

Wallace & Tiernan[®]

an eVOQUA brand

Amperometric Titrator Series A-709

BOOK NO. WT.050.262.001.UA.IM.1014

W3T109528

**AMPEROMETRIC
TITRATOR
SERIES A-790**

BOOK NO. WT.050.262.001.UA.IM.1014

AMPEROMETRIC TITRATOR

EQUIPMENT SERIAL NO. _____

DATE OF START-UP _____

START-UP BY _____

Prompt service available from nationwide authorized service contractors.

ORDERING INFORMATION

In order for us to fill your order immediately and correctly, please order material by description and part number, as shown in this book. Also, please specify the serial number of the equipment on which the parts will be installed.

WARRANTY

Seller warrants for a period of one year after shipment that the equipment or material of its manufacture is free from defects in workmanship and materials. Corrosion or other decomposition by chemical action is specifically excluded as a defect covered hereunder, except this exclusion shall not apply to chlorination equipment. Seller does not warrant (a) damage caused by use of the items for purposes other than those for which they were designed, (b) damage caused by unauthorized attachments or modifications, (c) products subject to any abuse, misuse, negligence or accident, (d) products where parts not made, supplied, or approved by Seller are used and in the sole judgment of the Seller such use affects the products' performance, stability or reliability, and (e) products that have been altered or repaired in a manner in which, in the sole judgment of Seller, affects the products' performance, stability or reliability. **SELLER MAKES NO OTHER WARRANTY OF ANY KIND, AND THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR OF FITNESS OF THE MATERIAL OR EQUIPMENT FOR ANY PARTICULAR PURPOSE EVEN IF THAT PURPOSE IS KNOWN TO SELLER.** If Buyer discovers a defect in material or workmanship, it must promptly notify Seller in writing; Seller reserves the right to require the return of such defective parts to Seller, transportation charges prepaid, to verify such defect before this warranty is applicable. In no event shall such notification be received by Seller later than 13 months after the date of shipment. No action for breach of warranty shall be brought more than 15 months after the date of shipment of the equipment or material.

LIMITATION OF BUYER'S REMEDIES. The **EXCLUSIVE REMEDY** for any breach of warranty is the replacement f.o.b. shipping point of the defective part or parts of the material or equipment. Any equipment or material repaired or replaced under warranty shall carry the balance of the original warranty period, or a minimum of three months. Seller shall not be liable for any liquidated, special, incidental or consequential damages, including without limitation, loss of profits, loss of savings or revenue, loss of use of the material or equipment or any associated material or equipment, the cost of substitute material or equipment, claims of third parties, damage to property, or goodwill, whether based upon breach of warranty, breach of contract, negligence, strict tort, or any other legal theory; provided, however, that such limitation shall not apply to claims for personal injury.

Statements and instructions set forth herein are based upon the best information and practices known to Evoqua Water Technologies, but it should not be assumed that every acceptable safety procedure is contained herein. Of necessity this company cannot guarantee that actions in accordance with such statements and instructions will result in the complete elimination of hazards and it assumes no liability for accidents that may occur.



725 Wooten Road
Colorado Springs, Co 80915

AMPEROMETRIC TITRATOR

INTRODUCTION

This instruction book provides installation, operation and maintenance instructions for the Evoqua Water Technologies Amperometric Titrator, an instrument which offers a simple, reliable method of the quantitative determination of halogen residuals. It is commonly used for the measurement of free available residual chlorine, total residual chlorine, or combined residual chlorine in water. Other determinations that can be made include:

- Differential between mono-chloramine and di-chloramine in water.
- Determination of residual iodine.
- Determination of residual bromine.
- Determination of residual chlorine in wastewater.
- Determination of residual chlorine in highly polluted water.
- Determination of residual sulfur dioxide (sulfite).



WARNING: CHEMICAL REAGENTS MAY BE HAZARDOUS TO HEALTH AND MUST BE HANDLED WITH DUE CARE OBSERVING PRECAUTIONARY INFORMATION PROVIDED ON PRODUCT LABELS. TO AVOID POSSIBLE SEVERE PERSONAL INJURY OR DAMAGE TO EQUIPMENT, THIS EQUIPMENT SHOULD BE INSTALLED, OPERATED AND SERVICED ONLY BY TRAINED, QUALIFIED PERSONNEL WHO ARE THOROUGHLY FAMILIAR WITH THE ENTIRE CONTENTS OF THIS INSTRUCTION BOOK.

NOTE: When ordering material always specify model and serial number of apparatus.

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VERY IMPORTANT SAFETY PRECAUTIONS

This and the following page titled “Very Important Safety Precautions” provide, in brief, information of urgent importance relative to safety in the installation, operation, and maintenance of this equipment.

WARNING

TO AVOID POSSIBLE SEVERE PERSONAL INJURY OR EQUIPMENT DAMAGE, OBSERVE THE FOLLOWING:

REMOVE POWER PLUG FROM POWER SOURCE BEFORE SERVICING.

USE ONLY EVOQUA WATER TECHNOLOGIES LISTED PARTS EXCEPT COMMERCIALY AVAILABLE PARTS AS IDENTIFIED BY COMPLETE DESCRIPTION ON PARTS LIST. THE USE OF UNLISTED PARTS CAN RESULT IN EQUIPMENT MALFUNCTIONS HAVING HAZARDOUS CONSEQUENCES.

THIS EQUIPMENT SHOULD BE INSTALLED, OPERATED AND SERVICED ONLY BY TRAINED, QUALIFIED PERSONNEL WHO ARE THOROUGHLY FAMILIAR WITH THE ENTIRE CONTENTS OF THIS INSTRUCTION BOOK.

DO NOT DISCARD THIS INSTRUCTION BOOK UPON COMPLETION OF INSTALLATION. INFORMATION PROVIDED IS ESSENTIAL TO PROPER AND SAFE OPERATION AND MAINTENANCE.

ADDITIONAL OR REPLACEMENT COPIES OF THIS INSTRUCTION BOOK ARE AVAILABLE FROM:

Evoqua Water Technologies
725 Wooten Road
Colorado Springs, CO 80915
Phone: (800) 524-6324

NOTE

Minor part number changes may be incorporated into Evoqua Water Technologies products from time to time that are not immediately reflected in the instruction book. If such a change apparently has been made in your equipment and does not appear to be reflected in your instruction book, contact your local Evoqua Water Technologies sales office for information.

Please include the equipment serial number in all correspondence. It is essential for effective communication and proper equipment identification.

AMPEROMETRIC TITRATOR



PROTECT YOUR EQUIPMENT INVESTMENT

MINIMIZE DOWNTIME

**ORDER A PREVENTIVE MAINTENANCE KIT NOW ...
KEEP ONE ON HAND**

Quality Equipment	+	Preventive Maintenance	=	Dependable Operation Minimum Downtime
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There's no question about it.

Equipment that is properly maintained is dependable equipment.
It will give optimum performance with minimum unscheduled downtime.

Evoqua Water Technologies manufactures quality equipment designed for performance and reliability. Each product is carefully tested and inspected before shipment to ensure that it meets our high standards.

Our equipment is engineered for easy maintenance. To ensure maximum service life and minimize unscheduled repairs, we recommend a program of regular preventive maintenance, as described in the Service section of this book. To support this program, we developed standard parts kits. These kits can also be used for minor emergency repairs to minimize downtime.

We recommend that these kits be available in your stock at all times. When the complete kit or any of its parts are used, the kit should be replaced immediately.

Preventive maintenance kits may be ordered directly from the company that supplied your equipment, or they may be ordered directly from Evoqua Water Technologies. For ordering numbers, refer to the parts list at the rear of this book.

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PREVENTIVE MAINTENANCE SCHEDULE AND RECORD OF PERFORMANCE

This equipment should receive preventive maintenance on a one (1) year cycle.* It is recommended that the following table be used to plan, schedule, and record this important work.

Date of Installation	
-----------------------------	--

Preventive Maintenance Log	
Schedule Date	Date Performed

***NOTE:** This is the recommended cycle. Your local operating conditions may call for more frequent preventive maintenance.



PROTECT YOUR EQUIPMENT INVESTMENT

MINIMIZE DOWNTIME

**ORDER A PREVENTIVE MAINTENANCE KIT NOW ...
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REGIONAL OFFICES

INSTALLATION, OPERATION, MAINTENANCE, AND SERVICE INFORMATION

Direct any questions concerning this equipment that are not answered in the instruction book to the Reseller from whom the equipment was purchased. If the equipment was purchased directly from Evoqua Water Technologies, Colorado Springs, CO contact the office indicated below.

UNITED STATES

725 Wooten Road
Colorado Springs, CO 80915
TEL: (800) 524-6324

CANADA

If the equipment was purchased directly from Evoqua Water Technologies, Canada, contact the nearest office indicated below.

ONTARIO

Evoqua Water Technologies Ltd.
2045 Drew Road
Mississauga, Ontario
L5S 1S4
(905) 944-2800

QUEBEC

Evoqua Technologies des Eaux Itee
505 Levy Street
St. Laurent, Quebec
H4R 2N9
(450) 582-4266

AMPEROMETRIC TITRATOR

1 TECHNICAL DATA

Resolution	Selectable 0.01 and 0.001 mg/L of residual chlorine
Range	0-20 mg/L
Sensitivity	Greater than 0.0005 mg/L
Electrical Requirements	115V \pm 10%, 50/60 Hz, @ 0.3 amperes
Ambient Temperature	32 to 120°F
Sample Container Capacity	200 mL
Shipping Weight	30 lb.

2 MECHANICAL FEATURES (REFER TO FIGURE 2.1)

- Cell (2) - The cell is a plastic cylinder which has a platinum alloy ribbon helically wound around the lower outside section of the cylinder and a silver-silver chloride tube as a reference electrode inside the cylinder. The two electrodes are electrically connected to two contacts at the top of the unit. Between the turns of the platinum alloy ribbon is a helically wound porous wick. In operation, the inside of the cylinder is partially filled with an electrolyte solution so that the silver-silver chloride electrode is immersed in the electrolyte solution at all times while the platinum alloy electrode is exposed to the water sample being tested. The cylinder is constructed so that the electrolyte solution diffuses slowly through the porous wicking to the outside of the cylinder. Since the wicking is immediately adjacent to the platinum alloy ribbon, a high conductivity path is provided for the passage of current between the two electrodes. The cell, therefore, has a very low internal resistance and is not affected by dissolved salts, chlorides, or other substances which influence the conductivity of the water being tested.
- Agitator (2) and Shaft (1) - An essential part of the cell unit is a plastic agitator which fits closely around the lower end of the cell. The agitator is coupled to a motor located above the cell unit by means of a shaft which runs up through the silver electrode. When the switch is moved to mg/L or μ g/L, the motor rotates the agitator which acts like a pump to produce a continuous flow of the water sample past the platinum alloy electrode. Another important function of the agitator is to provide rapid and thorough mixing of the reducing agent with the water sample so that the result of a small addition of reducing agent can be seen on the panel meter (5) almost immediately.

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- Rotary Switch (3) - The four-position switch serves as a power switch and an operation selector. The OFF position disconnects line power from the electronics and the motor. The mg/L position selects titrator operation with 0.01 mg/L resolution of residual chlorine. Selection of the STBY position disconnects power from the agitator motor. The STBY position should be used to replace water samples between successive titrations. Finally, the $\mu\text{g/L}$ position selects titrator operation with 0.001 mg/L resolution of residual chlorine.
- Turns-Counting Dial (4) - Any change in current produced by the electrode assembly is reflected on the panel meter. To obtain a high degree of sensitivity, use a meter that covers a relatively low current range. However, in practice the titrator is called upon to handle rather wide ranges of electrode currents depending upon the operating conditions.

