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.

A. 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. A list of the material required is included in Fig. 1. Also, 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 "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 #2. 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 tank #2. A valve used on this tank 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 phosphate solution tank #2 and the graphite tank #4 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 #4 to prevent excessive graphite deposit on the pistons at time of removal.

B. SOLUTIONS REQUIRED

1. Tank #1

Tank #1 should be filled with plain water and kept at the boiling point and allowed to overflow slightly to prevent soil build-up.

2. Tank #2

The phosphate solution in tank #2 consists of ten (10) gallons of Thermoil-Granodine #112, a product of the American Chemical Paint Company, or Parco Lubrite #1 or #2, a product of the Parker Rust Proof Company, to every ninety (90) gallons of water. Tank #2 phosphate solution temperature should be kept between 190° - 205° F. A temperature much below 190° F. 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 solution in a wire basket. Avoid throwing steel wool into the phosphate tank in lumps or wads that may cause sludge deposit on the pistons. The wire basket with steel wool should be agitated occasionally to assure 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.

3. Tank #3

This tank contains plain water kept at a temperature of 150° - 180° F., and allowed to overflow slightly to prevent soil build-up.

4. Tank #4

This tank contains the graphite solution consisting of 3-1/2 gallons of soluble oil (Texas CX or equal) and one (1) pound of Acheson Colloid Company "Aquadag" (or equal) added to every 100 gallons of water and mixed thoroughly. Temperature of this solution can be from room temperature to 140° F. maximum. Air agitation should be provided to prevent the colloidal graphite from accumulating on the surface.

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.

C. PHOSPHATE TREATMENT PROCEDURE

1. Cleaning

   In order to insure 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. Piston Preparation For Tank #1 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 #1 for 10 - 15 minutes. Lift out and allow excess water to drain out, and immediately place in phosphate solution, tank #2.

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.

3. Phosphate Application - Tank #2

   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 #3.

4. Piston Rinse, Tank #3

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

5. Graphite Treatment, Tank #4

   After removal from tank #3, submerge hot piston quickly in tank #4 to coat with soluble oil and 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.

D. TESTING AND MAINTENANCE OF SOLUTIONS

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

1. Phosphate Tank #2

   a. Total Acidity

      Pipette 2 cc. of the tank #2 solution into a clean glass beaker 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 .1 the strength of normal solution consisting of 40 grams NaOH powder in 1000 cc's of distilled water) until a light pink color develops. The number of cubic

