover.

Stock Number	Actual Capacity Quarts	Dimensions Diameter	Dimensions Height	Packing	Weight Per Doz	Price Per D
10	1.00	5-11 16	3-1 4	2 Doz	9 Lbs	
15	1.50	6-3 8	3-9 16	2 Doz	11 Lbs	
20	2.00	7-5 16	4	2 Doz	15 Lbs	
30	3.00	7-15 16	4-5 16	2 Doz	18 Lbs	
40	4.00	8-9 16	4-15 16	1 Doz	20 Lbs	
60	5.90	9-1 2	5-5 8	1 Doz	25 Lbs	
80	8.00	10-1 4	6-11 16	1 Doz	30 Lbs	
Blue Brilliant Only						
20	20	3-11 16	8-1 8	1 3 Doz	60 Lbs	
24	24	14¾	9-5 8	1 3 Doz	75 Lbs	

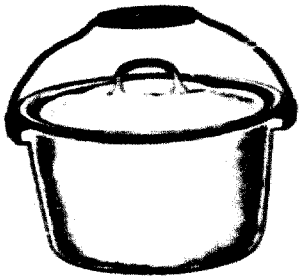
Figure 3 - Typical Porcelain Enamelware Units

KETTLE, TEA

Easy fill spout—Seamed bottom — Heavy wire bail with wood grip handle.



Stock Number	Actual Capacity Quarts	Dimensions Diameter	Height	Packing	Weight Per Doz.	Price Per Doz.
401	3.04	8-5/16	4-3/4	½ Doz.	20 Lbs.	
601	4.31	9-1/8	5-5/8	½ Doz.	24 Lbs.	



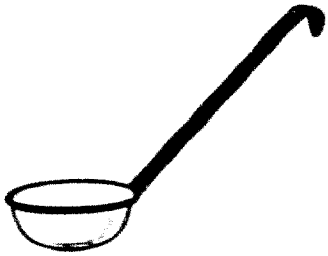
KETTLE, WINDSOR

Enameled close fitting cover, back tilt handle. Nested shape bowl reduces freight costs and warehouse space.

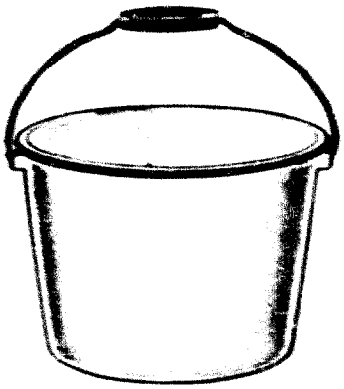
Stock Number	Actual Capacity Quarts	Dimensions Diameter	Height	Packing	Weight Per Doz.	Price Per Doz.
40	4.00	9-3/8	4-5/8	1 Doz.	21 Lbs.	
60	6.00	10-3/16	6-1/16	1 Doz.	25 Lbs.	
80	8.00	10-15/16	7-1/16	½ Doz.	30 Lbs.	
100	9.16	11-3/16	7-5/8	½ Doz.	37 Lbs.	
120	11.50	11-3/4	8-3/4	½ Doz.	40 Lbs.	

LADLE

Flat long handle with Hook Seamless Bowl.



Stock Number	Actual Capacity Quarts	Dimensions Diameter	Height	Packing	Weight Per Doz.	Price Per Doz.
38	20	4	1-9/16	4 Doz.	5 Lbs.	



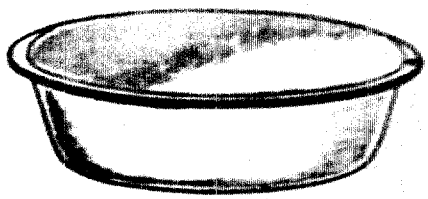
PAIL, DAIRY OR WATER

Deep wide shape — Seamless construction—Heavy wire bail with wood grip handle.

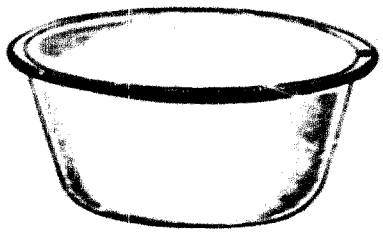
Stock Number	Actual Capacity Quarts	Dimensions Diameter	Height	Packing	Weight Per Doz.	Price Per Doz.
50	1.63	5-13/16	5-3/8	2 Doz.	18 Lbs.	
108	7.87	10-15/16	6-13/16	½ Doz.	20 Lbs.	
110	9.16	11-3/16	7-5/8	½ Doz.	26 Lbs.	
112	11.50	11-3/4	8-3/4	½ Doz.	30 Lbs.	

PAN, DISH

Deep—Seamless construction—Wide roll edge —Hole for hanging.



