

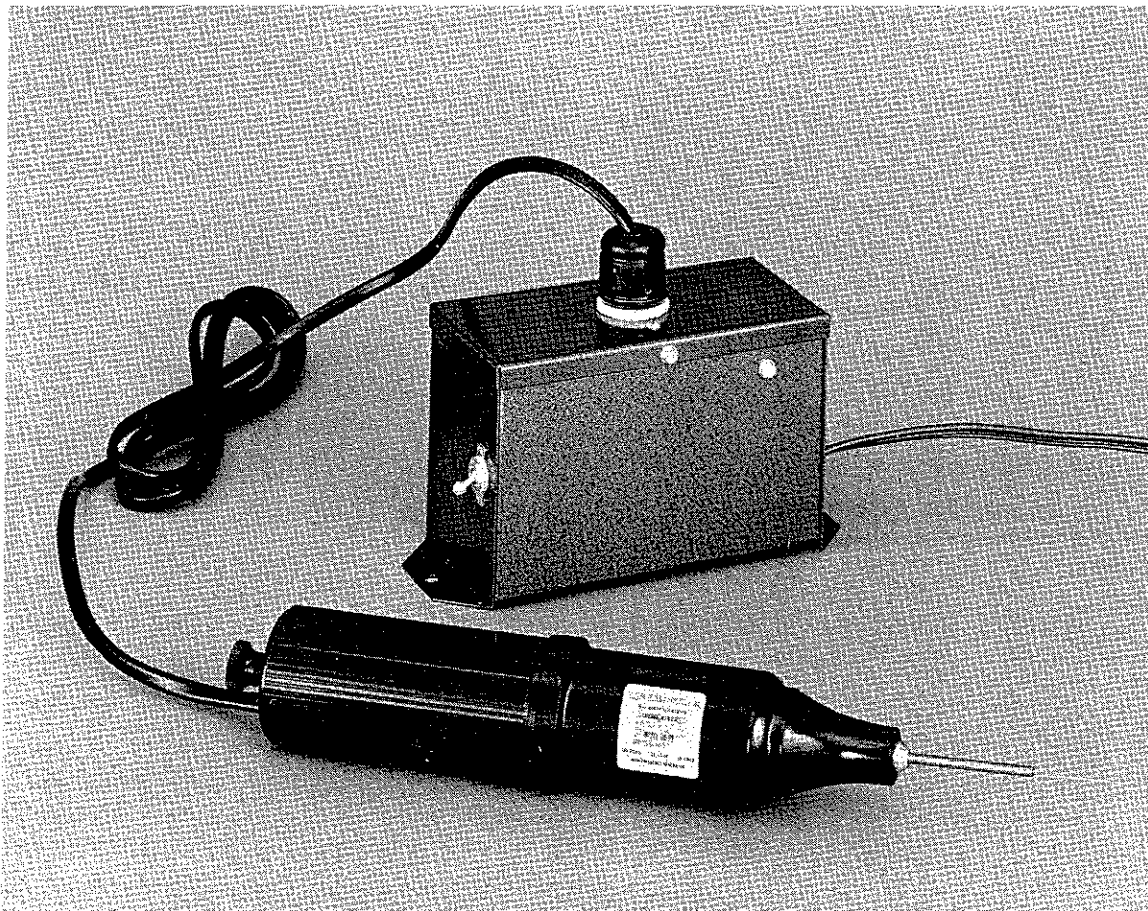


ELECTRO-TECHNIC PRODUCTS, INC.
4642 N. RAVENSWOOD, CHICAGO, ILLINOIS 60640-4592
TELEPHONE: 312-561-2349 FAX: 312-561-3130

OPERATING MANUAL

High Frequency Tester and Mixer

Models BD-20, BD-20V



SECTION 1 - GENERAL INFORMATION

1.1 Description

1.1.1 The Models BD-20 and BD-20V High Frequency Generators produce a high voltage, high frequency spark at the tip of an electrode. The electric field created around the electrode is used for a variety of industrial, scientific, and laboratory applications including the following:

- a) Check for a vacuum in a tube or glass-enclosed vacuum system
- b) Start gas discharge tubes
- c) Detect minute cracks and fissures which cannot otherwise be seen in materials such as plastic, rubber and glass linings of tanks
- d) Mix small amounts of liquids quickly and without contamination, for use in analytical chemistry and similar laboratory applications.