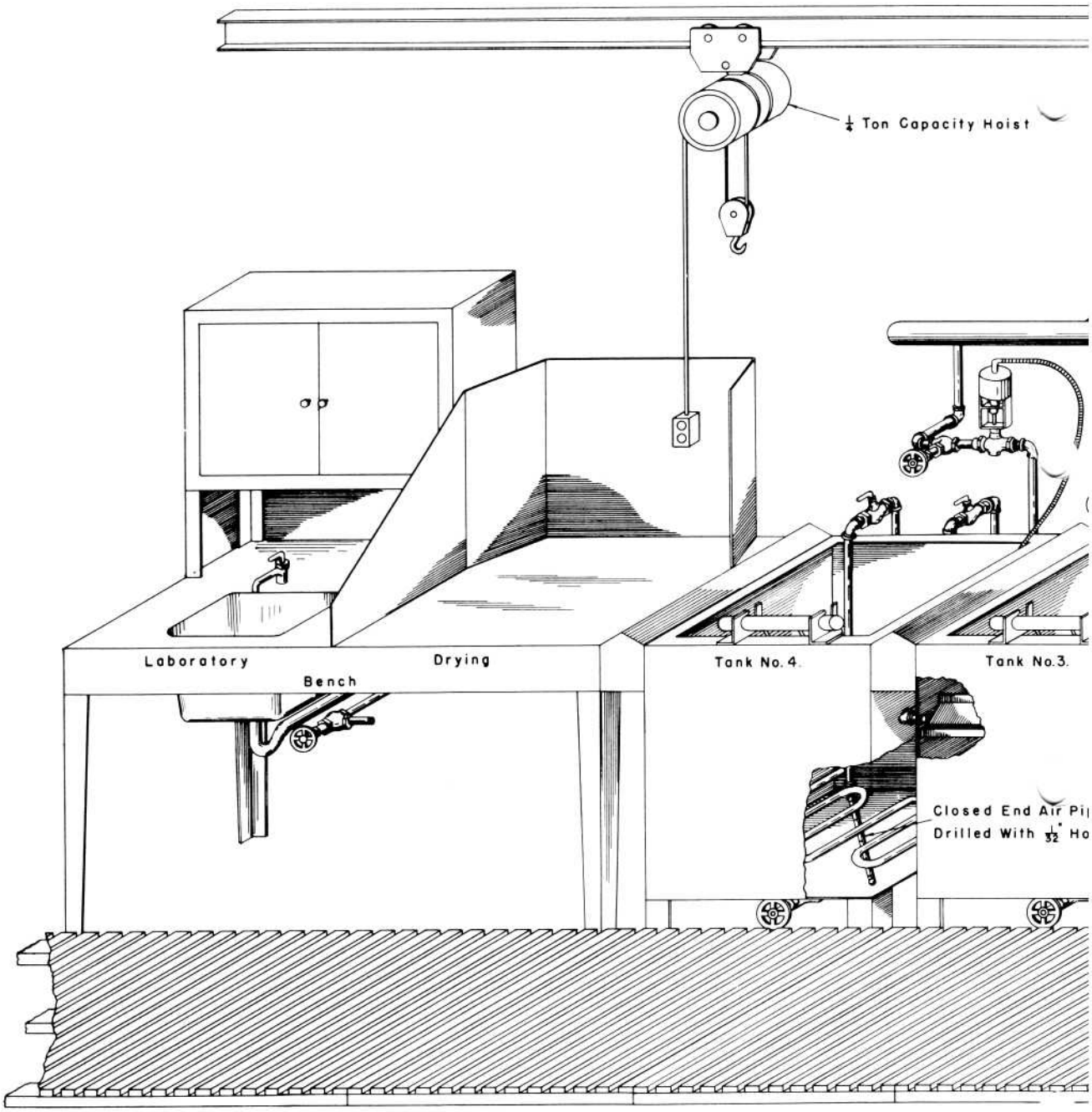