Stock Number	Actual Capacity Quarts	Dimensions Diameter	Height	Packing	Weight Per Doz.	Price Per Doz.
010	8.67	14-15/16	4-5/8	½ Doz.	26 Lbs.	
014	11.00	16-3/8	4-3/4	½ Doz.	28 Lbs.	
017	14.26	18-1/8	5	½ Doz.	36 Lbs.	



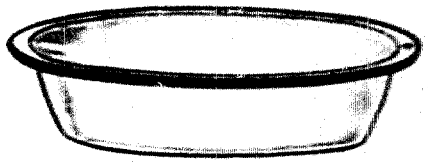
PAN, DISH

Sink — Roll Edge — Extra Deep Seamless construction.

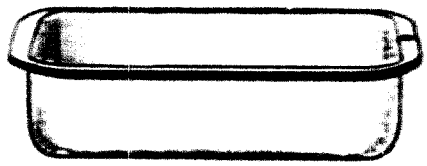
Stock Number	Actual Capacity Quarts	Dimensions Diameter	Height	Packing	Weight Per Doz.	Price Per Doz.
C 4	8.72	13-3/4	5-9/16	½ Doz.	20 Lbs.	
036	11.50	15	6	½ Doz.	24 Lbs.	

PAN, DISH

Oval Shape — Roll Edge —Seamless. Extended rim for handles.



Stock Number	Actual Capacity Quarts	Dimensions Diameter	Height	Packing	Weight Per Doz.	Price Per Doz.
90	7.72	17-1/2 x 12-1/4 x 4		½ Doz.	26 Lbs.	



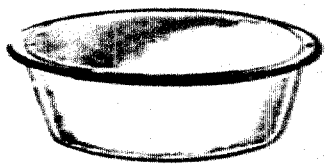
PAN, DISH

Oblong—Roll Edge—Designed to fit the sink.

Stock Number	Actual Capacity Quarts	Dimensions Diameter	Height	Packing	Weight Per Doz.	Price Per Doz.
16	10.03	16⅜ x 11-⅞ x 4½		1/3 Doz.	40 Lbs.	
18	12.75	18 x 12-11/16 x 4¾		1/3 Doz.	60 Lbs.	

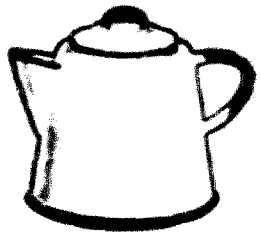
PAN, PUDDING

Seamless—Deep Shape—Rolled Edge—Rounded corners for easier stirring and cleaning.



Stock Number	Actual Capacity Quarts	Dimensions Diameter	Height	Packing	Weight Per Doz.	Price Per Doz.
1	1.04	7-3/8	2-9/16	2 Doz.	5½ Lbs.	
1½	1.50	8-3/16	3	2 Doz.	6 Lbs.	
2	2.00	8-11/16	3-3/16	2 Doz.	7 Lbs.	
2½	2.47	9-5/8	3-1/8	2 Doz.	8 Lbs.	
3	3.00	10-1/4	3-3/8	2 Doz.	8½ Lbs.	
4	4.00	11-1/8	3-3/4	2 Doz.	10 Lbs.	

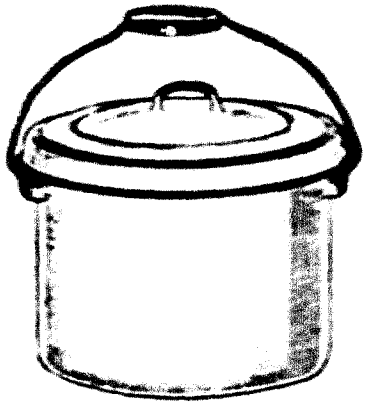
Figure 4 - Typical Porcelain Enamelware Units



POT, COFFEE

Seamed Bottom—Enamel Close Fitting Cover — Welded handle and spout.

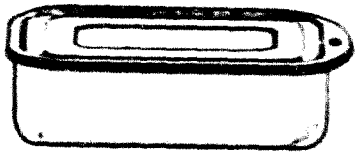
Stock No.	Actual Capacity Quarts	Cups	Dimensions Diameter	Height	Packing	Weight Per Doz.	Price Per Doz.
2	1.63	8	5-13/16	5-3/8	½ Doz.	15 Lbs.	
3	2.52	14	6-3/8	7-5/8	½ Doz.	17 Lbs.	



PAIL

Utility — Garbage — Diaper Hood Cover — Heavy wire bail with wood grip handle —Sanitary—Easy to clean Multiple uses.

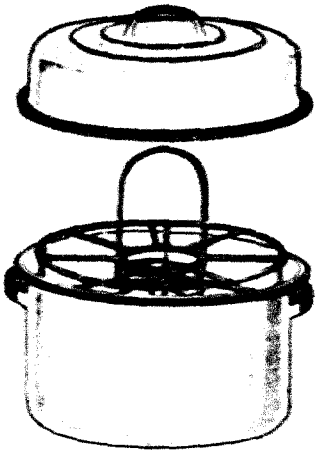
Stock Number	Actual Capacity Quarts	Dimensions Diameter	Height	Packing	Weight Per Doz.	Price Per Doz.
14	14	10¾	9-1/8	1/3 Doz.	60 Lbs.	



