ELECTRO-MOTIVE DIVISION • GENERAL MOTORS CORPORATION
SERVICE DEPARTMENT
MAINTENANCE INSTRUCTION

PISTON PHOSPHATE TREATMENT

DESCRIPTION

The phosphate treatment of pistons outlined in the following instruction provides such an acceptable surface aid for lubrication on all series EMD engine cast iron pistons, that all pistons used in new engines, those supplied by our Parts Department, and pistons returned for Factory Rebuild Service are given this treatment. This treatment produces a non-metallic, oil absorbent, anti-friction coating on the piston surface that aids rapid break-in and reduces subsequent wear.

To assure continued service life of used pistons, the skirt surface should be inspected whenever pistons are removed from an engine and, if required, given a new phosphate treatment. A used piston should be given re-treatment whenever any area of the skirt shows shiny bare metal, of approximately three (3) square inches.

A piston properly phosphatized will have a uniform dark grey appearance with a fine smooth grain structure and a flat dull finish where the metal being processed is uniform in composition.

EQUIPMENT REQUIRED

The piston treatment layout shown in Fig. 1 should be applicable to most shops. The size of the tanks will provide adequate facilities for a large shop where piston turnover is heavy. However, only a small saving would result if the tanks were reduced in size for a smaller volume of pistons. The schematic piping diagram, Fig. 2, is a suggested method for piping the tanks in Fig. 1.

The following drawings are available upon request: File Print 581 showing construction details of the tanks, and File Print 484 showing a cover arrangement for the tanks.

A small cabinet should be provided, as shown in Fig. 1, for storing and protecting the laboratory equipment. The cabinet may be shop built, as may a bench with a protective shield for air blowing the pistons following the final graphite treatment, as explained under "Phosphate Treatment Procedure."

Several piston holding fixtures should also be made, as indicated in Fig. 3, for properly immersing pistons in the various baths, at an angle of about 45°. The cross-member of the hook is held in the notched brackets welded to the front of the tank to provide a pivot bearing for the piston when lowering into solution and for automatically up-ending and draining the piston when lifting it out of the solution.

If it is planned to keep the equipment in constant use, it will be necessary to provide a spare steam coil for tank No. 5. The coil in this tank becomes coated rather quickly with the phosphate deposit, and it should be changed often in order that solution temperature can be maintained. The design should be such that the pipe unions are well above the level of the solution, facilitating the removal of the coil for cleaning.

One inch drain valves should be installed at the bottom of each tank, except tanks No. 1 and No. 5. A valve used on the No. 1 tank would have to be lined with lead. The No. 5 drain would have to be of stainless steel construction and is not considered necessary. In normal practice, the phosphate solution is not thrown away, but is siphoned out periodically in order to dispose of the sludge which accumulates at the bottom of the tank. During this time a rinse tank may be used to receive the solution while the stainless steel tank is cleaned.

The sulfuric acid solution tank No. 1, the phosphate solution tank No. 5, and the graphite tank No. 7 should be equipped with temperature regulating steam admission valves and accurate thermometers in order to maintain proper temperatures during processing. Air agitation, or surface cleaning air should be provided for tank No. 7 to prevent excessive graphite deposit on the pistons at time of removal.

*This bulletin is revised and supersedes previous issues of this number.

SOLUTIONS REQUIRED

1. Tank No. 1.

Tank No. 1 contains the sulfuric acid solution consisting of seventeen (17) gallons of commercial 66° Baume sulfuric acid and five (5) pints of Rodine Inhibitor for every hundred gallons of solution at working level. This solution should be kept between 140°-150° F.

Great care must be taken when preparing the sulfuric acid solution. Fill the tank with half of the complete amount of fresh cold water and slowly, and cautiously add the acid to the water in the tank while stirring. After the full charge of acid has been well mixed into the partially full pickle tank, add the remaining fresh water and the Rodine Inhibitor, mixing the solution well. At this point tank No. 1 is ready to heat up to operating temperature.

WARNING: Wear protective clothing when preparing this solution. Never pour water on top of the concentrated acid, but add acid to the water while mixing. The concentrated acid is much heavier than water and will settle out in a layer in the bottom of the tank and cause an eruption of the mixture unless precaution is taken to stir it in a little at a time as it is added.