The titrator circuit uses the low range, high sensitivity meter, but includes a feature which permits the unit to handle wide ranges of current. That feature is the adjustable current source, which offsets the cell current

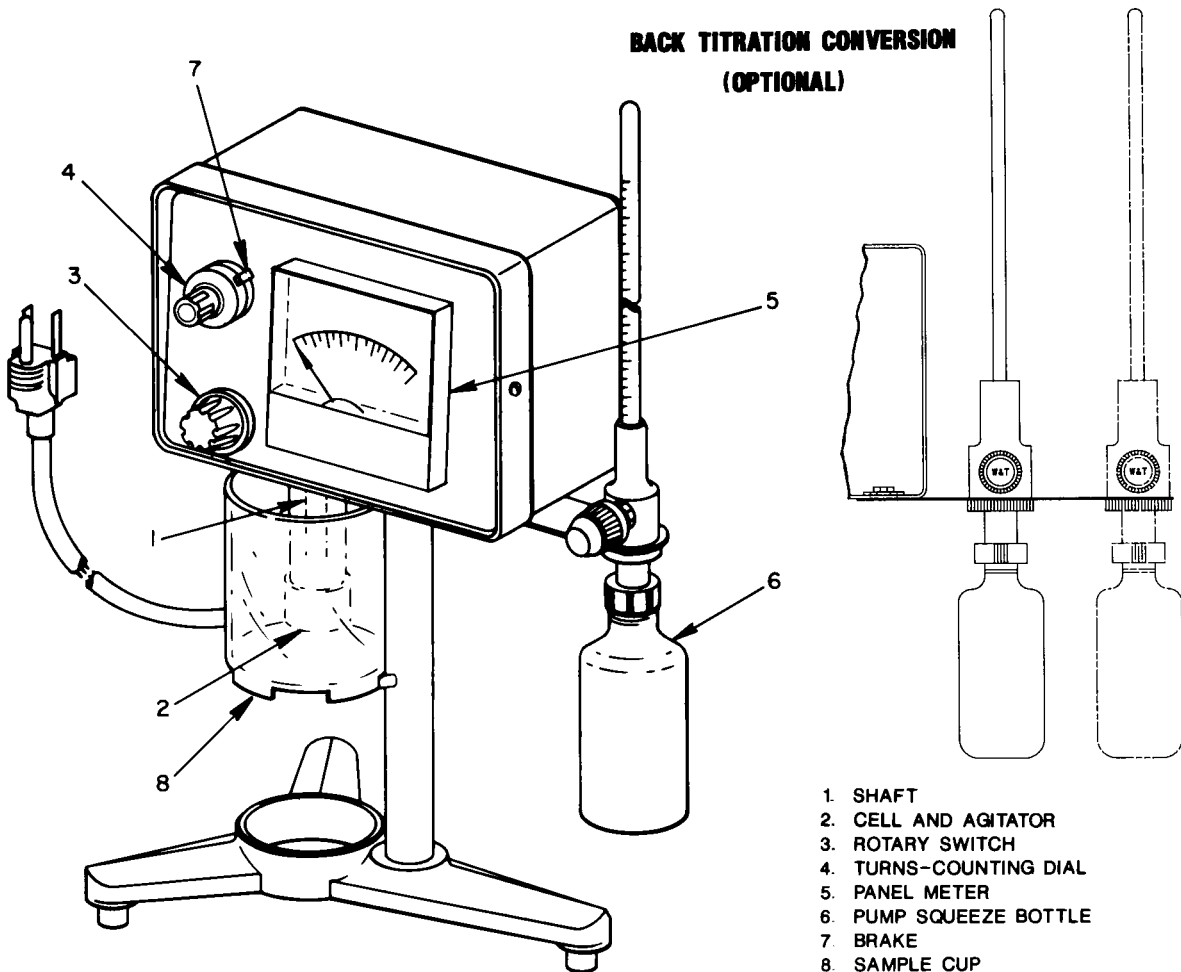


Figure 2.1

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making it possible to always adjust the pointer on the scale. For a given cell current, the meter pointer reading can be varied by rotating the turns-counting dial. Rotating the turns-counting dial clockwise will increase the meter reading and vice versa. The turns-counting dial also provides the means for presetting the current source for known waters. This arrangement permits the titrator to handle a wide variety of operating conditions. When the turns-counting dial is preset, the setting may be locked by moving brake (7) to the left (counterclock-wise).

- Cup (8) - Whenever the term “sample” is used in these instructions, it shall mean a 200-mL volume of the water to be tested. The cup has a line indicating the 200-mL level. For greater accuracy a graduated cylinder or volumetric flask may be used. Fill the cup with the water to be tested and then pour off the excess until the water level is at the line on the cup.

NOTE: Maintain the 200-mL or more water level in the sample cup at all times. Lowering the sample level or leaving the cup empty will allow the saturated electrolyte solution to be depleted and the dry salt crystals to clog the cell and agitator.

- Back Titration Unit (Optional) - For greater ease in performing back titrations, a second reagent pump, and the necessary mounting hardware, is available to feed iodine and PAO through separate lines. This option must be ordered separately and installed by user.

3 PREPARATION FOR OPERATION

3.1 Assembly (See Dwg. 50.262.000.013)

Two pipettes are furnished with the titrator. The one-mL pipette is generally used when the residual being measured is one mg/L or less. A five- mL pipette is furnished for use with higher residuals to permit operation without repeated refilling and where readings of a high degree of accuracy are not required. For back titration units refer to the instructions supplied with that unit.

- a. Select the pipette to be used, lightly grease the O-ring on the lower end with silicone grease U10242 and insert it in the top of reagent pump unit (33) on the side of the titrator.
- b. Fill the pump squeeze bottle about 3/4 full with phenylarsene oxide solution of desired normality. Attach the bottle to the pump.

NOTE: It is easier to turn the bottle than the cap.

- c. Remove cap plug (61) and insert sufficient electrolyte tablets in cell unit (45) to fill the chamber about 2/3 full. Add enough distilled water to cover the tablets. Replace the cap plug.

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NOTE: For proper operation, ensure that plug is always in place in the cell plug hole.

- d. Dry and clean terminals of salt solution. Plug the cell unit into the titrator. The cell is so designed that it cannot be plugged in except in the correct position. Hold the cell by the body rather than by the agitator cup on the bottom. Fill cup (44) to the line with water and place under the cell.
- e. Allow the titrator to remain in this condition for a 24-hour period before use to establish equilibrium of the silver-silver chloride reference electrode. This is necessary for sharp endpoint detection and precision of titration.

3.2 Chemicals

An initial stock of chemicals required for titration is furnished in each packaged titrator as follows:

- Phenylarsene Oxide Solution 0.00564N: 4-oz. bottle U28961. Available in 16-oz. bottle U10533.

NOTE: This solution cannot be used for the 0.001 mg/L resolution setting.

- pH7 Buffer Solution: 4-oz. bottle U28960 also available in 16-oz. bottle U23306.
- Potassium Iodide Solution: 4-oz. bottle U28959. This solution may be prepared by dissolving five parts of CP grade potassium iodide in 95 parts of distilled water. Keep this solution in a brown bottle and refrigerated. Discard solution which turns yellow.
- Electrolyte tablets: 8-oz. bottle U9936. Tablets are made from USP sodium chloride.
- pH4 Buffer Solution: 4-oz. bottle U28962. Available in single one-gallon containers (U24494).

For the 0.01 mg/L resolution (mg/L switch position), the above-listed solutions are used full strength.

For the 0.001 mg/L resolution ($\mu\text{g/L}$ switch position), make up 0.000564N phenylarsene oxide solution by diluting U28961 or U10533 10:1.

For convenience in operation of the titrator, three one-mL droppers are furnished for the potassium iodide and buffer solutions.

3.3 Preparation of Iodine Solution

- 0.00564N iodine solution (to be used with the mg/L sensitivity switch setting):

Dilute the 0.0282N iodine solution (5:1) using one part 0.0282N iodine solution and four parts distilled water.

- 0.0282N iodine solution:
 - a. Dissolve 25 g of KI in approximately 500 mL of distilled water.
 - b. Add 3.58 g of iodine, dissolve, and make up to one liter.
- 0.000564N iodine solution (to be used with $\mu\text{g/L}$ sensitivity switch setting):

Dilute the 0.00282N iodine solution (5:1) using one part 0.00282N iodine solution and four parts distilled water.

- 0.00282N iodine solution:
 - a. Dissolve 2.5 g of KI in approximately 500 mL of distilled water.
 - b. Add 0.358 g of iodine, dissolve, and make up to one liter.

3.4 Theory of Operation

The fundamental chemical procedure involved in the Amperometric Titrator is the neutralization of an oxidizing agent (free available chlorine, potassium permanganate or free iodine) in a sample of water by the addition of a reducing agent of known strength. The actual chemical reactions for Phenylarsene Oxide Solution with free chlorine (1) or free iodine (2) are as follows:



Immersed in the sample is a cell unit which produces a small direct current which is proportional to the free chlorine, potassium permanganate or free iodine present in the sample. The current is indicated on a meter which is connected to the cell unit. As the reducing agent is added, the amount of free chlorine or free iodine is reduced, the cell current decreases and the meter pointer moves down-scale (to the left). The endpoint of the reaction occurs when enough reducing agent has been added to just neutralize all of the free chlorine or free iodine in the sample. When this point is reached, the further addition of an equal amount of reducing agent does not produce an equal deflection of the pointer to the left (or none at all). On the titrator, the sample

volume and the strength of the reducing agent have been selected to make one mL (one milliliter) of 0.00564N PAO equivalent to 1.0 mg/L of chlorine and 1.0 mL of 0.000564N PAO equivalent 0.1 mg/L of chlorine. When the endpoint is reached, therefore, the volume of reducing agent used represents the chlorine concentration in mg/L.

Under the conditions specified in the titration procedure, the titration can be used to distinguish between free available residual chlorine and combined residual chlorine because the reducing agent (phenylarsene oxide solution) employed reacts readily with free chlorine but does not react with combined chlorine. If either combined or total residual chlorine is to be measured, potassium iodide is added to the sample to produce an amount of free iodine which is equivalent to the original residual chlorine. The reducing agent reacts readily with free iodine so that titration can be carried out in a manner similar to that used for free available residual chlorine determinations.

Further discussion of amperometric titration will be found in STANDARD METHODS FOR THE EXAMINATION OF WATER AND WASTEWATER.

3.5 Titration Procedure

The normal determination of residual chlorine in water usually involves one or more of the following measurements:

- Free available residual chlorine
- Total residual chlorine regardless of form
- Combined residual chlorine (chloramine)

The titration procedure for each of the above determinations, is outlined below, plus a specialized technique which permits the operator to differentiate between mono-chloramine and di-chloramine. Methods for determining potassium permanganate, bromide iodine, residual chlorine in highly polluted or wastewater and sulfur dioxide residuals are also provided.

- Determination Of Free Available Residual Chlorine
 - a. Connect the titrator to the appropriate source of line voltage and turn knob from OFF to STBY position.

NOTE: Refer to the rating plate on the titrator housing to determine power requirements.

- b. Fill the pipette with phenylarsene oxide solution by alternately squeezing and releasing the squeeze bottle on the reagent pump unit.

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- c. Remove all air from the pipette and plastic tubing by rotating the knob on the stem unit 1/4 turn counterclockwise. Catch the discharged solution in a beaker to avoid spilling into the closure in the base of the titrator. Refill the pipette to the top (zero) calibration mark.
- d. Measure a 200-mL sample of the water to be tested in the cup as directed under PREPARATION FOR OPERATION.
- e. Place the cup on the titrator.

NOTE: The top edge of the cup should go behind the cup guide post. The bottom of the cup should rest on the cup support post.