PAN

Refrigerator — Covered — Will fit any refrigerator — Deep shape—Vegetable refresher.

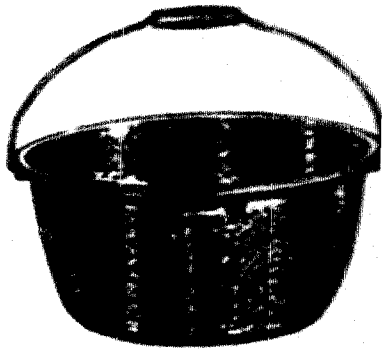
Stock Number	Actual Capacity Quarts	Dimensions Diameter	Height	Packing	Weight Per Doz.	Price Per Doz.
135	6.16	13½ x 9½ x 4		1/2 Doz.	44 Lbs.	



STERILIZER

Baby Bottle — Hood Cover — Easy to remove bottles—Sanitary—Easy to clean.

Stock Number	Actual Capacity Quarts	Dimensions Diameter	Overall Height	Packing	Weight Per Doz.	Price Per Doz.
7	5.80	10-1/8	9½	1/3 Doz.	40 Lbs.	



KETTLE, PRESERVING

Wire bail with wood grip— Rack rim handle.

Stock Number	Actual Capacity Quarts	Dimensions Diameter	Height	Packing	Weight Per Doz.	Price Per Doz.
30C	10.25	13-3/8	5-7/8	½ Doz.	26 Lbs.	
32C	13	14-1/16	6-5/8	½ Doz.	28 Lbs.	
36C	18	15	7-1/8	½ Doz.	30 Lbs.	

CANNER, "CANWELL"

3 Popular Sizes complete with rack and instruction

Stock No.	Actual Capacity Quarts	Jar Capacity	Dimensions Diameter	Height	Packing	Weight Per Doz.	Price Per Doz.
20	20	7 Qts. or 7 Pts.	13-11/16	8-½	1/3 Doz.	63 Lbs.	
24	25	8 Qts. or 8 Pts.	14-1/4	9-5/8	1/3 Doz.	78 Lbs.	
36	36	9 Pts. 9 Qts. or 7—½ Gals.	16-5/8	10-1/4	1/6 Doz.	108 Lbs.	

Figure 5 - Typical Porcelain Enamelware Units

V - SUPPLEMENTARY DATA

Table 1 - Gauge Weight and Thickness of Sheet Steel

Gauge Number	U. S. Standard Weight per Square Foot (Pounds)	Approximate Thickness* of Steel for U. S. Standard Weight per Square Foot (Inches)	Gauge Thickness Ordering Range (Inches)
10	5.625	.1345	.1419 to .1271
12	4.375	.1046	.1120 to .0972
14	3.125	.0747	.0821 to .0710
16	2.5	.0598	.0635 to .0568
18	2.0	.0478	.0508 to .0449
20	1.5	.0359	.0388 to .0344
22	1.25	.0299	.0313 to .0284
24	1.00	.0239	.0254 to .0225
26	.75	.0179	.0194 to .0172
28	.625	.0149	.0156 to .0142
30	.50	.0120	.0127 to .0113

* To convert from sheet weight to sheet thickness, use a factor of 41.82 pounds per square foot per inch thickness.

Source: Steel Products Manual, Carbon Steel Sheet, Section II. The American Iron and Steel Institute, New York City.

Table 2 - Typical Enamel Slip Formulations

	Ground Coat	Cover Coat
Porcelain Enamel Frit	100 pounds	100 pounds
Silica	10 "	----
Clay	7 "	4 pounds
Borax	8 ounces	----
Magnesium Carbonate	4 "	----
Potassium Chloride	----	4 ounces
Sodium Aluminate	----	2 "
Bentonite	2 ounces	2 "
Gum Tragacinth	----	1/2 "
Water	45 pounds	45 pounds
Specific Gravity of Slip	1.60-1.65	1.80-1.90
Residue on 200 Mesh Screen	4-8%	1-3%
Application Weight	30-40 grams per square foot	20-30 grams per square foot
Median Burning Temperature	1525-1600°F	1550°F

VI - SOURCES OF INFORMATION

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8. Kirk, R. E. and Othmer, D. F., eds. Encyclopedia of Chemical Technology. Vol. 5, 718-35 (1950). Interscience Encyclopedia, Inc., New York, New York.

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11. Zademach, E. R. and Clarke, W. W. (to Metalwash Machinery Co.). Porcelain Enameling Process. US 2,570,299. October 9, 1951.

12. Private communications with Porcelain Enamel Institute, Enameled Utensil Manufacturers Council, and selected representatives of the Porcelain Enamel Industry.