2. Tank No. 2.

This tank contains plain cold water and should be overflowing slightly to prevent soil build up.

3. Tank No. 3.

This tank contains the neutralizing solution consisting of three (3) ounces of Soda Ash added to every gallon of solution. Avoid too concentrated a solution of Soda Ash because of objectionable residues on drying dipped material. This tank should be operated hot.

4. Tank No. 4.

Tank No. 4 should be filled with plain water and kept at the boiling point and allowed to overflow slightly to prevent soil build-up.

5. Tank No. 5.

The phosphate solution in tank No. 5 consists of ten (10) gallons of a phosphating solution concentrate equivalent to Thermoil-Granodine No. 112, a product of the American Chemical Paint Company, or Parco Lubrite No. 1 or No. 2, a product of the Parker Rust Proof Company, to every ninety (90) gallons of water. Tank No. 5 phosphate solution temperature should be kept between 190° - 205° F. A temperature much below 190° will result in a poor coating.

The coating produced on articles in a freshly prepared bath is not as desirable as a coating produced in an "aged" bath. For this reason a freshly prepared bath should be "aged" by adding about one (1) pound of steel wool for every 100 gallons of solution. The steel wool should be suspended in the cool solution in a wire basket. Steel wool will dissolve more rapidly in a cool solution. Hot phosphate will coat the steel wool preventing complete dissolution. Avoid throwing steel wool into the phosphate tank in lumps or wads that may cause sludge deposits on the pistons. The wire basket with steel wool should be agitated occasionally to ensure proper iron build-up, then withdrawn when iron content is correct, in the proper range.

The "aging" period will last about one hour and, at the end of this time, free and total acidity of the solution should be checked by the method given under "Testing And Maintenance Of Solutions."

NOTE: Pistons should not be processed while bath is being aged with steel wool.

6. Tank No. 6.

This tank contains plain water kept at a temperature of 140° - 150° F, and allowed to overflow slightly to prevent soil build-up.

7. Tank No. 7.

This tank contains the graphite solution consisting of one (1) pound of Acheson Colloid Company "Aqua-Dag (No. 192)" (or equal) added to every 100 gallons of water and mixed thoroughly. Temperature of this solution should be from 170° to 180° F. Air agitation should be provided to prevent the