- f. Submerge the metal tip of the plastic tubing from the pump unit in the sample water about 1/4 inch while sample is being agitated. If necessary, adjust the tubing in the cup guide post to obtain this condition.
- g. Add one mL of buffer solution pH7 to the water sample. More buffer may be required to obtain pH7 if alkalinity is high.
- h. Start the agitator by turning the switch to the appropriate sensitivity position (mg/L or µg/L).
- i. Rotating the turns-counting dial clockwise should increase the meter reading and vice versa. Adjust the turns-counting dial to make the meter pointer read maximum on the scale. If the pointer is above maximum when the turns-counting dial is rotated completely counterclockwise, then start the titration with the turns-counting dial in this position. If the pointer is above maximum at the beginning of the titration, the pointer will remain above maximum until enough phenylarsene oxide solution has been added to reduce the free chlorine residual (and the cell current) to a point where the pointer will read less than maximum.
- j. The titration procedure consists of adding phenylarsene oxide solution to the sample and observing the action of the meter pointer. If free available chlorine is present in the sample and if the pointer is on scale at the beginning of the titration, then the first addition of phenylarsene oxide solution should produce a definite pointer movement to the left (down).

As long as the pointer is on scale, each additional increment of phenylarsene oxide solution should move the pointer down as long as free available chlorine is present. If the pointer goes below 10 during the addition of phenylarsene oxide solution, then it should be brought back on scale by rotating the turns-counting dial clockwise.

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In most waters the endpoint of the reaction is just passed when the addition of PAO solution (equivalent to the previous increment) does not deflect the pointer as much as the previous increment did. The pointer in this case may or may not move, but the deflection in any case will be much less than the previous deflection for an equal increment of PAO solution. If the switch is in mg/L position (0.00564N PAO solution is used), the amount of PAO solution used in the titration is then read from the pipette, the last increment is subtracted from the pipette reading, and the resultant figure, represents the free available residual chlorine in mg/L. If the switch is in $\mu\text{g/L}$ position (0.000564N PAO solution is used), the amount of PAO solution used in the titration is read from the pipette, the last increment is subtracted from the pipette reading, and the resultant figure, divided by 10, represents the free available chlorine in mg/L. Adjust the turns-counting dial to indicate 20 on the meter, and pull the brake lever down to lock the dial in position. This setting represents the approximate endpoint for that particular water on subsequent tests. As the indicator nears this endpoint setting, add PAO solution slowly to avoid overshooting the endpoint.

- Determination of Total Residual Chlorine

The general procedure for measuring total residual chlorine is the same as that given for measuring free available residual chlorine except for the following:

- a. The titration is performed at pH4 (3.5 - 4.5) instead of pH7 (6.0 - 7.5).
- b. Potassium iodide is added to the sample before the titration is started so that all the chlorine in the sample is converted to free iodine.

The first six steps (a through f) given for free available residual chlorine also apply to total chlorine determinations. Step (g) becomes:

“Add one mL of potassium iodide solution and one mL of buffer solution pH4 to the water sample. When potassium iodide is added, the pointer may first deflect to the left and then go up-scale.”

The remaining steps apply to total residual measurement if “total chlorine” is substituted for the phrase “free available chlorine”.

If the switch is in mg/L position (0.00564N PAO solution is used), the final burette reading, minus the last increment added, represents the total residual chlorine in mg/L.

If the switch is in $\mu\text{g/L}$ position (0.000564N PAO solution is used), the final burette reading, minus the last increment added, is divided by 10. The resultant figure represents the total residual chlorine in mg/L.

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- Determination of Free Available Residual Chlorine and Combined Residual Chlorine

Free available residual chlorine and combined residual chlorine may be measured in one sample by combining the two foregoing procedures. The free available residual chlorine is measured first. Potassium is added to the sample and mixed. The pH is then dropped to 4 by adding buffer solution of pH4 and mixing. If combined residual chlorine is present, the pointer will deflect to the right when potassium iodide is added and a further titration will be obtained. The first titration will represent the free available residual chlorine while the second titration will represent the combined residual chlorine.

NOTE: If free available residual chlorine determinations are to be made after potassium iodide has been used in preceding titrations, rinse the cell unit off in several sample jars of water to remove traces of potassium iodide solution and buffer solution pH4.



CAUTION: Do not polish or mechanically “clean” the center silver electrode. This would remove the silver chloride coating from the reference electrode.

- Determination of Residual Potassium Permanganate

Residual potassium permanganate is determined on the titrator using the same procedure as given for free available residual chlorine, i.e., using buffer solution pH7.

If the switch is in mg/L position (0.00564N PAO is used), multiply the milliliters of PAO used by 1.5 to obtain the KMnO₄ residual in mg/L (1.0 mL of 0.00564N PAO = 0.297 mg KMnO₄).

If the switch is in µg/L position (0.000564N PAO is used), multiply the milliliters of PAO used by 0.15 to obtain the KMnO₄ residual in mg/L (1.0 mL of 0.000564N PAO = 0.0297 mg KMnO₄).

Any free available residual chlorine in the sample can be suppressed by adding 0.5 mL of 0.1M ammonium chloride (approx. 5.35 gm/L) solution with the pH7 buffer and waiting five minutes for it to react with the free chlorine before proceeding with the titration.



CAUTION: The porous wick in the cell of the titrator tends to become coated with manganese dioxide. This can be readily removed by soaking the cell in a 5% solution (approx. 50 gm/L) of sodium bisulfite. The cell must then be thoroughly rinsed to remove all traces of the sodium bisulfite before it is restored to service.

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- Determination of Mono-chloramine and Di-chloramine

The titration procedures given previously cover the determination of free available residual chlorine, combined residual chlorine, or total residual chlorine. In certain cases, it may be desirable to determine the concentration of mono-chloramine and di-chloramine in a sample and this can be accomplished on the titrator. The following procedure outlines the method of measuring free available residual chlorine, mono-chloramine and di-chloramine in one sample:

- a. Titrate for free available residual chlorine as described in paragraph a; i.e., at pH7 (6.0 - 7.5) and with no potassium iodide in the sample. Note the pipette reading at the endpoint.
- b. Add 0.2 mL of potassium iodide solution to the sample.

NOTE: The dropper furnished with the equipment delivers approximately 20 drops per mL. Therefore, four drops correspond to 0.2 mL.

If mono-chloramine is present, the needle will deflect to the right and it will be possible to continue the titration to a second endpoint. Note the pipette reading at this endpoint. The difference between this pipette reading and the reading obtained in the free determination represents mono-chloramine.

NOTE: This titration is performed at pH7 (6.0 - 7.5) with four drops of potassium iodide in the sample.

- c. Drop the pH of the sample to 4 (3.5 - 4.5) by adding one mL of buffer solution pH4 and add one mL of potassium iodide solution. If di-chloramine is present, the pointer will deflect to the right and it will be possible to continue the titration to a third endpoint. Note the burette reading at this endpoint. The difference between this reading and reading obtained in Step d represents di-chloramine.

- Determination of Iodine

Total available iodine is determined on the titrator by using the procedure given for total available residual chlorine; i.e., using buffer solution pH4 and potassium iodide solution. The potassium iodide is used in this case to improve the sharpness of the endpoint. Although the answer is expressed as total available iodine, it will usually represent free available iodine since combined iodine is very rarely encountered.

It has been stated previously that the PAO (phenylarsene oxide solution) is standardized so that 1.0 mL of 0.00564N solution is equivalent to 1.0 mg/L of chlorine, and 1.0 mL of 0.000564N solution is equivalent to 0.1 mg/L of chlorine. This means that 1.0 mL of 0.00564N PAO solution is

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equivalent to 3.58 mg/L of iodine, and 1.0 mL of 0.000564N PAO solution is equivalent to 0.358 mg/L of iodine. When titrating for iodine, the burette reading in milliliters must be multiplied by 3.58 when 0.00564N PAO is used, or by 0.358 when 0.000564N PAO is used if the answer is to be expressed in mg/L of iodine.

NOTE: Do not confuse this with standardization of iodine solution used in BACK TITRATION.

- Determination of Bromine

Total available bromine is determined on the titrator by using the procedure given for total available residual chlorine; i.e., using buffer solution pH4 and potassium iodide solution. When titrating for bromine, the pipette reading in milliliters must be multiplied by 2.25 when 0.00564N PAO is used, or by 0.225 when 0.000564N PAO is used if the answer is to be expressed in mg/L of bromine. The titrator does not offer a satisfactory method of distinguishing between the free available bromine and combined available bromine.

- Determination of Residual Chlorine in Polluted Waters

The BACK TITRATION described for use in wastewater also applies to waters which are subjected to a high degree of pollution from sewage plants, industrial wastes, etc.

- Determination of Residual Chlorine in Wastewater

In determining residual chlorine in wastewater or effluent, it is necessary to modify the standard titration method given in the first part of this book. Under any conditions of practical chlorination of wastewater, the residual chlorine will be in the form of combined chlorine so that there is no necessity for attempting to distinguish between free chlorine and combined chlorine. Hence, the normal residual determination on wastewater is that for total residual chlorine and this requires the use of potassium iodide.

However, when the standard total residual determination is attempted on wastewater, a portion of the liberated iodine may be consumed by constituents of wastewater during the titration so that the answer is usually too low. In order to prevent this loss, the titration procedure must be modified so that only the merest trace of free iodine is present in the sample at any one time. To distinguish it from the standard titration for total residual chlorine, this specialized procedure is known as BACK TITRATION. The procedure for chlorine residual measurement consists of five steps as follows:

- a. Standardize the iodine solution, using distilled water.
- b. Take sample.

AMPEROMETRIC TITRATOR

- c. Add PAO.
- d. Titrate sample.
- e. Calculate the residual.

For the purpose of discussion, 0.00564N solutions and mg/L residuals will be used in this section. If smaller residuals ($\mu\text{g/L}$) were anticipated, solutions of 0.000564N iodine and PAO would be used. Refer to paragraph 3.3 for the preparation of iodine solution.

- a. The iodine solution is not stable and must be standardized each time titrations are performed. To standardize the iodine the following steps should be followed.

(1) Fill the sample cup with 200 mL of distilled water. Place the sample cup in the titrator and turn the titrator on.

(2) Add 1 mL of pH 4 buffer, 1 mL of potassium iodide (KI), and using the standard clear reagent pump 1 mL PAO (0.00564N) to the water in the titrator sample cup.

(3) Set the indicator needle to approximately 20% (to the left side of the scale).

(4) Slowly add iodine, (using the optional amber reagent pump or a hand pipette) (approximately 0.00564N) until the meter needle first moves to the right (in a positive direction).

(5) Note the amount (mL) of iodine required to neutralize the PAO. This is A, the standardized value of the iodine. The normality of the iodine is $0.00564/A$.

- b. Take sample. Rinse the sample cup and titrator.
- c. The PAO should be added to the sample as soon as possible. The PAO will neutralize the chlorine immediately on addition, reducing the effects of evaporation or continued reaction with the sample water. Add a little more PAO than that which is required to react with the anticipated chlorine residual. For example, if 4 ppm chlorine was anticipated, add 5 mL PAO. If the sample is taken in a 250-mL graduated cylinder, the PAO can be added before the sample is taken, and the sample measurement increased by the amount of PAO added. For instance, if 4 ppm chlorine was anticipated, 5 mL of PAO could be pipetted into the graduated cylinder and the sample would be added to the 205-mL graduation for a 200-mL sample.

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- d. Add one mL of KI and 4 mL of pH4 buffer, and titrate in the same manner as the iodine was standardized (Step (1) (d)).

NOTE: If there is an immediate deflection to the right (in a positive direction), there is still untreated chlorine in the sample, indicating that enough PAO was not added and additional PAO is required.

- e. The residual is calculated using the following equation:

$$\text{Rmg/L Cl}_2 = (\text{mL PAO}) - (\text{mL I}_2 \text{ titrated} / A)$$

example:

- (1) It takes 1.15 mL iodine to neutralize 1.0 mL PAO therefore $A=1.15$.
- (2) Two mL of PAO are added to the sample.
- (3) It takes 0.43 mL I_2 to neutralize the excess PAO.
- (4) The residual equals 1.63 ppm as determined below:

$$2.0 - (0.43/1.15) = 1.63 \text{ mg/L}$$

- Titration for Sulfur Dioxide (SO_2) Measurement

Titrations for SO_2 are the same as a back titration, with the exception that it is not necessary to add PAO to the sample. To correct for the difference in molecular weight the result must be multiplied by 0.9. If this is not done the residual is reported as a negative chlorine residual.