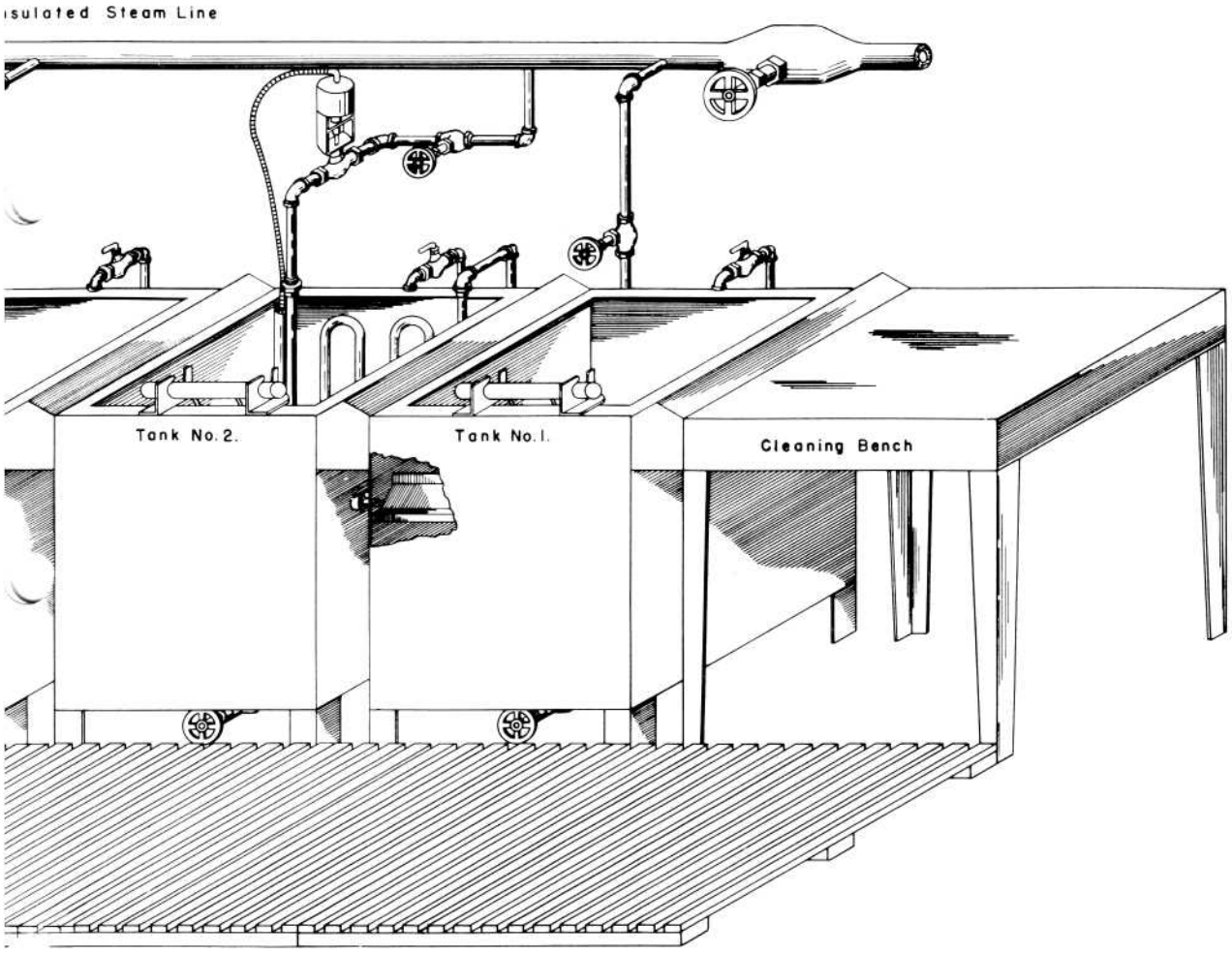