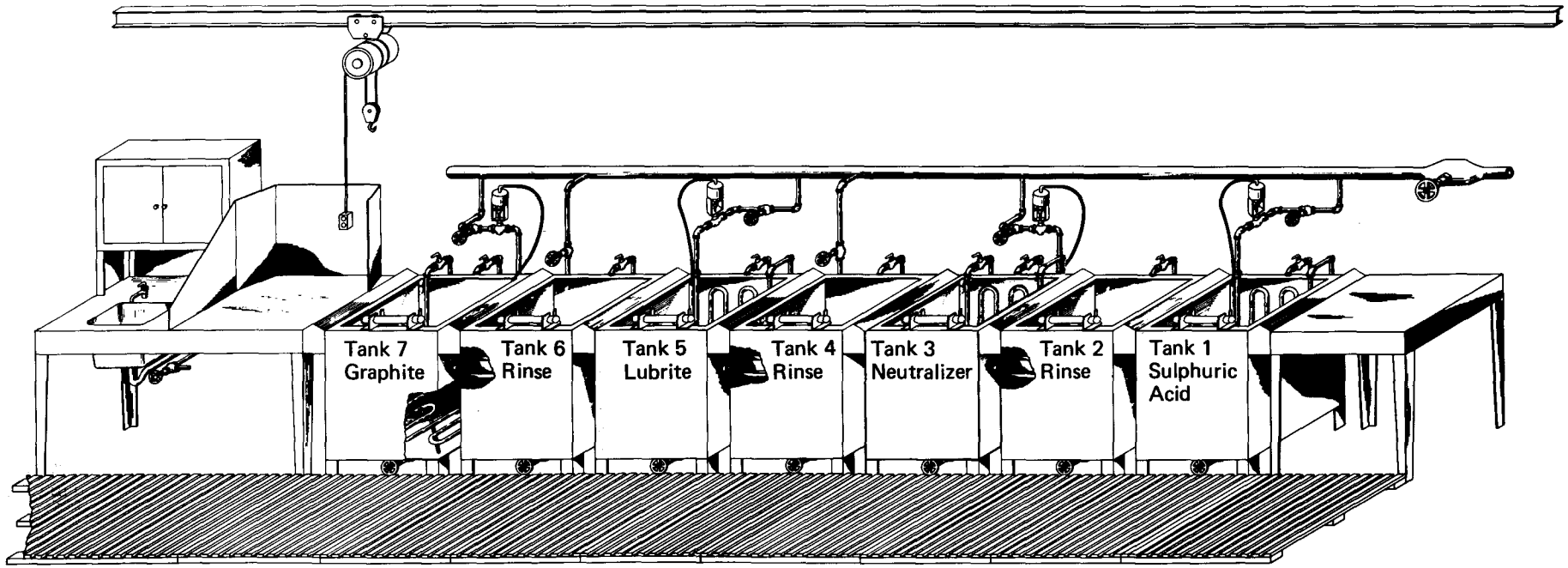


Fig. 1 – Piston Phosphate Treatment Equipment Layout