- There are four steps to an SO_2 titration:
 - a. Standardize the iodine solution, using distilled water.
 - b. Take sample.
 - c. Titrate sample.
 - d. Calculate the residual.

For the purpose of discussion, 0.00564N solutions and mg/L residuals will be used in this section. If smaller residuals ($\mu\text{g/L}$) were anticipated, a solution of 0.000564N iodine and PAO would be used.

- a. The iodine solution is not stable, and must be standardized each time titrations are performed. To standardize the iodine the following steps should be followed.

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- (1) Put the sample cup in the titrator and turn the titrator on.
 - (2) Add 4 mL of pH 4 buffer, 1 mL of potassium iodide (KI), and using the clear reagent pump 1 mL PAO (0.00564N) to 200 mL of distilled water in the titrator sample cup.
 - (3) Set the indicator needle to approximately 20% (to the left side of the scale).
 - (4) Slowly add iodine, (using the optional amber reagent pump or a hand pipette) (approximately) 0.00564N until the meter needle first moves to the right (in a positive direction).
 - (5) Note the amount (mL) of iodine required to neutralize the PAO. This is A, the standardized value of the iodine. The normality of the iodine is 0.00564/A.
- b. Rinse the sample cup and titrator. Take sample.
- c. Add 1 mL of KI and 4 mL pH4 buffer, and titrate in the same manner as the iodine was standardized. If there is an immediate deflection to the right (in a positive direction), there is still unreacted chlorine in the sample, and no SO₂ residual. Use a forward titration (refer to 3.5 b) to complete the titration, remembering to subtract out the effect of any I₂ that was added per the equation in step e of BACK TITRATION FOR CHLORINE RESIDUAL MEASUREMENT. If more than one pipette is required to neutralize the SO₂, be sure to note the total amount used from each pipette.
- d. The residual is calculated using the following equation:

$$\text{Rmg/L SO}_2 = (0.9) \times (\text{mL I}_2 \text{ titrated}/A)$$

example:

- (1) It takes 1.15 mL iodine to neutralize 1.0 mL PAO therefore A=1.15.
- (2) It takes 0.43 mL I₂ to neutralize the excess SO₂.
- (3) The residual equals 1.34 ppm SO₂, as determined below:

$$0.9 \times (0.43/1.15) = 0.34 \text{ ppm SO}_2$$

3.6 Titration Calculation Using Nomograph

To determine whether or not the iodine has deteriorated:

- 0.00564N iodine solution:

Add one mL of 0.00564N PAO solution to 200 mL of distilled water. Titrate with 0.00564N iodine solution. The endpoint is reached when a small addition of iodine gives a pointer deflection to the right (up scale) which holds for 15 to 20 seconds. If 1.0 mL of iodine neutralizes the one-mL PAO solution, the iodine solution is 0.00564N. If the iodine solution has deteriorated, the volume of iodine solution to reach the endpoint (something greater than 1.0 mL) is equal to one mL of PAO solution.

- 0.000564N iodine solution:

Add one mL of 0.000564N PAO solution to 200 mL of distilled water. Titrate with 0.000564N iodine solution. The endpoint is reached when a small addition of iodine gives a pointer deflection to the right (up scale) which holds for 15 to 20 seconds. If one mL of iodine neutralizes the one-mL PAO solution, the iodine solution is 0.000564N. If the iodine solution has deteriorated, the volume of iodine solution to reach the endpoint (something greater than one mL) is equal to one mL of PAO solution.

- 0.0282N iodine solution:

Add 5 mL of 0.00564N PAO solution to 200 mL of distilled water. Titrate with 0.0282N iodine solution. The endpoint is reached when a small addition of iodine gives a pointer deflection to the right (up scale) which holds for 15 to 20 seconds. If one mL of iodine neutralizes the 5-mL PAO solution, the iodine solution is 0.0282N. If the iodine solution has deteriorated, the volume of iodine solution to reach the endpoint (something greater than one mL) is equal to 5 mL of PAO solution.

- 0.00282N iodine solution:

Add 0.5 mL of 0.00564N PAO solution to 200 mL of distilled water. Titrate with 0.00282N iodine solution. The endpoint is reached when a small addition of iodine gives a pointer deflection to the right (up scale) which holds for 15 to 20 seconds. If one mL of iodine neutralizes the 0.5-mL PAO solution, the iodine solution is 0.00282N. If the iodine solution has deteriorated, the volume of iodine solution to reach the endpoint (something greater than one mL) is equal to 0.5 mL of PAO solution.

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BACK TITRATION for residual chlorine may be made with weaker than 0.0282N (0.00282N) or 0.00564N (0.000564N iodine solution using the above procedures). If mg/L position is selected, use Chart 1 for 0.0282N iodine and Chart 3 for 0.00564N iodine. If $\mu\text{g/L}$ position is selected, use Chart 2 for 0.00282N iodine and Chart 4 for 0.000564N iodine. Follow the steps below:

- a. Locate on line A the mL of 0.0282N iodine solution equal to 5 mL of 0.00564N PAO on Chart 1, or the mL of 0.00282N iodine solution equal to 0.5 mL of 0.00564N PAO on Chart 2, or the mL of 0.00564N iodine solution equal to one mL of 0.00564N PAO on Chart 3, or the mL of 0.000564N iodine solution equal to one mL of 0.000564N PAO on Chart 4.
- b. Locate on line C the volume of iodine as determined in Step (8) of the BACK TITRATION procedure.
- c. Determine where a line connecting these points crosses line B. This is the excess of phenylarsene oxide solution.
- d. As expressed in the formula, the mg/L of chlorine residual is the excess phenylarsene oxide subtracted from the total.

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EXAMPLES OF USING CHART 1

EXAMPLE 1

mL total PAO	= 5
mL iodine equal to 5 mL of PAO	= 1.0 (0.0282N)
mL iodine to reach endpoint of BACK TITRATION	= 0.6
mL excess PAO (from Chart 1)	= 3.0
mg/L chlorine residual	= $5 - 3 = \underline{2}$

EXAMPLE 2

mL total PAO	= 10
mL iodine equal to 5 mL of PAO	= 1.2
mL iodine to reach endpoint of BACK TITRATION	= 0.4
mL excess PAO (from Chart 1)	= 1.6 (approx.)
mg/L chlorine residual	= $10 - 1.6 = \underline{8.4}$

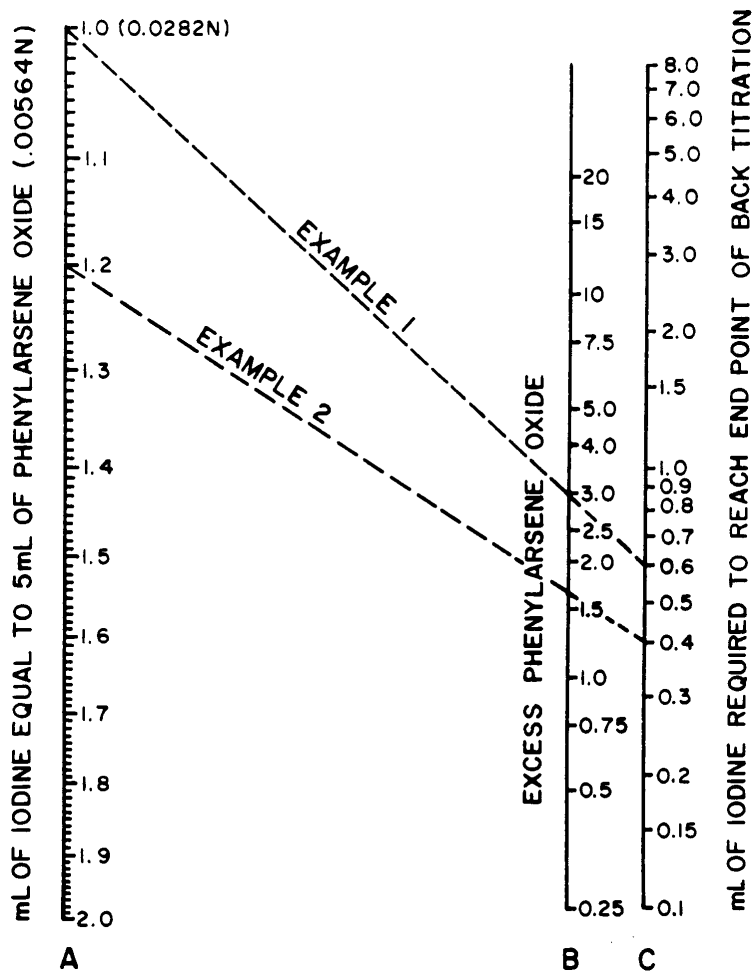


CHART 1

AMPEROMETRIC TITRATOR

EXAMPLES OF USING CHART 2

EXAMPLE 1

mL total PAO	= 5
mL iodine equal to 0.5 mL PAO	= 1.0 (0.00282N)
mL iodine to reach endpoint of BACK TITRATION	= 6
mL excess PAO (from Chart 2)	= 3
 mg/L chlorine residual	 = 5 - 3 = <u>2</u>

EXAMPLE 2

mL total PAO	= 10
mL iodine equal to 0.5 mL PAO	= 1.2
mL iodine to reach endpoint of BACK TITRATION	= 4
mL excess PAO (from Chart 2)	= 1.6 (approx.)
 mg/L chlorine residual	 = 10 - 1.6 = <u>8.4</u>

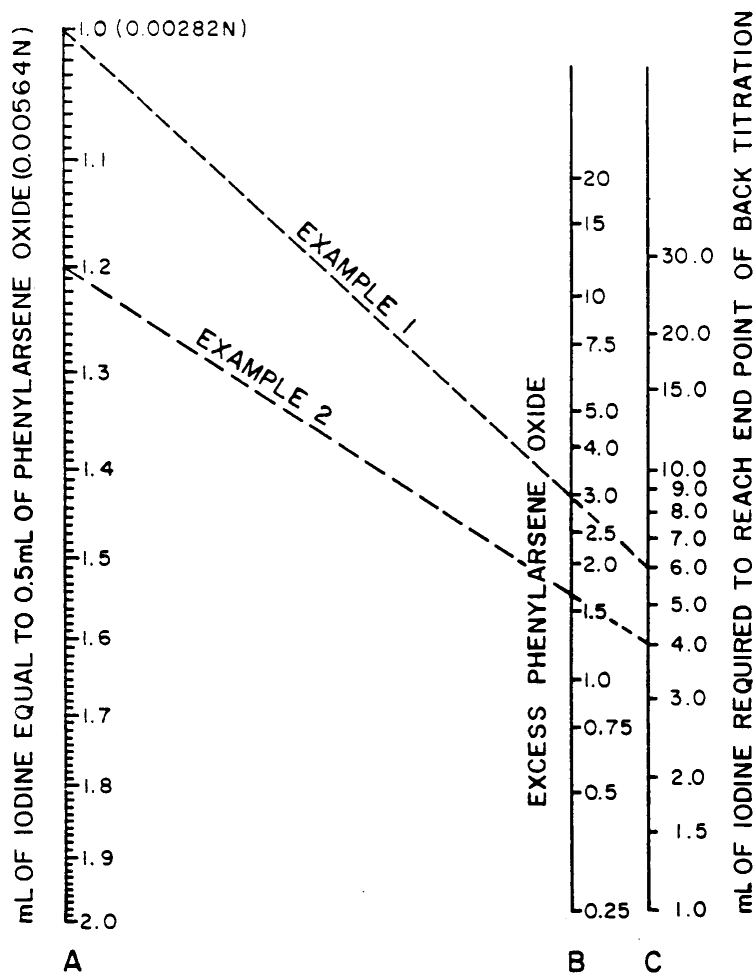


CHART 2

AMPEROMETRIC TITRATOR

EXAMPLES OF USING CHART 3

EXAMPLE 1

mL total PAO	= 1.0
mL iodine equal to one mL of PAO	= 1.0 (0.00564N)
mL iodine to reach endpoint of BACK TITRATION	= 0.6
mL excess PAO (from Chart 3)	= 0.6

mg/L chlorine residual = 1.0 - 0.6 = 0.4

EXAMPLE 2

mL total PAO	= 1.0
mL of iodine equal to one mL of PAO	= 1.2
mL iodine to reach endpoint of BACK TITRATION	= 0.4
mL excess PAO (from Chart 3)	= 0.33 (approx.)