Fig. 1 - Piston Phosphate Treatment Equipment Layout

EQUIPMENT LIST

Quantity	Description
3	Dipping tanks, 36" x 30" x 28" - 1/4" steel plate
1	Phosphate tank, 36" x 30" x 28" - 11 gauge, stainless steel
275 feet	1/2" wrought steel pipe
100 feet	1" wrought steel pipe
12	1/2" Globe valves 150#
3	1" Globe valves 150#
1	1" Glove valve 150# stainless steel (optional)
	Miscellaneous pipe fittings



EQUIPMENT LIST (Cont'd)

Quantity	Description
1	1/4 Ton Monorail hoist with 35 ft. rail
2	Temperature regulating valves - indicating type with stainless steel bulb - 3/4" pipe size 170-230 psi
1	Tank construction details, File Print #581
1	Tank cover arrangement, File Print #484

This equipment list is in accordance with the general arrangement shown in Fig. 1 and will necessarily vary according to location installation requirements.

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.

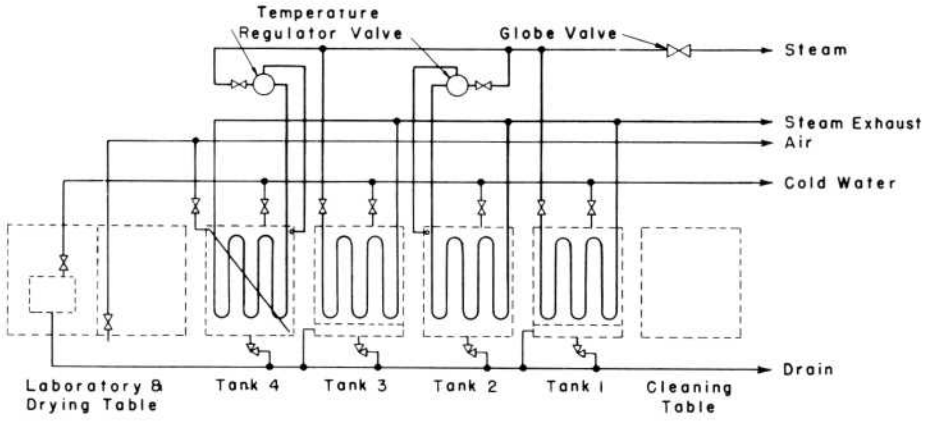
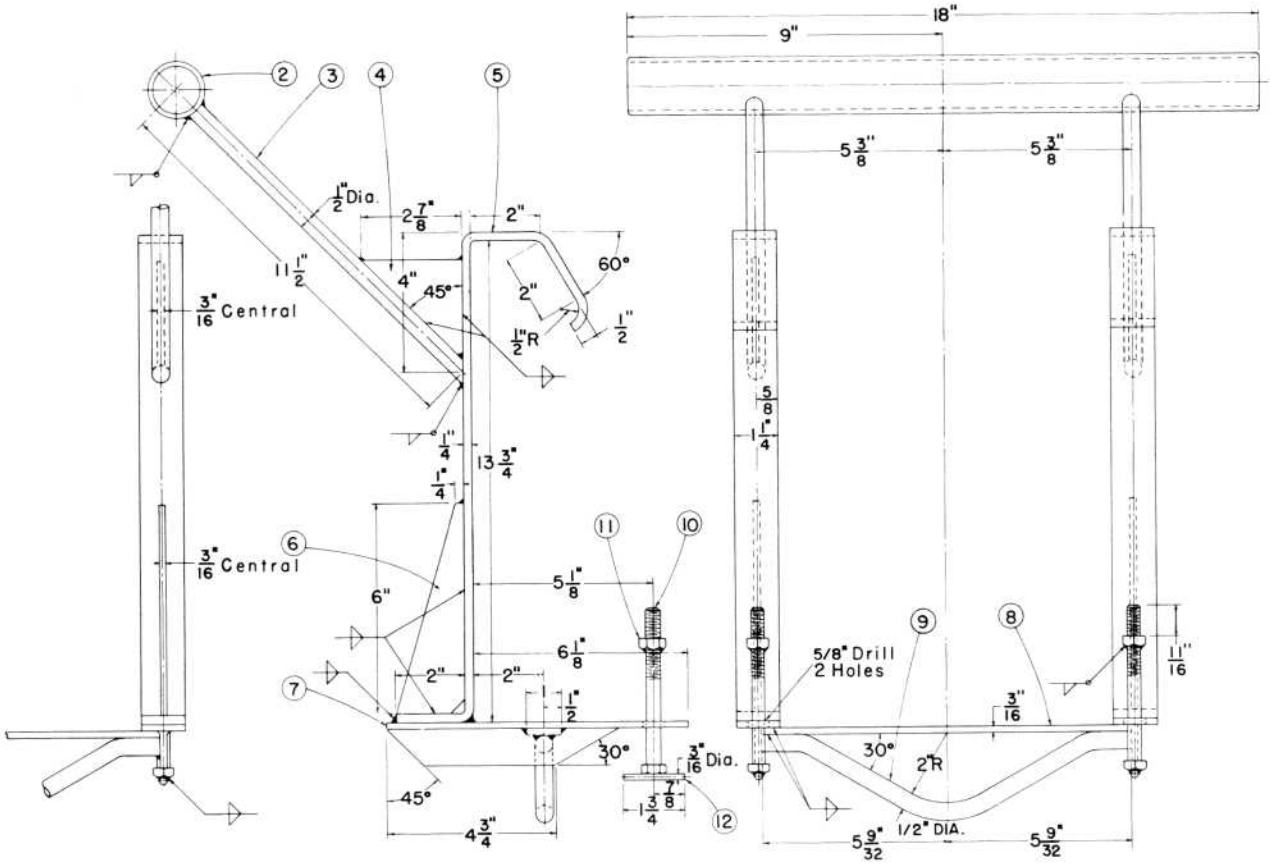


