# SECTION 1
# DESCRIPTION

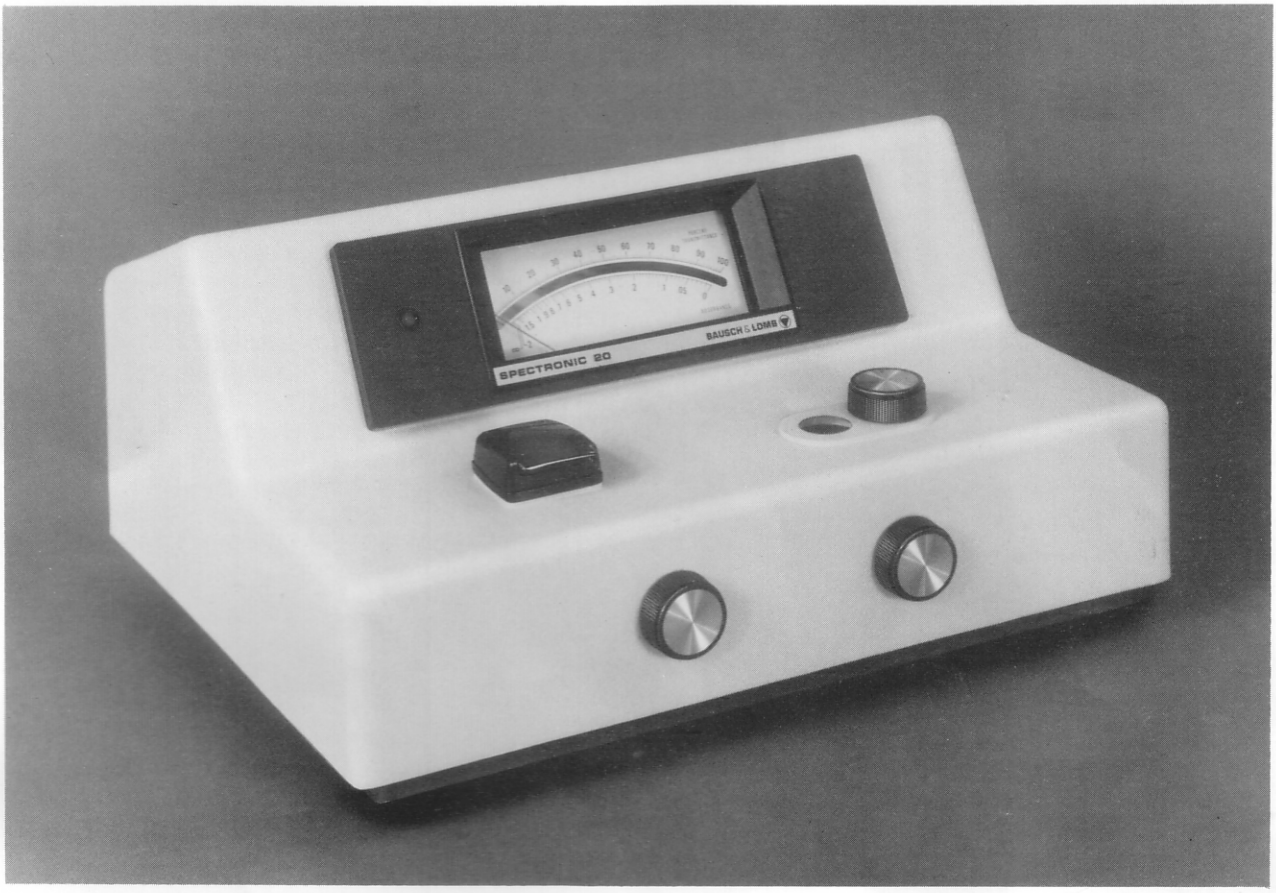


**Figure 1. SPECTRONIC 20 Spectrophotometer**

The SPECTRONIC® 20 (cat. no. 33-31-72), Figure 1, is a single-beam spectrophotometer with an overall wavelength range of 340nm to 950nm. The nominal spectral slit width of 20nm is constant over the entire range.

The basic wavelength of 340nm to 600nm is extended to 950nm by adding an infrared filter (cat. no. 33-29-18) and changing the phototube (requires cat. no. 33-29-72). A special phototube (cat. no. 33-29-89) and filter (cat. no. 33-29-92) combination provides continuous operation from 400nm to 700nm without changing filter or phototube.

The accessory Filter Kit (cat. no. 33-31-28) also provides the capability, in many cases, of extending the overall wavelength ranges, in addition to providing a simple-to-use wavelength calibration filter.

If this manual is being used to operate an older SPECTRONIC 20 spectrophotometer, operational procedures are basically the same as Model 33-31-72 for which this manual is written. For replacement parts for earlier models, consult SPECTRONIC 20 Service Manual (cat. no. 333171-10020), which contains detailed technical description of all SPECTRONIC 20 models.