1.1.2 The Generator and associated electronic and mechanical assemblies are housed in a durable Bakelite case which can be held comfortably in the hand. It has a 6 ft (1.8 m) power cord to permit ample movement over the work surface. Power is supplied by a transformer which is housed in a separate unit for better heat dissipation. This case is finished in a durable, silicone-based paint which is scratch resistant. Metal tabs are incorporated into the case for permanent mounting.

1.1.3 The Power Supply is furnished with a polarized and grounded power line cord 6 ft. in length. Operation is from 115 volts, 50/60 Hz for the Model BD-20, and 230 V, 50/60 Hz for the Model BD-20V. Each model is equipped with a line cord plug which meets US electrical code configurations for that voltage.

1.1.4 Both models are supplied with one electrode.

1.2 Packing List

1.2.1 Carefully remove the instrument and accessories from the packing materials. Check all parts against the Packing List. Report any shortages immediately.

Quantity	Part/Model No.	Description
1	080-1201-1	Generator
1	080-1200-1	Power Supply, 115 V (BD-20)
1	080-1202-1	Power Supply, 230 V (BD-20V)
1	12201	Electrode, Spring Tip
1	085-0002-1	Instruction Manual

1.3 Specifications

Output Voltage	10,000 to 50,000 volts
Frequency	4 to 5 MHz
Operating Duration	Continuous
Input Voltage	BD-20: 115 V, 50/60 Hz BD-20V: 230 V, 50/60 Hz
Generator (l x d)	11 x 2-1/2 in. (28 x 6.4 cm)
Power Supply (h x w x d)	4-1/8 x 7-3/4 x 3-1/8 in. (10.5 x 19.7 x 8 cm)
Shipping Weight	BD-20: 6 lbs (2.7 kg) BD-20V: 7 lbs (3.2 kg)

1.4 Warranty Repair/Replacement Information

- 1.4.1 Forward the instrument, freight prepaid to the factory or distributor from which it was purchased, along with a copy of the invoice for warranty verification. The instrument is date coded as to the date of manufacture.
- 1.4.2 Electro-Technic Products, Inc. reserves the right to repair or replace any instrument sent in for warranty repair.
- 1.4.3 Instruments found to be out of warranty will be repaired for a minimal labor and parts charge, unless directed to do otherwise. If it is determined that repair costs will exceed the cost of a new instrument, the customer will be so advised.
- 1.4.4 Parts for discontinued models will be made available, wherever possible, for a minimum period of five years after the model has been discontinued.

SECTION 2 - INSTALLATION

2.1 Installation

- 2.1.1 The instrument should be located away from sources of heat or air conditioners. Avoid areas of high humidity or highly corrosive atmospheres; if operation is required under any of these conditions, use intermittently and remove to another location for storage.
- 2.1.2 Do not use near flammable liquids or explosive gases.

2.2 Assembly

- 2.2.1 Connect the plug from the Generator into its matching receptacle on the Power Supply. The plug is polarized to fit into the receptacle only one way. Arrows indicate its proper position in the socket. Do not attempt to force the plug into the receptacle. Reseat until it fits easily. Once properly seated, push firmly into place.
- 2.2.2 Connect the power line cord to its matching three wire power line receptacle. This provides power properly polarized and grounded. Operation in any other way will result in a potential shock hazard and may affect the performance of the instrument.
- 2.2.3 If it is necessary to replace the power line plug with a different type for use outside of the United States, use one with a ground connection and install following this wiring convention: black wire to the high side of the power line; white to the neutral side of the power line; green wire to earth ground.

2.3 Accessory Information

- 2.3.1 Push the electrode furnished into the matching socket in the Generator. To remove the electrode, firmly grasp the metal base of the electrode which protrudes about 1/4 in. (6 mm) from the case and gently rock back and forth while pulling it out. Do not install or remove the electrode while in operation.

SECTION 3 - OPERATION

3.1 Operation Controls

- 3.1.1 Power ON/OFF Switch. Located on the side of the Power Supply case. In the ON position, circuitry is energized.
- 3.1.2 High Voltage Adjust Knob. Located on the end of the Generator case opposite the electrode. Adjusts the spark length by changing the spacing between the tungsten contacts inside. A clockwise rotation increases the spark length.