mg/L chlorine residual = 1.0 - 0.33 = 0.67

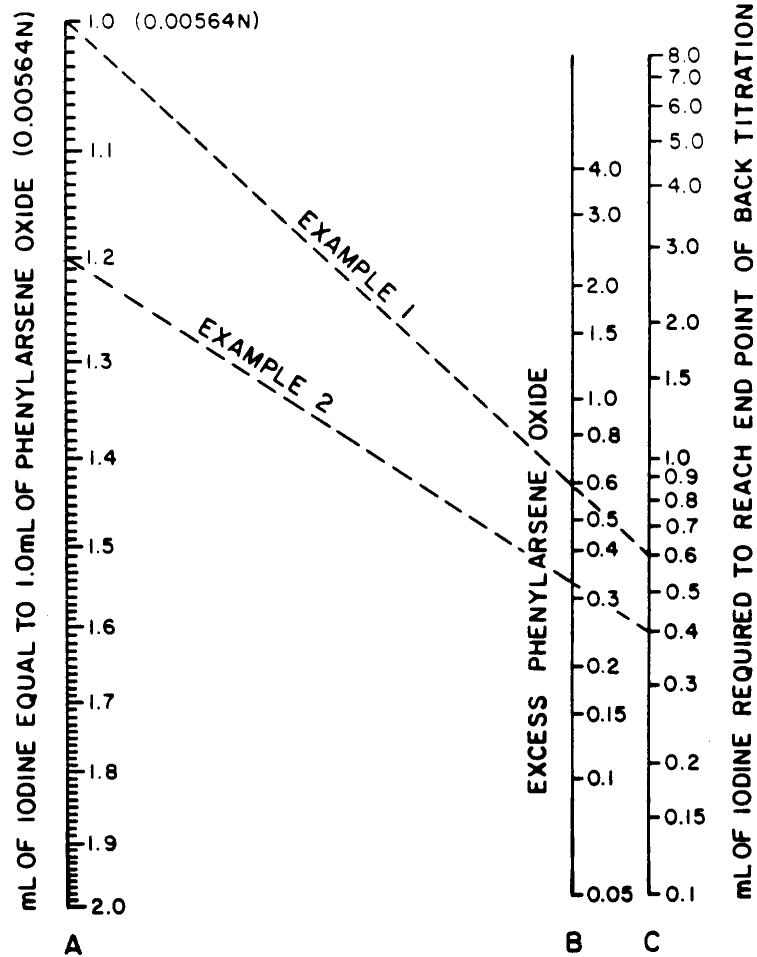


CHART 3

AMPEROMETRIC TITRATOR

EXAMPLES OF USING CHART 4

EXAMPLE 1

mL total PAO	= 10
mL iodine equal to one mL PAO	= 1.0 (0.000564N)
mL iodine to reach endpoint of BACK TITRATION	= 0.6
mL excess PAO (from Chart 4)	= 0.6
 mg/L chlorine residual	 = (10x.1) - 0.6 = <u>0.4</u>

EXAMPLE 2

mL total PAO	= 10
mL iodine equal to one mL PAO	= 1.2
mL iodine to reach endpoint to BACK TITRATION	= 0.4
mL excess PAO (from Chart 4)	= 0.33 (approx.)
 mg/L chlorine residual	 = (10x0.1) - 0.33 = <u>0.67</u>

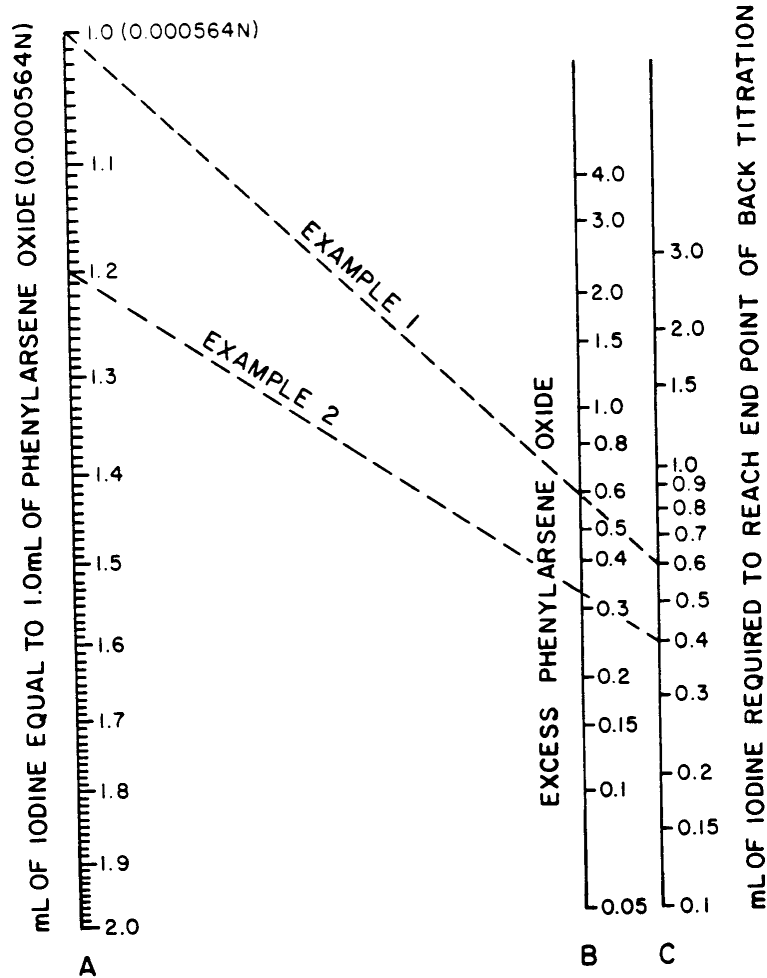


CHART 4

3.7 General Operating Suggestions

- Accuracy of Titration

The overall accuracy of the titration is governed by the volume of the sample, the strength of the reagent solution, and the degree of precision with which the endpoint can be determined.

The sample volume can be expected to have an error of less than 2% if the sample is measured (bottom of meniscus) to the line on the cup with reasonable care.

The phenylarsene oxide solution used with the titrator has been found to be extremely stable and in general, may be ruled out as a source of error.

The precision of the endpoint is largely a matter of the size of the increments of phenylarsene oxide solution which are added to the sample as the endpoint is approached. With a little practice, it is possible to manipulate the valve on the applicator to add increments of 0.01 mL or less. The one-mL pipette reads directly to 0.01 mL and smaller volumes may be estimated. Normally, the addition of less than 0.01 mL of reagent solution will produce a deflection of the pointer as long as free chlorine (or free iodine) is present.

NOTE: To maintain accuracy during the more sensitive testing (0.5 mg/L chlorine or less) it is recommended that the titration be completed within a six-minute period.

- Panel Meter Scale

It should be noted that the numbers on the meter scale have no significance as far as the titration procedure is concerned. The value of residual chlorine is always determined from the pipette reading.

The meter simply provides a method of determining whether or not the cell current changes (decreases) when phenylarsene oxide solution is added to the sample. The point at which the cell current ceases to change with the addition of phenylarsene oxide solution is the endpoint. It makes no difference whether the pointer reads 20, 50, or 80 when the endpoint is reached. The main consideration is to have the pointer somewhere on the scale at the endpoint so that the movements of the pointer can be correlated with the additions of the reagent solution.

In practice, position the turns-counting dial so that the pointer reads about 20 on the scale when the endpoint is reached. This provides leeway against overshooting the endpoint.

- Speed of Titration

When the titrator is used regularly on a given water to measure a given type of residual chlorine, the turns-counting dial can be left alone once it has been positioned to make the pointer read about 20 at the endpoint. Subsequent titrations can be expected to reach the endpoint at about the same pointer position. If this procedure is followed, the titration can be speeded up. The pointer is allowed to go off-scale to the right and the reagent solution is added rapidly. As soon as the pointer shows signs of coming down, the addition of the reagent solution is stopped and the pointer is observed. Usually, the pointer will stop above the endpoint so that the final titration steps can be done in small increments.

Different types of water may have different endpoints and thus require different turns-counting dial settings. The endpoint for free available residual chlorine may be different from that for combined residual chlorine and again call for slightly different turns-counting dial settings.

3.8 Routine Operating Suggestions

- In routine operation, when the titrator is being used regularly, keep enough water in the cup to keep the cell unit wet at all times. At the conclusion of a titration on finished water, do not leave sample in the cup unless consecutive titrations are to be made. Replace sample with distilled or tap water. If the water being tested contains alum or is wastewater, rinse the cell unit off two or three times with distilled or tap water after the titration has been completed. Leave the sample jar filled with distilled or tap water between titrations.
- If the meter needle is jumpy or erratic, it generally indicates that the cell unit electrical contacts are dirty and require cleaning. Refer to SERVICE. Check that plastic tubing feeding reagent is submerged at least 1/4 inch below sample surface.
- The normal reaction of the cell unit to potassium iodide has been previously described. Occasionally, when potassium iodide is added to the sample, the pointer will drop to the left and will not come back on scale even though the turns-counting dial is turned completely clockwise. Under these conditions, the cell unit is said to have lost its sensitivity to iodine. This situation is likely to arise if the titrator has been used to determine free chlorine only for extended periods of time; i.e., the cell unit has not been exposed to iodine for prolonged periods.
- The sensitivity of the cell unit to iodine can be restored by adding enough free iodine to the water in the sample jar to create a yellowish color. The free iodine may be in the form of tincture of iodine or may be obtained by

adding potassium iodide to a strong chlorine solution. Agitate the sample for two or three minutes and then allow the cell unit to stand in the iodine solution for 10 to 15 minutes. After this treatment, rinse the cell unit off thoroughly to remove all traces of free iodine.

- Good laboratory practice dictates filling the pipette to the top and running the contents to waste before beginning a series of titrations.
- The main requirement as far as electrolyte tablets are concerned is to have saturated electrolyte solution inside the cell unit at all times. Theoretically, this requirement is met as long as any tablets and water are in the cell unit. The actual water level inside the cell unit cannot be controlled since this level tends to equalize with (or even go below) the water level in the sample jar through the porous wicking. The salt tablets may disappear within the cell unit, leaving just water. Add salt tablets to the water within the cell unit to ensure a saturated salt solution.

NOTE: Always replace the cell unit stopper after recharging.

3.9 Conditions Affecting Operation

- Chemical Substances

Substances, such as iron and manganese, which ordinarily interfere with the colorimetric determination of residual chlorine, have no effect on the results obtained with the titrator when the titration is performed under the conditions specified in the titration procedures. Many other substances such as nitrites, nitrates, phosphates, sulphates, carbonates, borates, chlorides, chlorites, hydrogen peroxide, calcium aluminum and copper have been tested and found to have no effect on the accuracy of the titration. In the presence of more than one mg/L of copper, the response of the meter is slow but accuracy of the titration is not affected.

- Color and Turbidity

Color and turbidity of the sample do not interfere with the determination.

- Sample pH

Adhere to the pH ranges specified in the titration procedures. On a total or combined determination, it is especially important to have the sample pH at less than 4.5 because di-chloramine does not give a rapid and quantitative release of iodine from potassium iodide above this value. The sample pH should be above 3.5 on a total or combined determination because manganese will interfere with the titration below pH 3.5.

The volumes of buffer solutions specified will adjust the pH of most waters to a value within the required ranges. In special cases, it may be necessary to use more than one mL of buffer solution. If there is any doubt as to whether additional buffer solution is required, measure the pH of the sample after the normal quantity of buffer solution has been added. If the pH is not within the required limits, then experimentation will be required to find the correct volume of buffer solution.