## 1.1 SPECIFICATIONS

| | |
|---|---|
| Wavelength Range | |
| Standard Phototube | 340nm to 600nm |
| Red Phototube | 600nm to 950nm |
| Wide Range Phototube | 400nm to 700nm |
| Spectral Slit Width | 20nm |
| Wavelength Accuracy | 2.5nm |
| Wavelength Readability | 1.0nm (1/5 division) |
| Stray Radiant Energy | Less than 0.5%T with appropriate stray radiant energy filter (available in accessory filter kit, cat. no. 33-31-28). |
| Photometric Range | 0% to 100%T<br>0A to 2.0A (Non-linear scale) |
| Photometric Readability | 0.5%T |
| Photometric Noise Level | ± 0.5%T |
| Photometric Stability 100%T Drift | 1.0%T/Hour |
| Accessory Output | 0VDC to 1.0VDC |
| Power Requirements | 100, 115, 220, 240VAC, 50/60 Hz, 90VA |
| Size | 41.3cm W x 21.0cm H x 33.0cm D<br>(16.25" W x 8.25" H x 13" D) |
| Weight | 7.9kg (17.4 lbs.) |
| Accessories Supplied | Box of twelve ½-in. test tubes, ½-in. adapter, Operator's Manual, dust cover. |

**Bausch & Lomb reserves the right to change specifications as part of our on-going program of product development.**

## 1.2 OPERATING FEATURES

Figure 2 shows the key features of your spectrophotometer. The three main controls for routine operation are Wavelength Control, Power Switch/Zero Control and Transmittance/Absorbance Control. The accessory Analog Output Jack is located on the underside of the instrument, as shown in Figure 3.

### 1.2.1 Meter

Readings are taken directly from the meter in either transmittance or absorbance mode.

If the meter malfunctions, refer to Table 3, Operator's Troubleshooting Guide.

### 1.2.2 Wavelength Control

The wavelength control selects the desired analytical wavelength of the instrument. The selected wavelength is indicated on the wavelength scale in the window next to the knob. The scale is color-coded to correspond to the operating range of the instrument's phototube: black gradations for the basic 340nm - 600nm range, and red gradations for the 600nm - 950nm range of the optional red phototube/filter combination. All gradations are in 5nm intervals.

### 1.2.3 Power Switch/Zero Control

The ON-OFF main power switch is operated by the Zero Control knob.

Zero Control is used to set the meter to a 0%T readout WHEN THE TEST TUBE ADAPTER IS EMPTY AND THE ADAPTER COVER IS CLOSED.

### 1.2.4 Transmittance/Absorbance Control

This control is used to set the meter to 100%T (0.0A) with a blank reference solution. IT MUST BE RESET WHENEVER THE ANALYTICAL WAVELENGTH HAS BEEN CHANGED. When operating at a fixed wavelength for an extended period of time, periodically check the 100%T (and 0%T) readout and readjust if necessary.

### 1.2.5 Accessory Output Jack

The analog output signal level is factory-set to approximately 1.0 VDC at 100%T. To provide compatibility with a wide variety of readout devices (recorders, digital display units, etc.), the output signal is adjustable from 0.0 to 1.0 VDC at 100%T. For readout devices which may require slightly more than 1 volt, the output signal can be adjusted to 1.3 VDC. However, the manufacturer's recognized output signal for this instrument is 0.0 to 1.0 VDC and the warranty covers performance only within that range.

To make the adjustment, use a small screwdriver on the recessed control marked Analog Output Adjustment in Figure 3.