3.2 Calibration

- 3.2.1 The instrument requires no user calibration internally. However, use of the Model 1270 Peak Voltage Calibrator is recommended when setting the output voltage accurately and with repeatability.

3.3 Operation

- 3.3.1 Bring the electrode tip near a large metal object or a ground connection. Turn the Power Switch to the ON position. If no spark is seen to jump from the electrode, the spark is being confined between the two internal tungsten contacts in the Generator. (NOTE: An associated electric field can be felt near the location of the tungsten contacts located opposite the electrode side of the Generator.) While the electrode is near the metal object, turn the High Voltage Adjust Knob until the spark is seen to jump from the electrode to the metal surface.
- 3.3.2 Continue to turn the knob until a spark of the desired length emanates from the electrode. A nearly linear relationship exists between spark length and spark voltage. A 1 in. (25 mm) spark represents peak voltages of approximately 50,000 volts; a 1/2 in. (13 mm) spark, 25,000 volts. Adjust the length of the spark most suitable for the application. Usually the proper spark length is determined through experience; however, the shortest possible spark length should be used to achieve the desired effect.
- 3.3.3 This device is a tesla coil, which is an induction coil generating a high frequency, high voltage. To understand its operation, refer to the Schematic Diagram at the end of this instruction manual. The power transformer T1 sets up a high voltage, which causes a spark gap to break down at the rate of twice the line frequency (100 or 120 Hz). The spark gap charges capacitors C1 and C2, which are connected to the primary windings of the resonator coil T2, which is an air core rather than the iron core of standard transformers. Because of the inductance of the primary windings of T2 and the capacitors, an oscillating current of very high frequency is set up. When the spark gap is adjusted to the resonant frequency of the circuit (of the order of megahertz) frequency, high voltage is induced in the secondary windings of T2. This voltage is brought out to the electrode.

3.4 Applications

- 3.4.1 Check for a vacuum in a tube or glass-enclosed vacuum system

To test for leaks, adjust the High Voltage Adjust Knob to the desired voltage, and then place the electrode tip on the surface of the vacuum tube or on a glass tube or enclosure of a vacuum system which is under vacuum. Move the tip back and forth until the entire surface is covered. The pinholes, cracks, or fissures will be indicated by a bright concentration of the spark through the hole.

Unless the vacuum system is evacuated, at least to a partial degree, this type of leak detection will not work. With experience the operator can approximate the vacuum level in the vacuum system by observing the color of the discharge within, when the electrode tip is placed on the glass. The color ranges from red when the vacuum is in the millimeter of mercury (Torr) range, blue in the micron (milliTorr) range, and a very faint blue in the submicron (10^{-4} Torr) range. In vacuum systems in the ultrahigh vacuum range, 10^{-5} Torr and lower, there are too few gas molecules to see any ionization.

3.4.2 Start gas discharge tubes

High pressure sodium and mercury discharge lamps typically take a while to come up to full intensity. The corona discharge generated around the tip of the electrode can be used to "strike" the gas, shortening the time required to reach full intensity.

CAUTION: Before attempting to use this High Frequency Generator for this application, refer to the instructions for the lamp and follow any precautions recommended.

Adjust the High Voltage Adjust Knob to the desired output. Turn the gas discharge lamp on. Bring the electrode tip near the glass tube of the lamp. Normally, this will cause the intensity of the discharge to increase. Remove the electrode tip from the lamp, and let it continue to warm up to full intensity. Increase the output of the Generator if it fails to "strike" the gas.

3.4.3 Detect minute cracks and fissures in insulating materials covering metal surfaces

To test for leaks in lining, adjust the High Voltage Adjust Knob to the desired voltage, and then place the electrode tip on the surface of the insulation being tested. This insulation must cover a metallic, or conducting surface for this test to work.

Move the electrode back and forth until the entire surface is covered. The holes, cracks, or fissures will be indicated by a bright concentration of the spark through the hole to the metal, or conducting material, below.