Fig. 2 - Piston Treatment Layout — Schematic Piping Diagram



Item	Name	Material	No. Req.	Item	Name	Material	No. Req.
1	Assembly			7	Std. Tee	1-1/4 × 1-1/4 × 3/16	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	3/8-16 × 4-1/2 lg.	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

Small quantities of Parco Lubrite #2 or Thermoil-Granodine #112 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 #2 solution, add a few drops of methyl orange xylene cyanole indicator, then add 0.1N sodium hydroxide from a burette 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 Thermoil-Granodine #112 or Parco Lubrite #2 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 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 light grey color instead of dark grey.

To test for iron, pipette a 10 cubic centimeter sample of the tank #2 solution into a glass beaker, add 10 to 20 drops of a 50% sulphuric acid and, using a 10 cubic centimeter Mohr 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 #18 (potassium permanganate) until a pink color persists. Each cubic centimeter of titrating solution #18 used indicates the presence of .1 of one per cent of iron in the solution. Thus 3 cubic centimeters of titrating solution #18 indicates .3 of one per cent iron in the tank #2 solution. In general, the iron content of the Lubrite solution is maintained between .2 to .3 of one per cent (0.2 to 0.3%) equivalent to use of 2 to 3 cubic centimeters of titrating solution #18.

When the upper limit of iron (0.3%) in the tank #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 .1 of one per cent iron

from each 100 gallons of solution. The phosphate solution should be stirred after each addition of hydrogen peroxide to insure 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.

CAUTION: 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.

2. Graphite Solution, Tank #4

The strength of this solution should be tested at least once a week to determine the proportion of oil. To do this, place 100 cc's of the solution in a graduated cylinder and add 20 cc's of 50% sulphuric acid or reagent 44. This will cause separation of the oil and it will float to top of cylinder. The separated oil should be about 2% of the total volume. Surface scum should be removed periodically from tank #4.

E. REAGENTS USED FOR TESTING

Alkaline Testing Solution or (Test Solution #11)	Dissolve 4.0 grams NaOH in 1 liter distilled water, standardize against a known acid, and adjust to 0.1N.
Methyl Orange-Xylene Cyanole or (indicator Solution #8)	Dilute methyl orange-xylene cyanole solution 200% with distilled water.
Potassium Permanganate or (Titrating Solution #18)	Dissolve 6.0 grams potassium permanganate in a liter of distilled water, standardize against a known (ferrous) iron solution and adjust so that the 1 cc, is equivalent to 0.01 grams of iron.
50% Sulphuric Acid or (Reagent #44)	Add slowly to 540 cc. of distilled water, 410 cc. concentrated C.P. sulphuric acid.

F. PISTON PHOSPHATE TREATMENT MATERIAL

Quantity	Description
1 drum	Parker Rust Proof Company Parco Lubrite No. 1 or No. 2 - approximately 400 lbs. (55 gal.) or American Chemical Paint Co. Thermoil-Granodine #112
1 drum	Soluble Oil (Texas CX or equal)
100 lbs.	Neutralizer No. 200
24 lbs.	Graphite (Acheson Colloid Co. "Aquadag" or equal)
1 gal.	30% hydrogen peroxide solution
	Testing Apparatus And Reagents
9 lbs.	Concentrated C.P. sulphuric acid
1 gal.	Sodium hydroxide
1 pint	Methyl orange xylene cyanole indicator
1 pint	Phenolphthalein indicator
1	Erlenmeyer flask — 250 cc.
1	Pipette - 2 cc.
1	Burette - 25 cc.
1	Burette stand
2	Beakers - 250 cc.
1	Pipette - 10 cc.
1	Mohr Pipette - 10 cc.