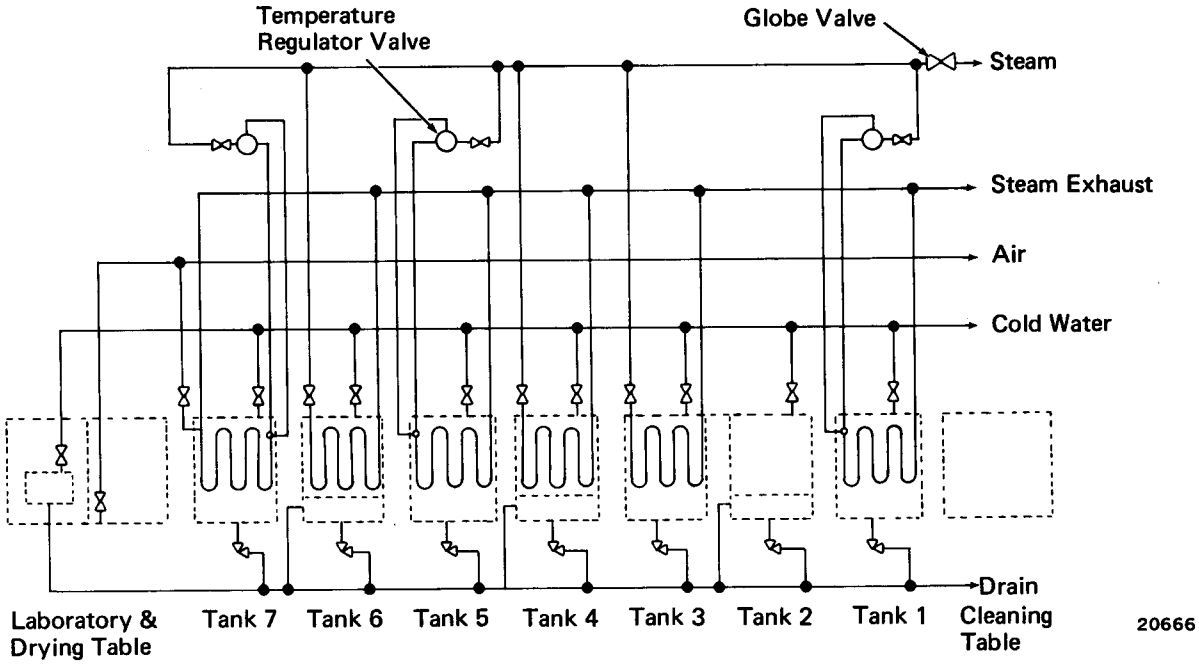
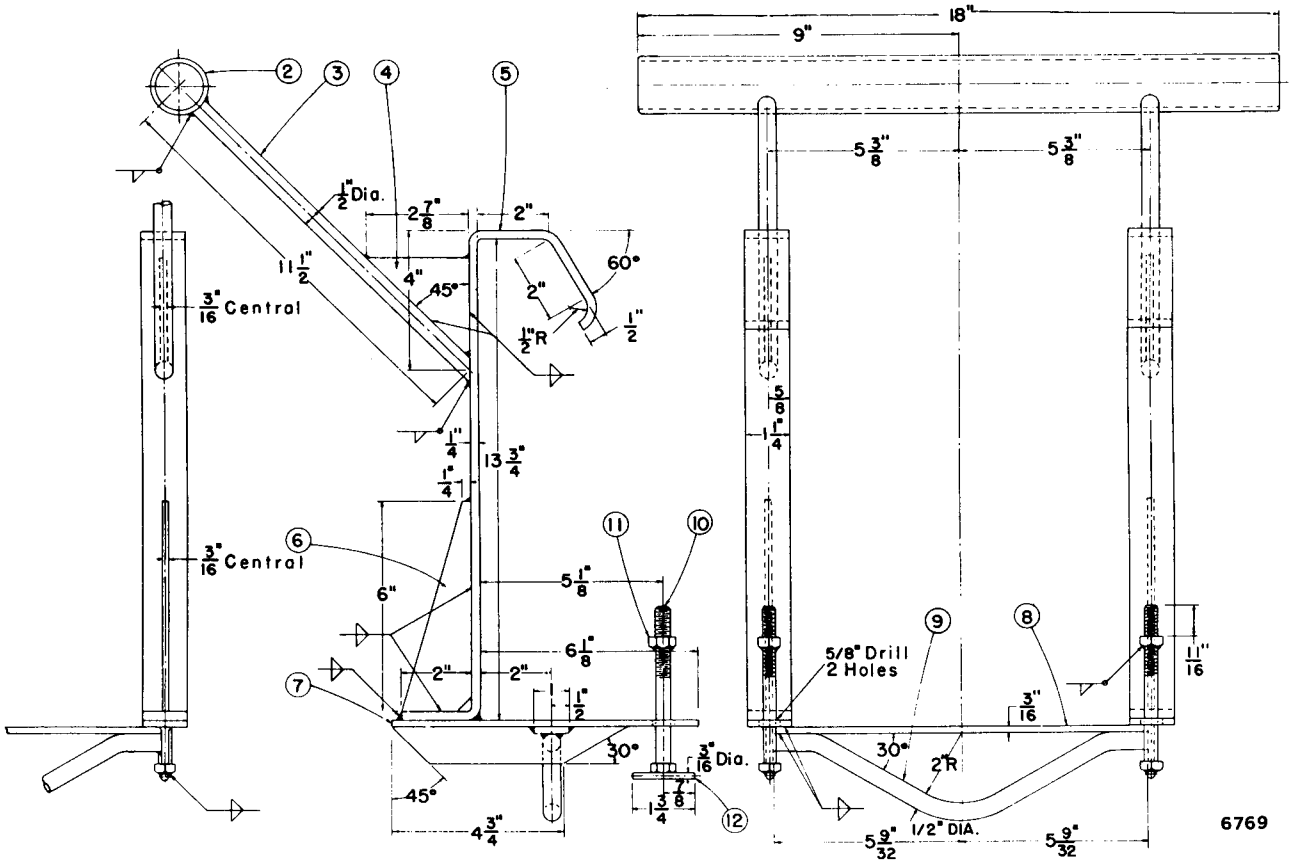