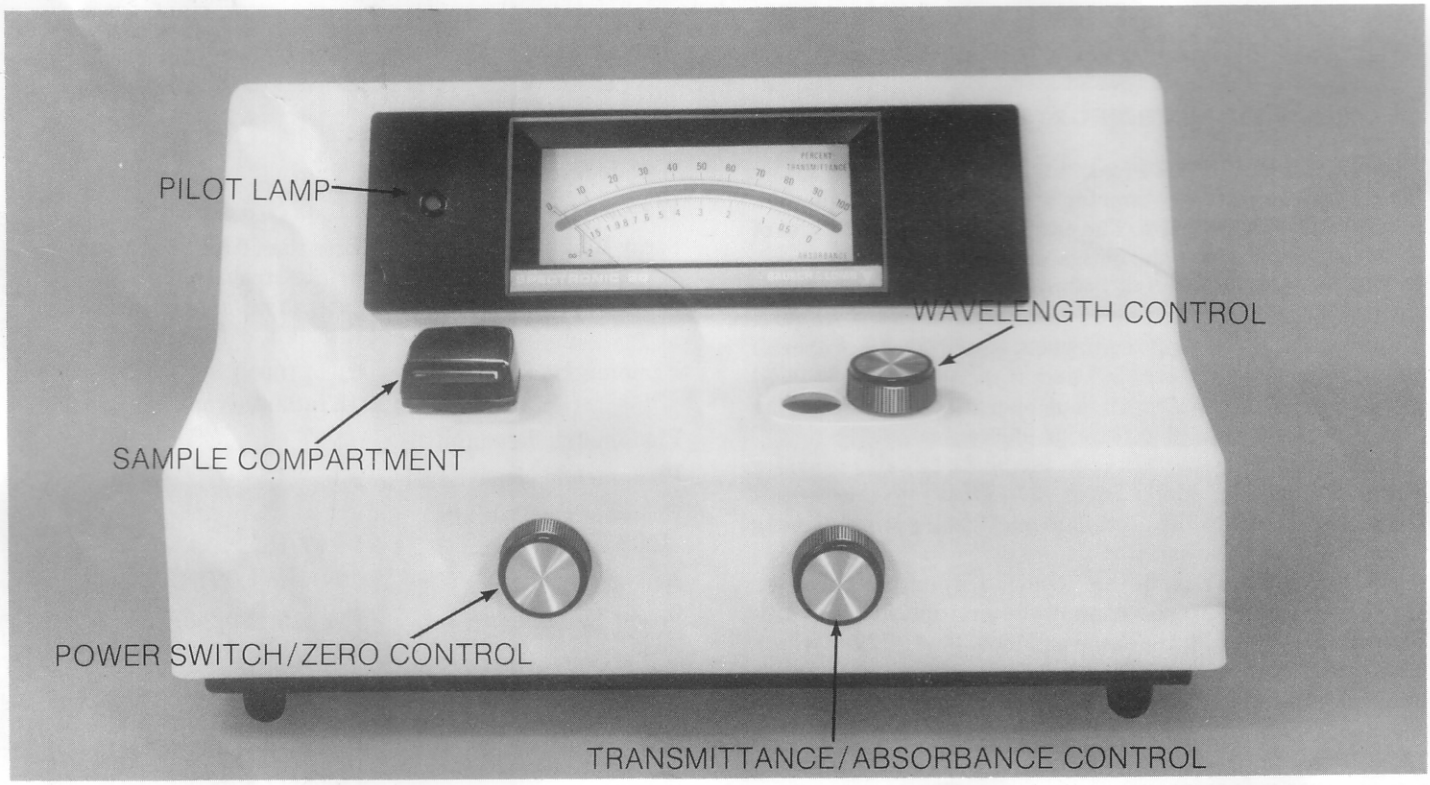


**Figure 2. Key Operating Features**

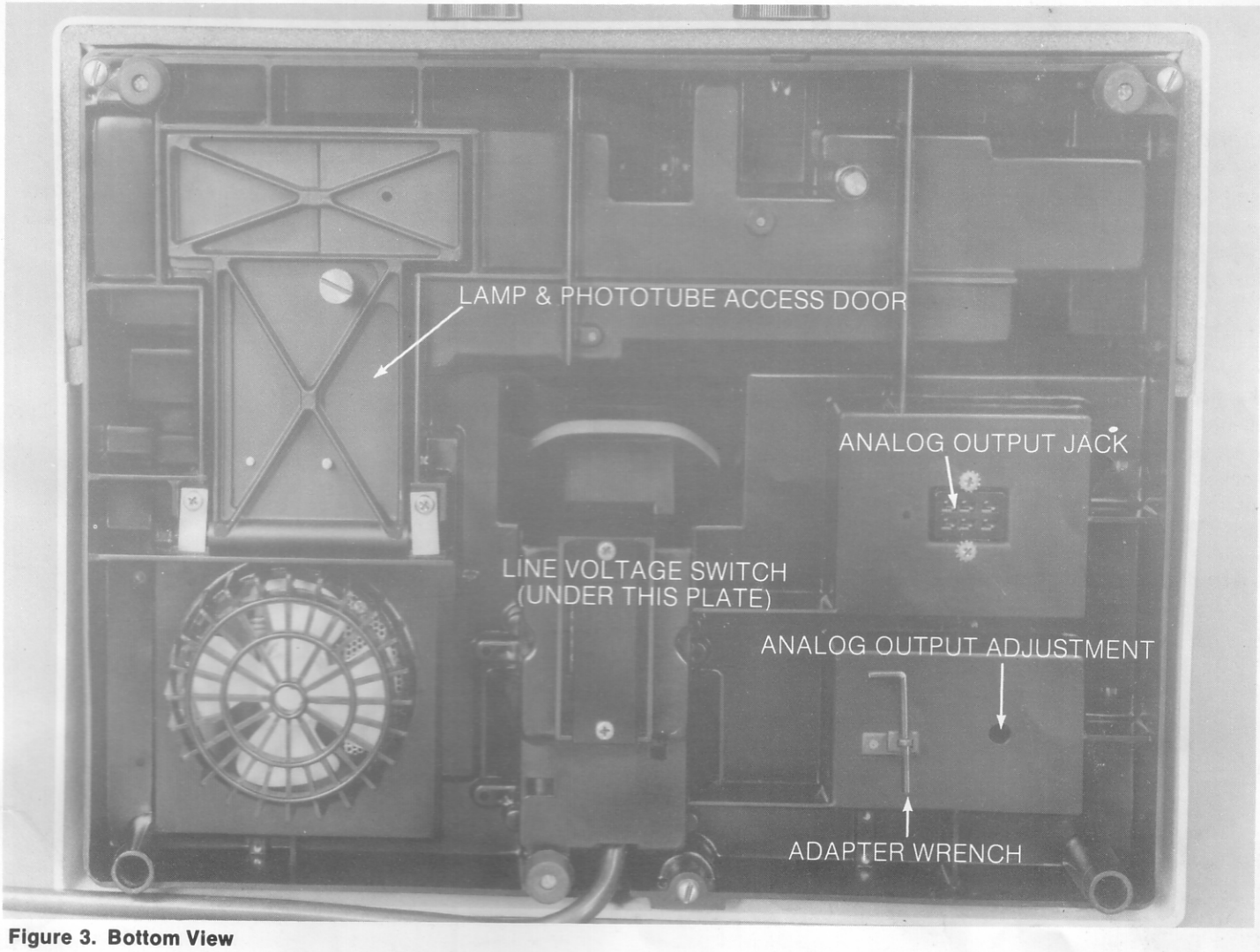


**Figure 3. Bottom View**

# SECTION 2
# INSTALLATION

## 2.1 ENVIRONMENT

The SPECTRONIC 20 spectrophotometer should be placed as far as possible from any strong magnetic or electric fields, or any electrical apparatus generating high frequency fields.

The instrument should be installed in an area that is free of dust, corrosive gases, and severe vibrations.

In addition, there should be no obstructions which might hinder air flow under and around the instrument.

## 2.2 LINE VOLTAGE CONVERSION

The spectrophotometer contains a multiple-tap power transformer for operation on 100, 115, 220, 240 VAC, 50/60 Hz. It is set to operate at 115 VAC when it leaves the factory in Rochester, New York, USA. If conversion is necessary, the voltage selection switch, shown in Figure 4, will adapt the instrument to the available line voltage. The switch is accessible by removing a cover plate located on the bottom of the instrument (see Figure 3).

**CAUTION**

UNPLUG THE INSTRUMENT BEFORE PROCEEDING

a. Tilt up the unit and set on its back panel.
b. Remove the two screws holding the switch cover plate located in the lower center of the base, shown in Figure 3.
c. Set the switch to the proper voltage position.
d. Replace the cover plate and change the line cord plug if required.
e. If converting to 220 or 240 VAC operation, after changing the Line Voltage Selection Switch:
   1. Remove control knobs, sample adapter and cover to expose fuse holder at the rear of the spectrophotometer.
   2. Replace the 1.5 ampere SLO-BLO 250 V fuse with the 0.7 ampere SLO-BLO 250 V fuse supplied; apply labels supplied to the fuse block and to the serial number plate on the bottom of the instrument.
   3. Replace cover, knobs and sample adapter. The instrument is now ready for operation at 220 or 240 VAC.