- Reagent Solution

Phenylarsene oxide solution is used in the titrator because it is extremely stable and reacts satisfactorily with free chlorine or free iodine over a wide range of pH.

- Temperature

Accuracy of the titration is not affected by the temperature of the sample. At low temperatures, the response of the meter is slower and greater care is needed in performing the titration.

4 SERVICE

Maintenance of a Series A-790 Titrator consists of three periodically performed operations:

- Periodic Performance Checks to detect the onset of any deteriorating conditions before their progress leads to serious malfunction.
- Periodic Cleaning to remove contaminants and deposits brought to the unit.
- Periodic Preventive Maintenance to disassemble, inspect, clean and accomplish recommended parts replacements. Kits of replacement parts required for this periodic maintenance are available and are listed in PREVENTIVE MAINTENANCE KITS.

PROTECT YOUR EQUIPMENT INVESTMENT
MINIMIZE DOWNTIME
REORDER A PREVENTIVE MAINTENANCE KIT NOW
KEEP ONE ON HAND

4.1 Motor

Place one or two drops of light machine oil on the motor bearings every five or six months.

4.2 Cell Unit

The electrolyte used in the inner chamber of the cell unit has a tendency to crystallize out on the contact springs, and on the terminals of the cell unit. This may slightly corrode the electrical contacts between the various units. Improper electrical connections cause erratic meter pointer readings during the titration.

If any crystals accumulate on the plastic cell unit, wash these parts off with warm water.



CAUTION: Never use water warmer than 125°F as hot water softens this plastic.

When most of the electrolyte tablets in the inner chamber of the cell are used up, replenish them. Before replenishing the electrolyte tablets, examine the platinum electrode and the cell unit terminals. If the platinum is dirty, it may be cleaned by rubbing it lightly with chlorine-free scouring powder and water. Rub the platinum surface lightly with the fingers and be careful not to disturb the porous wicking which lies between the turns of the platinum ribbon. A paper towel wrapped around platinum and rotated as a right handed thread will remove light dirt from the platinum.

To verify proper cell operation, proceed as follows:

- a. Make sure the cell unit has sufficient electrolyte tablets and distilled water. If newly added, wait 15 to 30 minutes before proceeding.
- b. Insert cell unit into titrator which must be in power OFF position.
- c. Fill sample cup with water and place over cell unit of titrator. Observe meter. Pointer must move upscale for a few meter divisions.
- d. If no response at c above, proceed as follows:
 - (1) Clean cell unit of salt deposits. Use distilled water.
 - (2) Clean titrator cell contacts of all salt deposits and check for good contacts between cell and clips within the housing.
 - (3) Repeat c above. If still no results, proceed as follows:

Disconnect cell unit from titrator. Remove salt and distilled water from cell unit and check platinum and silver electrodes for continuity. Resistance to be about 1-8 ohms from lower end of platinum ribbon to left post and about 0-2 ohms from the center silver electrode to the right post. If above resistance is higher check for open circuit or poor contact between platinum or silver electrode and contact plugs.

- e. If cell shows poor response, check for sufficient reference electrolyte solution seepage as follows:
 - (1) Unplug cell unit from titrator and remove cup and shaft unit.
 - (2) Observe salt water seeping through the wicking between the turns of platinum ribbon. Droplets of water should form at the wicking after a few minutes. They should run together and fall off at a rate of about one drop every one to five minutes.
 - (3) In case of a very low dripping rate, the wicking (cotton threads) is too tight and can be loosened up using a fine point needle.

4.3 Reagent Pump Unit (See Dwg. 50.262.001.010)

When the pipette is inserted in the top of the pump unit, push down so the lower end of the pipette is held in position by the bore of the pump body as well as by the O-ring.

The check valve of the reagent pump consists of seat holder (3), O-rings (4, 5), ball (6), spring (21) and ball guide (7). If the pipette indicates a leak above 0.01 mL in two minutes, the O-ring and ball and spring combination need adjustment as follows:

- a. Remove the squeeze bottle and pull out seat holder unit (3).
- b. Remove one washer (22) around the spring.
- c. Replace the holder and recheck the check valve for leakage.
- d. If a leak persists, replace O-ring (5) within the seat holder. To do this bend a paper clip 90 degrees at one end for about 1/32 inch from the end of the wire. Use this to remove the old O-ring being careful not to scratch the bore of the seat holder.
- e. Wet new O-ring (5) and insert it into the holder using ball guide (7) so that it seats flat at the bottom of seat holder (3).
- f. Add ball (6), spring (21) and one or two washers to position the seat holder correctly to properly tension the spring when it is within reagent valve body (13).
- g. Attach the plastic bottle and fill with reagent so as to again check the leakage rate.
- h. If valve doesn't leak but great difficulty is experienced in squeezing the bottle, add another washer to reduce the squeeze force but still not unseat ball (6). Dirt should be excluded because if it lodges on the O-ring or ball, leakage may develop.

- i. If pipette becomes broken, clean carefully and remove all small particles or glass so as to not damage the seat check valve.
- j. If filter plug (24) is dirty, replace with a new filter plug furnished with spare parts.

NOTE: Refer to the instruction sheet provided with the back titration kit for servicing that unit.

4.4 Electronic Circuitry

To verify proper functioning of circuitry, proceed as follows:

- a. Remove cell unit.
- b. Rotate switch to mg/L position; motor should run.
- c. Rotate turns-counting dial to the left; meter pointer must hit the left scale stop.
- d. Rotate turns-counting dial to the right; meter pointer must hit the right scale stop.
- e. Turn knob very slowly to allow the meter pointer to go from maximum scale to zero without the pointer hanging or binding at any point between 0 to 100%.
- f. Position meter pointer near 50% scale and observe pointer to remain at set position for a few minutes. Shake titrator gently and check meter for intermittent pointer reaction. No intermittent circuit or jumping to zero or maximum permitted. Pointer to remain at set point.
- g. Turn switch to OFF.

4.5 Periodic Preventive Maintenance

Because of aging of elastomeric components and the desirability of checking internal zones for possible accumulations of deposits not seen in routine maintenance, it is recommended that at one-year intervals, each of the principal components be completely disassembled. Before starting the work, ensure that the appropriate preventive maintenance kit is on hand.

Refer to the tabulated listing below and Preventive Maintenance Kits for appropriate kit numbers.

Disassembly and reassembly instructions necessary to install the maintenance kit parts are included in the kit.

AMPEROMETRIC TITRATOR



WARNING: TO AVOID POSSIBLE SEVERE PERSONAL INJURY FROM ELECTRICAL SHOCK, REMOVE POWER PLUG FROM POWER SOURCE BEFORE SERVICING.

Servicing of Evoqua Water Technologies Amperometric Titrator including installation of parts from maintenance kits should be restricted to trained, authorized personnel who are completely familiar with the entire contents of the equipment instruction book. The dealer from whom you purchased the equipment can provide the preventive maintenance kits or overhaul service.

Maintenance Item	When To Perform	Maintenance Kit No.
Titrator	At one-year intervals.	U26730

5 INSPECTION

After the disassembled parts are cleaned and prior to reassembly perform the following:

- a. Check for physical damage to removed parts (chipped, cracked, damaged threads, etc.). Replace damaged parts.
- b. Discard and replace all removed O-rings, seals and gaskets.

WARNING LABEL

The following warning label has been attached to the equipment and is listed below.

L2016: TO AVOID POSSIBLE SEVERE PERSONAL INJURY FROM ELECTRICAL SHOCK TURN POWER OFF BEFORE SERVICING.

AMPEROMETRIC TITRATOR

PREVENTIVE MAINTENANCE KITS AND SPARE PARTS

SERIES A-790 AMPEROMETRIC TITRATOR

DESCRIPTION	PART NO.
Preventive Maintenance Kit **	U26730
Back Titration Kit (Optional)	G2359

ADDITIONAL SPARE PARTS

QUANTITY	DESCRIPTION	PART NO.
2	O-Ring (Pipette)	P12530
10 in.	Tubing	RP154412
2	O-Ring (Bottle Cap)	PXA27409
4	O-Ring (Stem Units)	PXA24161
2	O-Ring (Stem Adapter)	PXA38347
1 set	Pipette	U20751*
4 oz.	Potassium Iodide	U28959
8 oz.	Electrolyte Tablets	U9936
4 oz.	PAO	U28961
16 oz.	PAO	U10533
1 gal.	PAO	U25213
4 oz.	pH4 Buffer	U28962
1 gal.	pH4 Buffer	U24494
4 oz.	pH7 Buffer	U28960
16 oz.	pH7 Buffer	U23036
3	Fuse (Normal Blow, 1/4 Ampere)	P46807

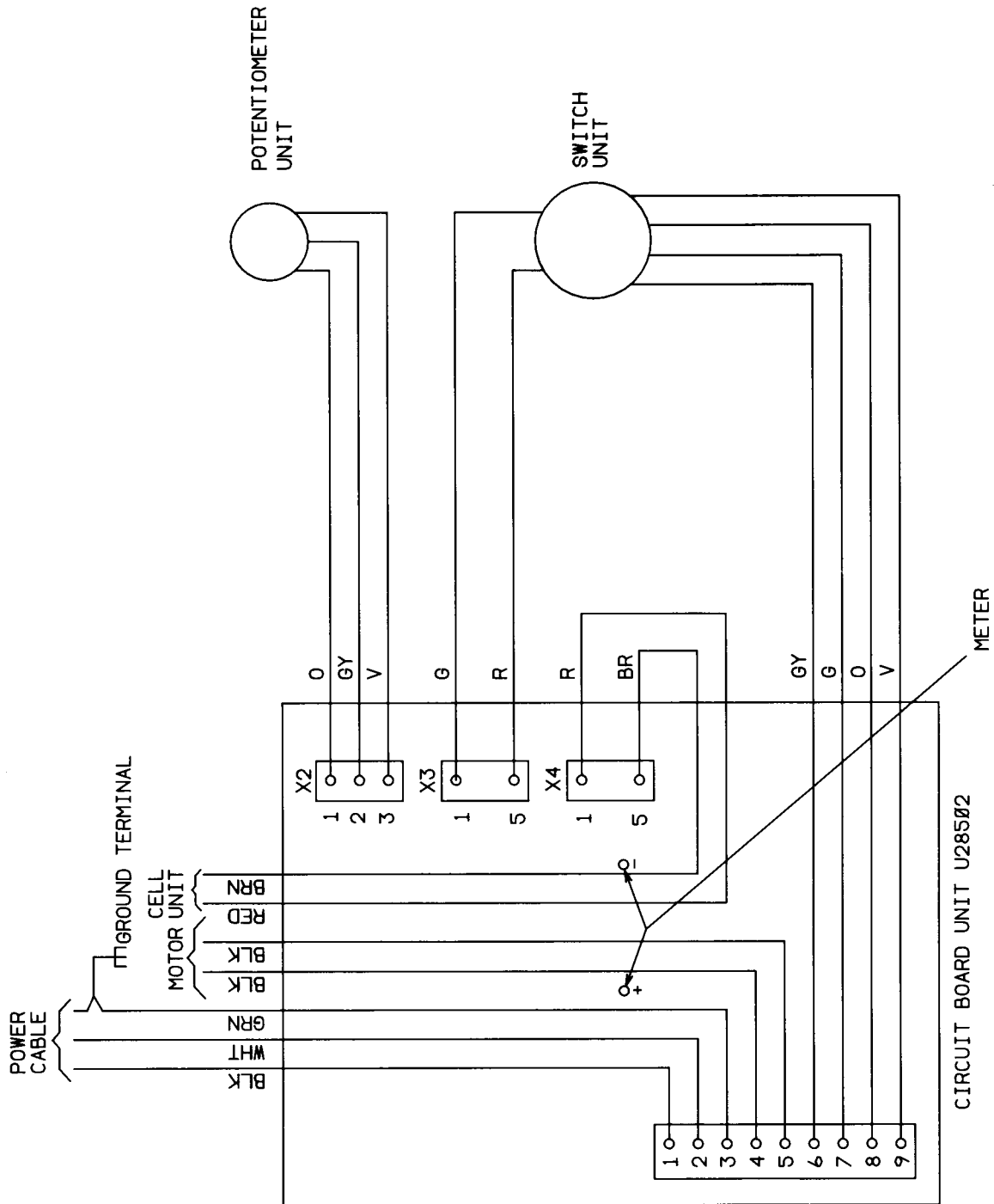
REAGENT PUMP PARTS

1	Spring	P36606
1	Ball	P41267
1	O-Ring	P43611
2	Washer	P42080
1	Seat Holder	U25370
1	Ball Guide	P43613
1	Vent	P43518
5	Filter Plug	P53827

*Consists of one-mL pipette P43508 and 5-mL pipette P43509.