Fig. 2 – Piston Treatment Layout - Schematic Piping Diagram



Item	Name	Material	No. Req.	Item	Name	Material	No. Req.
1	Assembly			7	Std. Tee	1-1/4"x1-1/4"x3/16"	2
2	Cross Member	1-1/4" NPS	1	8	Cross Bar	SAE 1020 Steel	1
3	Arm	SAE 1020 Steel	2	9	Eye	SAE 1020 Steel	1
4	Gusset	SAE 1020 Steel	2	10	Hex. Hd. Bolt	3/8"-16x4-1/2" Long	2
5	Piston Hook	SAE 1020 Steel	2	11	Hex. Nut	3/8"-16	2
6	Gusset	SAE 1020 Steel	2	12	Thumb Bar	SAE 1020 Steel	2

Fig. 3 – Piston Holding Fixture

colloidal graphite from accumulating on the surface. Periodically caustic potash or caustic soda should be added to the solution to maintain the pH between 7 and 9.

NOTE: In the event that this solution is allowed to become too hot, the graphite will separate and float to the surface. When this occurs, it should be skimmed off and new colloidal graphite added. A certain amount of this separation takes place normally, hence the need for air agitation.

PHOSPHATE TREATMENT PROCEDURE

1. Cleaning.

   In order to ensure complete adhesion of the phosphate coating, the outer surface of the piston must be clean prior to treatment. Ring grooves must be free of deposits and all oil and varnish removed from surfaces to be coated. Mild alkali cleaning in a hot soak tank with agitation or with high pressure spray can be used to remove most of the soil. Any hard carbon or rust deposits remaining can then be removed by careful wire brushing or by machines employing soft abrasives, such as ground corn cobs or ground peach pits for cleaning. Washing tank, drawing 8041054, may be used for the cleaning process. Copies of this drawing to show construction may be obtained on request.

2. Sulfuric Acid Treatment, Tank No. 1.

   Mount piston on piston rack and immerse in sulfuric acid solution in tank No. 1 for 2 - 5 minutes.

3. Piston Rinse, Tank No. 2.

   Rinse thoroughly in cold water tank No. 2.

4. Neutralization Treatment, Tank No. 3.

   Remove from tank No. 2 and dip in neutralizer tank No. 3.

5. Piston Rinse, Tank No. 4.

   After removal from neutralizing solution rinse in hot water tank No. 4 for 2 minutes.

6. Piston Preparation For Tank No. 5 Immersion.

   Wipe piston clean with a cloth saturated in a high flash point petroleum solvent (such as Stoddard Solvent 105° F flash point or equal), mount on piston rack and submerge in tank No. 4 for 10 - 15 minutes. Lift out and allow excess water to drain out, and immediately place in phosphate solution, tank No. 5.

NOTE: Wiping with petroleum solvent is important, since it helps control the grain size of the phosphate coating. Change wiping cloths and solvent frequently to avoid soil build-up on the piston.

7. Phosphate Application - Tank No. 5.

   Immerse piston in phosphate solution for a total time of 15 minutes. After completion of the operation, the piston should be drained and transferred quickly to rinse tank No. 6.

8. Piston Rinse, Tank No. 6.

   Rinse thoroughly by dipping in the hot rinse water for at least 30 seconds.

9. Graphite Treatment, Tank No. 7.

   After removal from tank No. 6, submerge hot piston quickly in tank No. 7 to coat with colloidal graphite and remove. After removal of piston from graphite treatment, it should be blown dry with clean compressed air before storing or returning to service.

NOTE: The phosphatized coating has only limited rust resistant qualities and is not a permanent type rust preventative. If pistons are to be stored for any length of time, place piston with V.P.I. paper in fairly air-tight container. V.P.I. paper should not be used to wrap piston as activated side of paper will rust metal in contact.

TESTING AND MAINTENANCE OF SOLUTIONS

For best results, maintain and control the neutralizing and phosphate solutions as follows:

1. Neutralizing Solution, Tank No. 3.

   The pH of the neutralizing solution should be maintained above ten (10) by periodically checking with a pH indicator paper.

2. Phosphate Tank No. 5.

   a. Total Acidity

      Pipette 2 cc. of the tank No. 5 solution into a clean glass beaker, add 1-2 inches (distilled) water, and add 3-5 drops of phenolphthalein indicator. Measure in 0.1N sodium hydroxide (NaOH) (this is 4 grams NaOH in 1000 cc's distilled water or 0.1 strength of normal solution consisting of 40 grams NaOH powder in 1000 cc's of distilled water), stirring constantly, until a light pink color develops. The number of cubic centimeters (cc's) of sodium hydroxide solution added will indicate the strength in points of total acid in the phosphate solution which should be maintained at 12 plus or minus 1 point.

      Small quantities of the phosphating solution concentrate should be added at intervals in order to restore the total acid strength of the solution. The amount being governed by the results of the total acid test.

   b. Free Acid

      Take 2 cc's of tank No. 5 solution, add (distilled) water and a few drops of methyl orange-xylene cyanole indicator, then add 0.1N sodium hydroxide from a burette, stirring constantly, until a faint green color appears. The number of cc's used indicates in points the strength of free acid in the phosphate solution. The strength of the solution should be maintained at 2 plus or minus 0.2 points.