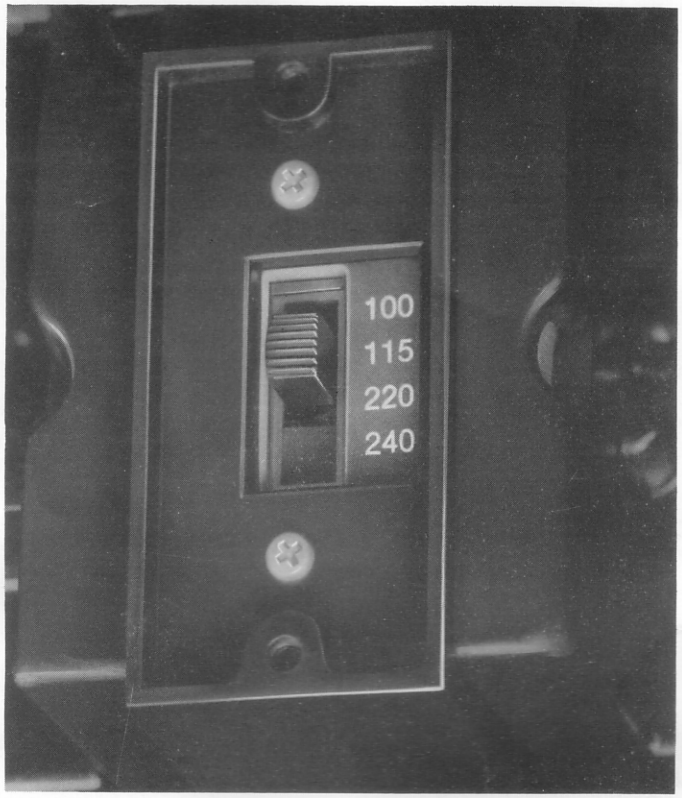


**Figure 4. Line Voltage Selection Switch (located under access plate shown in Figure 3)**

# SECTION 3
# OPERATING PROCEDURES

**CAUTION**

The instrument is set to operate at 115 VAC when it leaves the factory in Rochester, New York, USA and can be set to operate at 100, 220, or 240 V. If adjustment is required, see Section 2.2.

## 3.1 SETUP

To help ensure uncomplicated adjustment and operation of your spectrophotometer:

a. Install required adapter and select sample holder.
b. Select and install appropriate phototube filter.
c. Turn on Power Switch/Zero Control for a 15-minute warm-up.

### 3.1.1 Glassware Selection and Sampling Options

In addition to the standard ½-in. test tube and ½-in. adapter supplied with the instrument, several types of glassware are available. The sample adapter must match the glassware, as shown in Table 1. To change adapters, loosen the small set screw on the inner wall of the adapter using the adapter wrench clipped to the bottom of the instrument (see Figure 3).

**Table 1. Glassware and Adapters**

| Glassware | Adapter Cat. No. |
|---|---|
| Test Tubes: | |
| ½-in. dia., optical glass, box of 12, cat. no. 33-17-80. | 33-31-27 (Supplied with instrument) |
| ¾-in. dia., optical glass, box of 12, cat. no. 33-17-81. | 33-29-31* |
| 1-in. dia., optical glass, box of 12, cat. no. 33-17-82. | 33-29-30* |
| Cuvettes: | |
| Square, ½-in. pathlength, optical glass, set of 2 in case, cat. no. 33-17-01. | 33-29-49 |

*Requires Light Shield, cat. no. 33-29-32.

### 3.1.2 Phototubes

As shown in Table 2, the operating wavelength range is determined by the particular phototube-filter combination installed in the instrument.

**Table 2. Phototube Options**

| Range | Phototube Cat. No. | Filter Cat. No. |
|---|---|---|
| 340-600nm | 33-29-71 | None Required |
| 600-950nm | 33-29-72 | 33-29-18* |
| 400-700nm | 33-29-89 | 33-29-92* |

*Or appropriate filter from accessory Filter Kit, cat. no. 33-31-28.

To change the phototube:

a. TURN OFF AND UNPLUG THE INSTRUMENT.
b. Tilt up the unit and set on its back.
c. Loosen the thumbscrew on the lamp access door (see Figure 3) and open the door.
d. Remove the phototube using the plastic gripper as an aid.
e. Install the tube and plastic gripper. If a filter is required, insert into the holder on the inside of the door (see Figure 5). The tube and filter must be clean and free of fingerprints.
f. Close the door and securely fasten the thumbscrew. THIS IS ESSENTIAL FOR PROPER OPERATION.

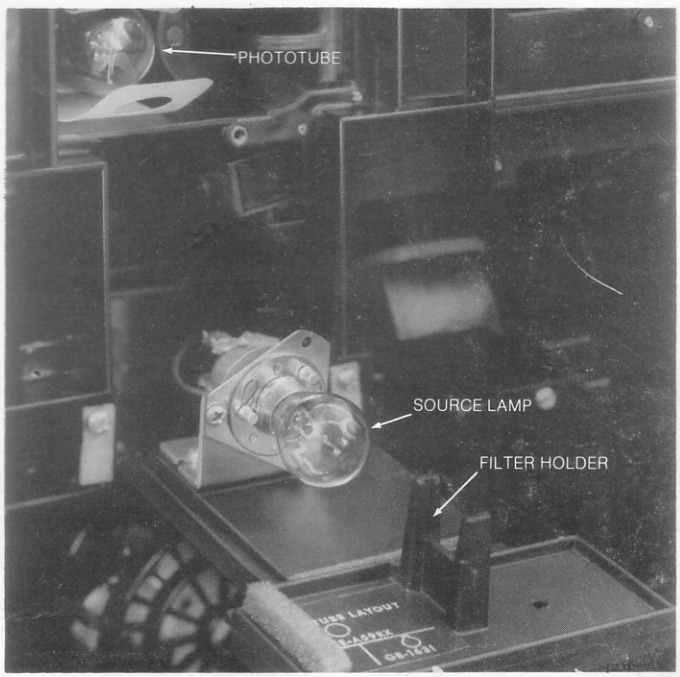


**Figure 5. Lamp Compartment**

## 3.2 SAMPLE MEASUREMENT

The sequence for sample measurement is:

a. Select wavelength using Wavelength Control.
b. With sample compartment empty and cover closed, adjust Zero Control so that the meter reads zero.
c. Insert reference blank into the sample compartment and set Transmittance/Absorbance Control to 100%T (0.0A).
d. Insert unknown sample into the sample compartment and read measurement from meter in percent transmittance or absorbance.

For added convenience, the self-stick instruction plate may be attached to the right side of the meter bezel to provide ready reference to the proper controls and procedures.

NOTE

Correct laboratory procedures and analytical techniques are necessary for successful use of your spectrophotometer.

a. All solutions must be free of bubbles.

b. All sample holders must be at least half full.

c. For greater accuracy, use square cuvettes, cat. no. 33-17-01, with adapter, cat. no. 33-29-49.

d. For optimum performance with test tube sample holders, ensure that the index mark on the tube aligns with the mark on the adapter.

e. During extended operation at a fixed wavelength, make an occasional check for 100%T meter drift. Possible causes of meter drift are listed in Table 3.

**Table 3. Operator's Troubleshooting Guide**

| Problem | Possible Cause | Remedy |
|---|---|---|
| 1. Instrument does not work. | a. Power line cord not connected to outlet. | Plug in power line cord. |
| | b. Dead power outlet. | |
| | c. Source lamp burned out. | Replace with new lamp. |
| | d. Phototube defective. | Replace as required. |
| | e. Defective electronic component. | Refer to service manual or service center. |
| 2. Meter does not zero. | a. Sample compartment cover not closed. | |
| | b. Occluder binding. | Check occluder action. |
| | c. Lamp access door not tightly closed. | |
| | d. Phototube defective. | Replace as required. |
| | e. Defective electronic component. | Refer to service manual or service center. |
| 3. Meter reading drifts | a. Poor sampling technique. | Eliminate bubbles or particles in solution. |
| | b. Fumes from sample. | Remove sample immediately after analysis. |
| | c. Excessive line voltage variation. | Check voltage and grounding. |
| | d. Wrong line voltage setting. | Reset Line Voltage Selection Switch. |
| | e. Source lamp defective. | Replace with new lamp. |
| | f. Phototube defective. | Replace as required. |
| | g. Meter defective. | Refer to service manual or service center. |
| | h. Defective electronic component. | Refer to service manual or service center. |
| 4. Cannot set 100%T (0.0A). | a. Occluder closed. | Install test tube in sample compartment. |
| | b. Sample holder not fully inserted into adapter. | Insert fully. |
| | c. Improper filter installed. | Remove or change filter. |
| | d. Source Lamp weak. | Replace with new lamp. |
| | e. Wrong line voltage setting. | Reset Line Voltage Selection Switch. |
| | f. Phototube weak. | Replace as required. |
| | g. Error in wavelength calibration. | Check calibration. |
| | h. Defective electronic component. | Refer to service manual or service center. |
| 5. Readings are not repeatable even though meter reading is zero and 100%T control is set correctly. | a. Loose lamp access door. | Tighten thumbscrew. |
| | b. Loose sample holder adapter. | Tighten set screw. |
| | c. Poor analytical technique. | Clean or replace dirty test tubes; remove bubbles, etc. |
| | d. Test tube position not repeating. | Always position fiducial line in exactly the same place when test tube is inserted into adapter. |
| | e. Meter sticking. | Tap lightly for possible correction. |

# SECTION 4
# MAINTENANCE

Because of the SPECTRONIC 20 spectrophotometer's functional design and its tested and field-proven reliability, routine customer maintenance has been reduced to replacement of the 6.5V, 2.75A source lamp (cat. no. 33-33-85) and phototube (Table 2). The operator can also perform routine checks for wavelength calibration and photometric accuracy, as well as change the operating line voltage.

If replacement parts are needed, a complete list is found in the Service Manual. For the protection of both the operator and the instrument, instrument repair or maintenance beyond the scope of this section should be performed by qualified dealer or Bausch & Lomb service personnel. Refer to Section 4.6, Service Procedure.

NOTE

SPECTRONIC 20 Spectrophotometer Service Manual (cat. no. 333171-10020) is available to those technically qualified to perform electronic servicing.