**If back titration kit is used two Preventive Maintenance Kits are required.

AMPEROMETRIC TITRATOR

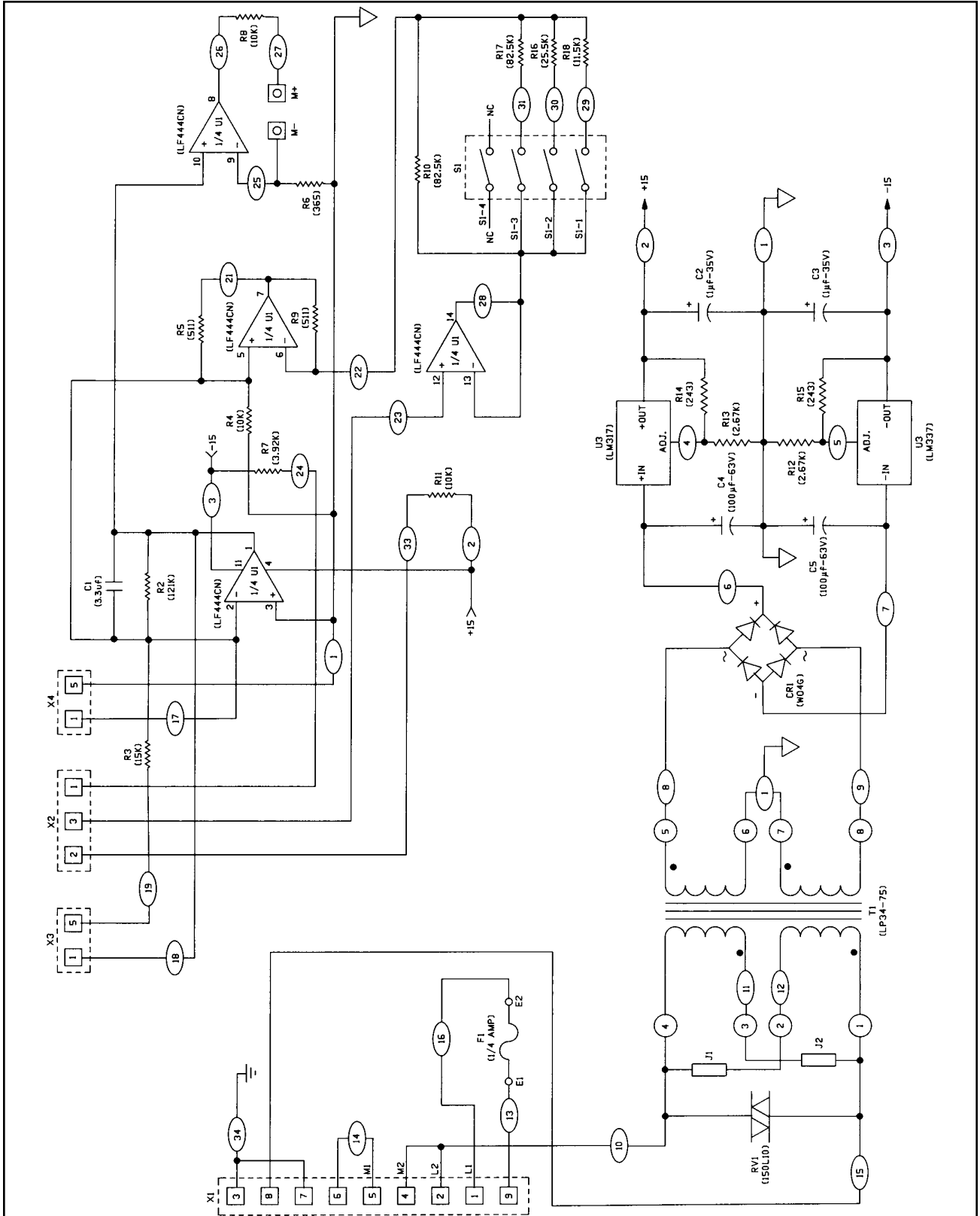


A-790044 AMPEROMETRIC TITRATOR - SCHEMATIC WIRING

50.262.155.013

ISSUE 0 9-92

AMPEROMETRIC TITRATOR

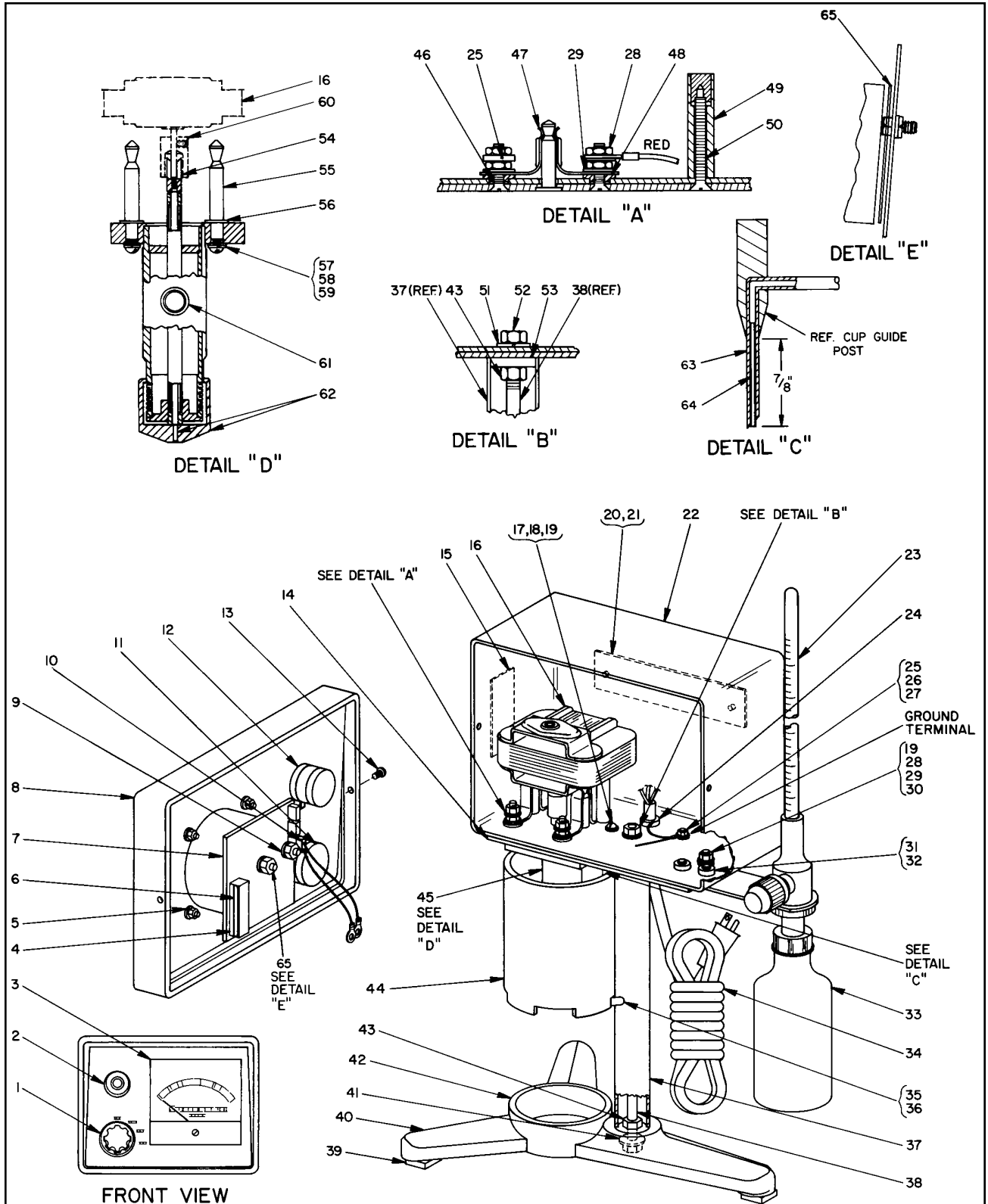


U28502 CIRCUIT BOARD - SCHEMATIC WIRING

50.262.155.020

ISSUE 1 7-92

AMPEROMETRIC TITRATOR



FRONT VIEW

NOTE: FOR PARTS LIST, SEE DWGS. 50.262.000.013B&C.

A-790044 AMPEROMETRIC TITRATOR - PARTS

50.262.000.013A

ISSUE 1 1-01

AMPEROMETRIC TITRATOR

KEY NO.	PART NO.	QTY.	DESCRIPTION
1	P54000	1	Knob
2	U28534	1	Dial
3	U28530	1	Meter
4	P58096	1	Plug (9 Pos.)
5	PC5662	4	#4 Washer (Brass)
6	P58864	1	Marker Strip
7	U28502	1	Circuit Board Unit
8	P58987	1	Bezel
9	P29713	2	1/4" Lockwasher (SS)
10	U28484	1	Cell Connector Assembly
11	U29150	1	Switch Unit
12	U28565	1	Potentiometer Unit
13	P40417	2	Self-Tapping Screw (Pan Hd., SS) #6-32 x 1/2" Lg.
14	P49970	1	Insulating Plate
15	L2016	1	Warning Label
16	U28531	1	Motor Unit
17	P43496	1	Cup Guide Post
18	PC744	1	Mach. Screw (Rd. Hd., Brass) #8-32 x 1/2" Lg.
19	P12850	2	#8 Lockwasher (SS)
20	P12164	1	Nameplate
21	P22447	2	Sheet Metal Screw (Rd. Hd., SS) #4-24 x 1/4" Lg.
22	P59044	1	Housing
23	U20751	1	Pipette Unit
24	P43038	1	Cable Bushing
25	P43747	5	#8 Lockwasher (SS)
26	P29488	1	Hex. Nut (SS) #8-32
27	P43701	1	Mach. Screw (Fil. Hd., SS) #8-32 x 3/8" Lg.
28	P3629	9	Hex. Nut (Brass) #8-32
29	P9581	5	#8 Washer (Brass)
30	P43702	1	Mach. Screw (Flat Hd., SS) #8-32 x 3/8" Lg.
31	P40489	2	Mach. Screw (Rd. Hd., SS) #8-32 x 3/8" Lg.
32	P43507	2	Fastener
33	U28937	1	Reagent Pump Unit (See Drawing 50.262.001.011)
34	U28569	1	Power Cord Unit
35	P43511	2	Mach. Screw (Hex. Hd., SS) #8-32 x 3/8" Lg.

WHEN ORDERING MATERIAL, ALWAYS SPECIFY MODEL AND SERIAL NUMBER OF APPARATUS.