      For every part of free acid present, there should be 5.5 to 6 parts of total acid. This is obtained by dividing the total acid points by the free acid points. When the total acid is at 12 points or higher, and the free acid is low, the free acid should be brought up by boiling the solution. This will cause the total acid to break up into free acid. If the total acid is low and free acid is low, the total acid may be brought up by adding phosphating solution concentrate and then boiling the solution to bring up the free acid. Too high free acid content of the solution can be remedied by neutralization. The addition of 4 ounces of manganese carbonate (neutralizer No. 200) per 100 gallons of processing solution will reduce the free acid 0.1 point (0.1 milliliters), or 40 ounces approximately to reduce the free acid 1 point. Add water to the neutralizer No. 200 in a container to form a slurry (thick soupy mixture) and distribute over the surface of the phosphate solution. The solution should then be stirred thoroughly. Allow to settle before using again.

   c. Iron Content

      A processing solution high in iron is apt to result in an incomplete coating in the normal processing time, a non-adherent coating, uneven etch of the metal surface, a thinner-than-normal coating, and a light grey color instead of dark grey.

      To test for iron, pipette a 10 cubic centimeter sample of the tank No. 5 solution into a glass beaker, add 10 to 20 drops of a 50% sulfuric acid and, using a 10 cubic centimeter Mohr (calibrated) pipette, titrate (process of determining amount of substance, by smallest amount to have a given effect in reaction with another known substance) the prepared sample with titrating solution No. 18 (potassium permanganate) until a pink color persists. Each cubic centimeter of titrating solution No. 18 used indicates the presence of 0.1 of one percent of iron in the solution. Thus 3 cubic centimeters of titrating solution No. 18 indicates 0.3 of one percent iron in the tank No. 5 solution. In general, the iron content of the phosphating solution is maintained between 0.2 to 0.3 of one percent (0.2 to 0.3%) equivalent to use of 2 to 3 cubic centimeters of titrating solution No. 18.

      When the upper limit of iron (0.3%) in the tank No. 2 phosphate solution is reached, hydrogen peroxide is added to precipitate and remove part of the iron. One pound (1 pint) of 100 volume (30%)

hydrogen peroxide will remove 0.1 of one percent from each 100 gallons of solution. The phosphate solution should be stirred after each addition of the hydrogen peroxide to ensure a uniform mix in the bath. To avoid a dusty coating on pistons after precipitating iron from the solution, sufficient time should be allowed for the sludge to settle out before introducing work into the bath.

WARNING: Hydrogen peroxide is a strong oxidizing agent and customary precautions should be taken in handling it and other solutions or materials used in this procedure.

SERVICE DATA

REAGENTS USED FOR TESTING

Alkaline Testing Solution	Dissolve 4.0 grams NaOH in 1 liter distilled water, standardize against a known acid, and adjust to 0.1N.
Methyl Orange-Xylene Cyanole	Dilute methyl orange-xylene cyanole solution 200% with distilled water.
Potassium Permanganate	Dissolve 6.0 grams potassium permanganate in a liter of distilled water, standardize against a known (ferrous) iron solution and adjust so that the 1cc, is equivalent to 0.01 grams of iron.
50% Sulfuric Acid	Add slowly to 540 cc. of distilled water, 410 cc. concentrated C.P. sulfuric acid.

PISTON PHOSPHATE TREATMENT MATERIAL

Parker Rust Proof Company Parco Lubrite No. 1 or No. 2
or American Chemical Paint Co. Thermoil-Granodine No. 112

Manganese carbonate

Graphite (Acheson Colloid Co. "Aquadag" or equal)

30% hydrogen peroxide solution

66° Baume sulfuric acid

Rodine Inhibitor

Soda Ash (sodium carbonate)

TESTING APARATUS AND REAGENTS

Concentrated C.P. sulfuric acid
Sodium hydroxide
Methyl orange-xylene cyanole indicator
Phenolphthalein indicator
Erlenmeyer flask - 250 cc.
Pipette - 2 cc.
Burette - 25 cc.
Burette stand
Beakers - 250 cc.
Pipette - 10 cc.
Mohr Pipette - 10 cc.
pH indicator paper

DRAWINGS

File Print No. 484 . . . . . Hood For Lubrizing Equipment
File Print No. 581 . . . . . Lubrizing Equipment
Drawing 8041054 . . . . . Washing Tank

Litho In U.S.A.