## 4.1 LAMP REPLACEMENT

a. TURN OFF & UNPLUG THE INSTRUMENT.

b. Tilt up the unit and set on its back.

c. Loosen the thumbscrew on the lamp access door and open the door.

d. Using finger pressure, press the lamp socket toward the mounting flange (see Figure 6). Rotate the lamp counterclockwise and remove.

e. To install the new lamp, use LIGHT finger pressure on the socket and rotate lamp clockwise until secure.

f. Clean the lamp, close the door, and tighten securely. THIS IS ESSENTIAL FOR PROPER OPERATION.

## 4.2 PHOTOTUBE REPLACEMENT

To replace the phototube, refer to the phototube changeover procedure in Section 3.1.2 of this manual.

## 4.3 WAVELENGTH CALIBRATION CHECK

Under normal operating condition the SPECTRONIC 20 spectrophotometer should retain its wavelength accuracy indefinitely. If the instrument is subjected to a severe shock or other abuse, wavelength performance may be checked by one of three methods:

a. Cobalt Solution Check.

b. Didymium filter from the accessory Filter Kit (cat. no. 33-31-28).

c. Wavelength Accuracy Test from SPECTRONIC Standards (cat. no. 33-31-50).

An explanation of the cobalt solution check follows. Instructions on use of the didymium filter and SPECTRONIC Standards are found in the user's manual for each accessory. SPECTRONIC Standards are available in the U.S.A. and Canada only.

### 4.3.1 Cobalt Solution Check

First prepare a stock cobalt solution as follows:

a. In a 1-liter volumetric flask, place 200 ml distilled water. Add slowly and with caution, 10 ml concentrated hydrochloric acid (ACS grade). Mix and make to volume with distilled water to obtain 1% hydrochloric acid solution.

b. In a 1-liter volumetric flask, place 22-23 gm cobalt chloride (ACS grade). Dissolve in the 1% hydrochloric acid. Make to volume with 1% hydrochloric acid solution to obtain chloride stock solution.

To perform cobalt solution check:

a. Turn power ON. Allow 15-minute warm-up.

b. Set Wavelength Control at 500 nm.

c. With sample compartment empty and cover closed, adjust Zero Control until meter reads zero.

d. Insert glassware filled with distilled water into the sample compartment and set Transmittance/Absorbance Control at 100%T.

e. Replace distilled water with glassware containing cobalt chloride stock solution. Read %T on meter.

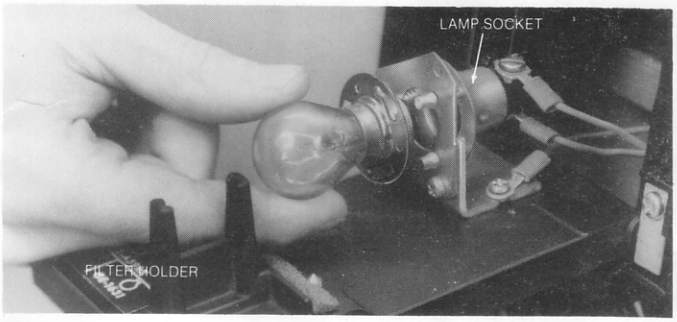


**Figure 6. Lamp Replacement**

HCl

Repeat steps c through e at 505, 510, 515, and 520nm. The instrument is in proper calibration when maximum absorbance (minimum transmittance) occurs between 505 and 515nm. (See Figure 7.) The specific absorbance values are unimportant.

### 4.3.2 Wavelength Calibration Adjustment

If the wavelength accuracy is out of tolerance, refer to Section 4.5, Service Procedure. Customer recalibration is not recommended.

## 4.4 PHOTOMETRIC LINEARITY CHECK

If the photometric linearity of the instrument is questionable, first check your analytical procedure and technique. If proper operation is still in doubt, use the Photometric

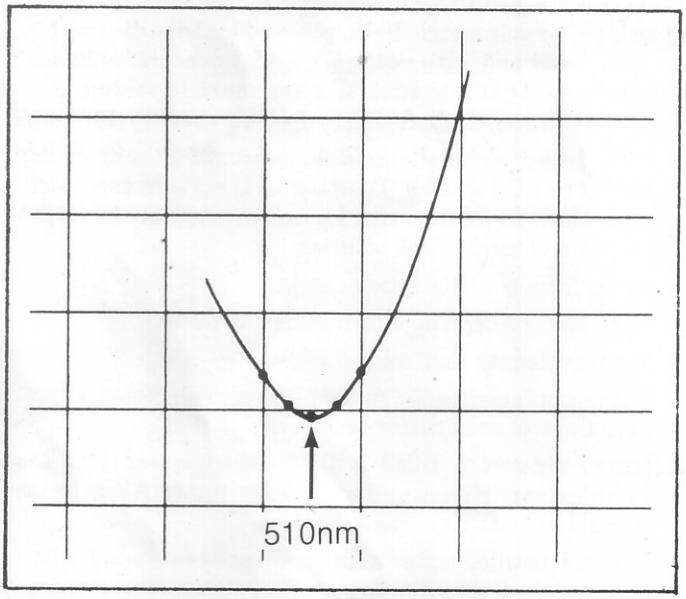


**Figure 7. Example of Wavelength Calibration Check Using Cobalt Solution**

Accuracy/Linearity Test from SPECTRONIC Standards (cat. no. 33-31-50) to test and evaluate photometric performance of your instrument.