A-790044 AMPEROMETRIC TITRATOR - PARTS LIST

50.262.000.013B

ISSUE 3 3-09

AMPEROMETRIC TITRATOR

KEY NO.	PART NO.	QTY.	DESCRIPTION
36	P43505	2	Cup Support Post
37	P49971	1	Support Tube
38	P43489	1	Tie Rod
39	P44723	3	Bumper
40	P43486	1	Base
41	PC5665	1	1/4" Washer (Brass)
42	P43498	1	Closure
43	PC5875	3	Hex. Nut (Brass) 1/4"-20
44	P43487	1	Cup
45	U22328	1	Cell Unit
46	P11734	4	Mach. Screw (Flat Hd., Brass) #8-32 x 5/8" Lg.
47	PXA43494	12	Spring Contact
48	P9466	4	Insulating Bushing
49	P43493	2	Motor Spacer
50	P21167	2	Mach. Screw (Flat Hd., Brass) #10-32 x 2" Lg.
51	P14635	1	1/4" Lockwasher (SS)
52	P6489	1	Hex. Nut (Brass) 1/4"
53	P44418	1	Washer (Alum.)
● 54	P47324	1	Shaft Nut
● 55	P43482	2	Contact Jack
● 56	P44113	2	Washer (Brass)
● 57	P6977	2	Mach. Screw (Rd. Hd., Brass) #6-32 x 5/16" Lg.
● 58	P6456	2	#6 Washer (Brass)
● 59	P13662	2	#6 Lockwasher (SS)
● 60	U22329	1	Coupling Nut
● 61	P35618	1	Cap Plug
● 62	U21294	1	Impeller Cup & Shaft Unit
63	RP154412	0.552 T.	Tubing (Plastic) 0.002" ID x 0.083/0.099" OD
64	P53840	1	Tubing Pin
65	P60253	1	Insulating Strip

● Part of Key No. 45.

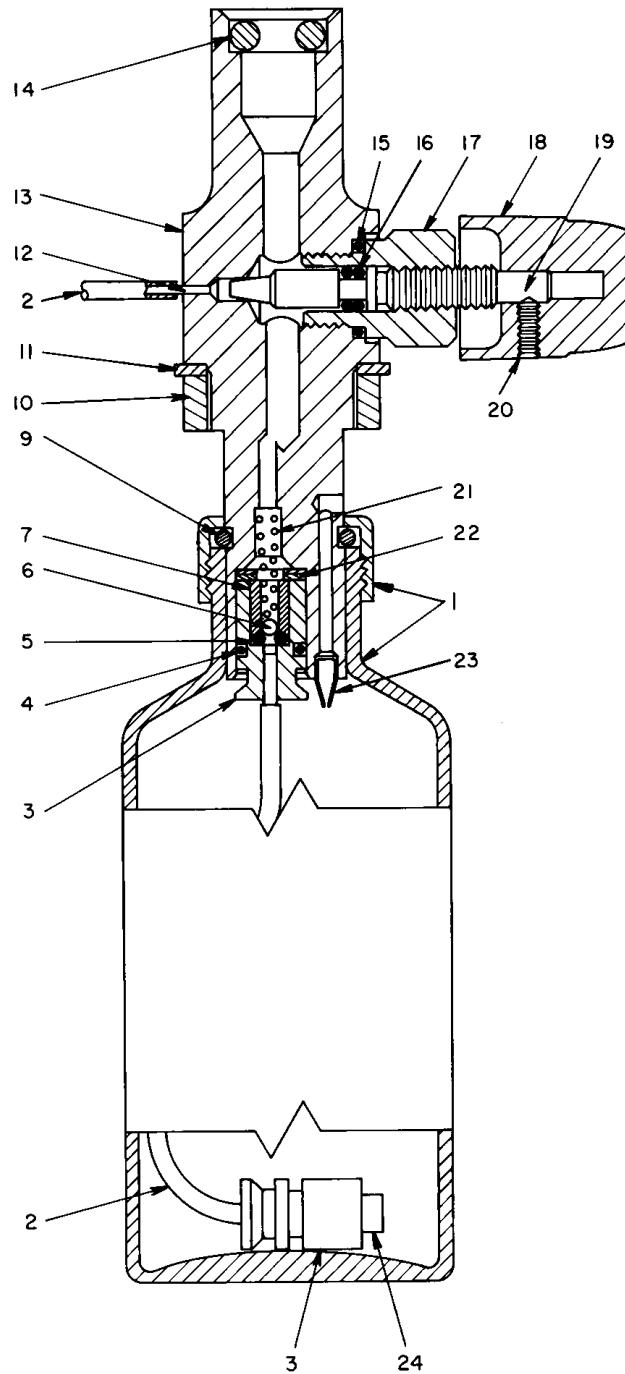
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A-790044 AMPEROMETRIC TITRATOR - PARTS LIST

50.262.000.013C

ISSUE 1 3-09

AMPEROMETRIC TITRATOR



WHEN ORDERING MATERIAL, ALWAYS SPECIFY MODEL AND SERIAL NUMBER OF APPARATUS.

U28937 REAGENT PUMP UNIT - PARTS LIST

50.262.001.011A

ISSUE 3 2-09

AMPEROMETRIC TITRATOR

KEY NO.	PART NO.	QTY.	DESCRIPTION
1	U29212	1	Bottle & Cap
2	RP154412	0.291"	Tubing (Plastic) 0.002" ID x 0.083/0.099" OD
3	U25370	1	Seat Holder
4	PXA25900	1	O-Ring (010) Viton, 1/4" ID x 3/8" OD
5	P53899	1	O-Ring (004) Viton, 5/61" ID x 13/64" OD
6	P41267	1	Ball
7	P43613	1	Ball Guide
9	PXA27409	1	O-Ring (113) Viton, 9/16" ID x 3/4" OD
10	P43515	1	Nut
11	P43500	1	Bracket
12	P43516	1	Nipple (SS)
13	P59708	1	Valve Body
14	P12530	1	Ring Gasket
15	PXA38437	1	O-Ring (013) Viton, 7/16" ID x 9/16" OD
16	PXA24161	2	O-Ring (006) Viton, 1/8" ID x 1/4" OD
17	NPXA2273	1	Adapter Stem
18	NP2304	1	Knob
19	P51482	1	Modified Stem
20	P50178	1	Set Screw (Hex. Hd., SS) #6-32 x 5/16" Lg.
21	P36606	1	Spring
22	P42080	2	#8 Washer (SS)
23	P43518	1	Vent
24	P53827	1	Filter Plug
--	AEK5662	1	Silicone Grease

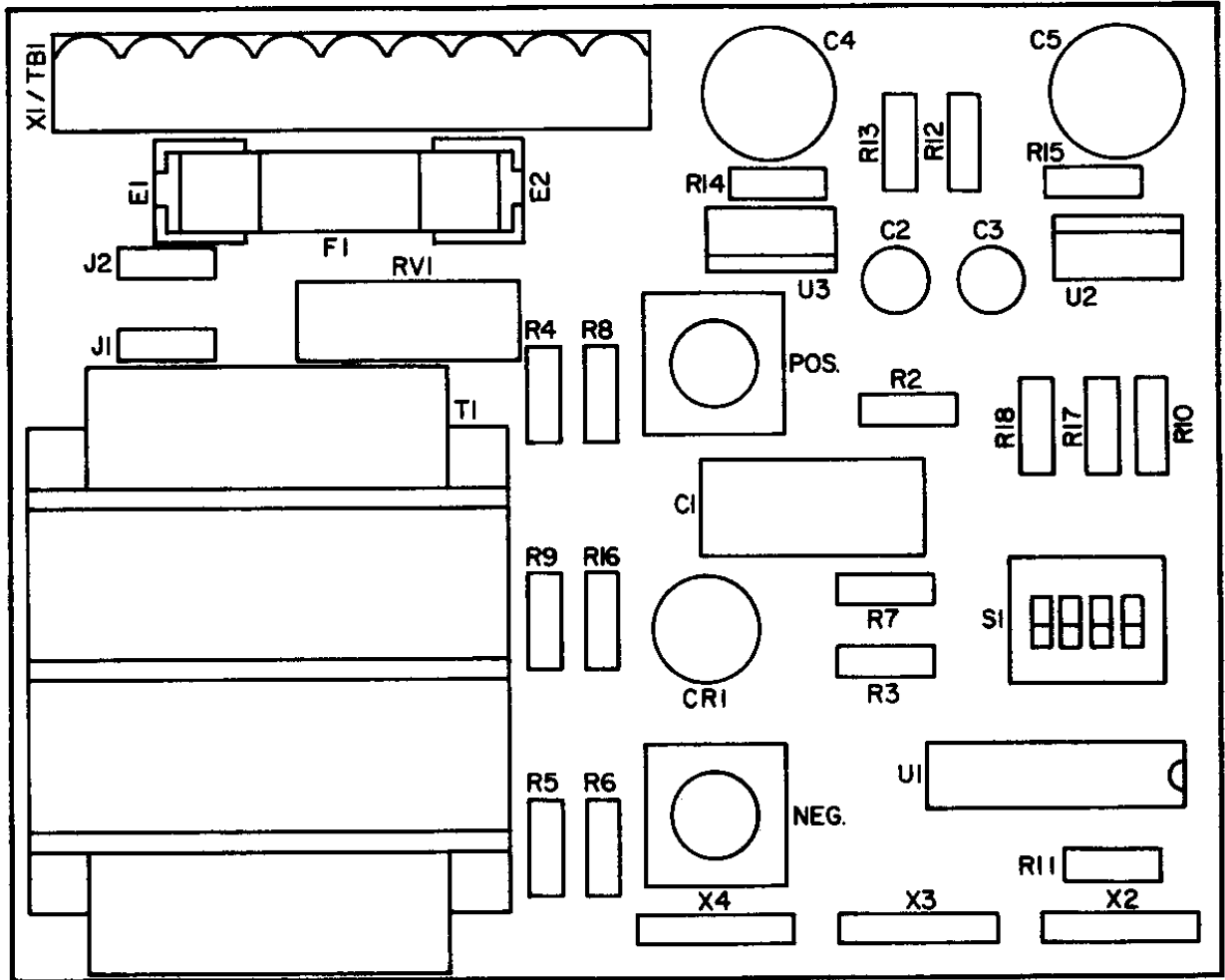
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U28937 REAGENT PUMP UNIT - PARTS LIST

50.262.001.011B

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AMPEROMETRIC TITRATOR



U28502 PRINTED CIRCUIT UNIT - PARTS LIST

50.262.002.010A

ISSUE 2 3-09

AMPEROMETRIC TITRATOR

SYMBOL	PART NO.	DESCRIPTION
C1	P59532	Capacitor, 3.3 μ F/100V, (Panasonic ECQ-E1335KZ)
C2 Thru C3	P56917	Capacitor, 1.0 μ F/35V, (Panasonic ECS-F35E1)
C4 Thru C5	P55028	Capacitor, 100 μ F/63V, (United Chemi-Con SM63VB100)
CR1	P53749	FWB Rectifier
E1 Thru E2	P52740	Fuse Clip
F1	P46807	Fuse, Normal Blow, 1/4A
J1 Thru J2	P53036	Jumper
R2	P57731	Resistor (30.1K, 1/4W, \pm 1%)
R3	P57702	Resistor (3.92K, 1/4W, \pm 1%)
R4	P57714	Resistor (10K, 1/4W, \pm 1%)
R5	P57682	Resistor (511 Ohm, 1/4W, \pm 1%)
R6	P59050	Resistor (365 Ohm, 1/4W, \pm 1%)
R7	P57702	Resistor (3.92, 1/4W, \pm 1%)
R8	P57714	Resistor (10K, 1/4W, \pm 1%)
R9	P57682	Resistor (511 Ohm, 1/4W, \pm 1%)
R10	P57746	Resistor (82.5K, 1/4W, \pm 1%)
R11	P57714	Resistor (10K, 1/4W, \pm 1%)
R12 Thru R13	P57698	Resistor (2.67K, 1/4W, \pm 1%)
R14 Thru R15	P57671	Resistor (243 Ohm, 1/4W, \pm 1%)
RV1	P52208	Varistor (150V)
S1	P58087	Switch, DIP SPST, 4 Pos.
T1	P56926	Transformer, Signal LP34-75
U1	P58767	Quad Op-Amp, National Semiconductor LF444ACN
U2	P58110	Negative Voltage Regulator, LM317
U3	P55593	Positive Voltage Regulator, LM337
X1	P58095	Header (9 Pos.)
X2 Thru X4	U25918	Header (5 Pos.)

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U28502 PRINTED CIRCUIT UNIT - PARTS LIST

50.262.002.010B

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