The alternate method uses the cobalt chloride stock solution preparation mentioned in Section 4.3.1:

a. Install required adapter and select sample holder.

b. Turn on Power Switch/Zero Control and warm-up instrument for 15 minutes.

c. Set Wavelength Control at 510nm.

d. With sample compartment empty and cover closed, adjust Zero Control until meter reads zero.

e. Insert sample of distilled water and set Transmittance/Absorbance Control at 100%T.

f. Remove distilled water and insert glassware containing sample of cobalt chloride stock solution. Note ABSORBANCE value on meter.

g. Carefully dilute cobalt chloride stock solution 1:1 with 1% hydrochloric acid.

h. Insert 1:1 cobalt dilution of step g. ABSORBANCE value must be ½ of stock solution (step f), ± 2 divisions.

## 4.5 SERVICE PROCEDURE

If the instrument should develop a malfunction that cannot be corrected by operator maintenance, it can be serviced by trained specialists at your dealer or Bausch & Lomb service center. To avoid unnecessary delays:

If the SPECTRONIC 20 spectrophotometer is under warranty, contact the dealer from whom the instrument was purchased.

If the warranty has expired, you may contact Bausch & Lomb Field Service Center given in the list packed with the instrument or call the Service Department, Instruments & Systems Division, Bausch & Lomb, Rochester, N.Y., area code 716, 338-8245 or 338-8306.

If it is necessary to ship the instrument:

a. Wrap the spectrophotometer in plastic, then pack carefully in a crush-resistant carton with at least 3 inches of shock absorbing material to prevent transit damage.

b. Include a detailed letter inside the shipping carton, fastened to the instrument, describing the trouble. Please include the name and phone number of the person or department head most familiar with the problem. This information will enable service personnel to make required repairs promptly and at least expense.

c. Mark on the shipping container:

FIRST CLASS LETTER ENCLOSED.

First class postage will be required only on the letter. The carton will be accepted at standard mail rates.

# SECTION 5
# ACCESSORIES

The following accessories are available for use with your SPECTRONIC 20 spectrophotometer:

a. SPECTRONIC Standards, cat. no. 33-31-50. Quick, reliable way to test and evaluate instrument performance: 0%T, wavelength accuracy, stray radiant energy, photometric accuracy and optical alignment; requires filter adapter, cat. no. 33-31-26, and cuvette holder, cat. no. 33-29-49.

b. Filter Adapter, cat. no. 33-31-26. Required for use with SPECTRONIC Standards.

c. Filter Kit, cat. no. 33-31-28. Includes 4 stray radiant energy/2nd order filters, 1 didymium filter.

d. 10-in. Strip-Chart Recorder, 115 V, cat. no. 39-11-20. Includes 1 roll of chart paper, 4 ink cartridges, Operator's Manual.

e. 10-in. Strip-Chart Recorder, 220 V, cat. no. 39-11-30. Includes 1 roll of chart paper, 4 ink cartridges, Operator's Manual.

f. Patch Cord, cat. no. 33-26-74. Connects Strip-Chart Recorder (cat. no. 33-11-20 or 39-11-30) to the SPECTRONIC 20 spectrophotometer.

g. DR-37 Digital Readout Accessory, 115 V, 50-60 Hz, cat. no. 33-30-92.

h. DR-37 Digital Readout Accessory, 230 V, 50-60 Hz, cat. no. 33-30-93.

i. Patch Cord, cat. no. 33-26-71. Connects DR-37 Digital Readout Accessory to SPECTRONIC 20 spectrophotometer.

j. Step-down transformer, cat. no. 33-32-97. Converts 220 V to 115 V.

k. SPECTRONIC 20 Service Manual, cat. no. 333171-10020.

l. Industrial Methods Manual. Purchase in separate sections. Aluminum Alloys, cat. no. 332903-10030; Steel Alloys, cat. no. 332904-10030; Copper Alloys, cat. no. 332905-10030; Gold and Gold Alloys, cat. no. 332906-10030. Ring binder to hold any or all sections, cat. no. 332902-10030.

m. Water Technology Manual, cat. no. 331015-10030. A grouping of EPA-recommended methods for water and wastewater analyses.

n. Accurate Water Testing Manual, cat. no. 330935-10030.