3.4.4 Mix small amounts of liquids quickly and without contamination

This procedure is used to mix minute amounts of liquids and reagents held in wells in small trays, typically 60 to 96 wells per tray. To use the High Frequency Generator as a mixer, place a grounded metal plate under the tray. Adjust the High Voltage Adjust Knob for a mid-range setting. Pass the electrode tip about 2 to 3 in. (5 to 7.5 cm) above the wells in a criss-cross pattern, covering all of the wells in a few passes over the tray. The contents of each well should be seen to mix. Do not, however, allow the spark to enter any of the wells directly. It should

take only a few seconds to mix an entire tray. If a few wells are not mixed, pass the electrode tip over them again. In a few instances, a thin wire may have to be used to mechanically mix a well that does not respond to electro-mixing.

In electro-mixing, the surface tension of the liquid in the wells is temporarily reduced, allowing any heavier liquids on the surface to drop to the bottom. Also, water molecules in aqueous solutions, being electric dipoles, flip from one orientation to another as the electric field oscillates. This agitates the aqueous layers which contributes to the mixing effect of the oscillating electric field.

3.4.5 Check for vacuum inside sealed bottles and vials

Work in a darkened area. Line up the bottles in a row. Pass the electrode tip near the top or neck of the glass container. Adjust the High Voltage Adjust Knob as required to observe the gas glow inside the container. One which does not exhibit the glow is presumed to have too high a pressure inside, and is rejected. A second or third pass through the rejected containers may be desired to determine whether a glow discharge is observed.

This test method is used by pharmaceutical and chemical companies to check the integrity of the seal of dried (usually lyophilized) products, and some liquids which must be stored in a vacuum. Electro-Technic Products, Inc. has developed an automated system to do this testing, and has published research on the time dependence of plastic sealing caps. Contact Electro-Technic for details.

3.5 Hazards

- 3.5.1 This instrument emits a high frequency, high voltage spark. Keep the electrode tip away from the body. Care should be taken to avoid letting the spark be attracted to metal objects worn on the body such as rings and jewelry. A spark to the body will not cause harm, but might cause a slight discomfort, like the sensation felt when a spark jumps from the finger tip to a metal object after having walked across a carpet on a dry day. The output of the instrument is at a very low current. Also, the skin of the body has a very high resistance to the high frequency current, causing any current to flow harmlessly over the skin.
- 3.5.2 Do not operate around flammable liquids or gases as the spark may ignite them.
- 3.5.3 Ozone gas is generated around the tip of the electrode when oxygen in the air is ionized. The gas has a pungent odor, but is harmlessly dissipated in a normally ventilated area. Do not use in a confined area where high concentrations of ozone gas can develop.
- 3.5.4 This instrument generates an output at the radio-frequency level. Users who wear a pacemaker, or similar devices which might be affected by radio-frequency waves, are advised to consult a physician before using this instrument.

SECTION 4 - MAINTENANCE

4.1 General

- 4.1.1 The instrument contains no user adjustable components inside either the Power Supply or Generator. Any attempt at repair while the instrument is in warranty will void the warranty.
- 4.1.2 Several components will exhibit wear with extended use and will eventually require replacement. The failure modes of several of these components are very similar to what causes the failure of a tungsten-filament incandescent light bulb after extended use.
- a) Due to a combination of corona discharge, high voltage, and high temperature, the insulation in the capacitors and resonator coil may eventually fail. Corona discharge develops around microscopic bubbles within the insulation material. Within time the corona discharge creates larger bubbles. The process accelerates until eventually a voltage breakdown occurs.
 - b) In time the tungsten contacts will require replacement in order to maintain the proper setting of the high voltage output.
 - c) When used continuously or for extended periods of time, the tungsten contacts will begin to evaporate and condense on the plastic molded base of Part Number 035-0002-1 Generator Mechanical Assembly, causing a short to develop across this component.
- 4.1.3 It is recommended that whenever this instrument requires service, it be returned to the factory or distributor, freight prepaid, with a statement concerning the problem. The instrument will be repaired for a nominal labor and parts charge.

4.2 Repair

- 4.2.1 Only personnel familiar with electronic circuitry should attempt repair. If it is necessary to repair while either the Power Supply cover or Generator housing are removed, be cautious as high voltage will be present at various locations in the circuitry. Refer to the Schematic Wiring Diagram at the end of this manual.
- 4.2.2 The Power Supply cover is removed as follows:
- a) Remove the two screws from the side flap of the cover.
 - b) Carefully lift the cover from the case and move it to the side. The wiring attached to the jack prevents the complete removal of the case cover.

4.2.3 The Generator housing is disassembled as follows:

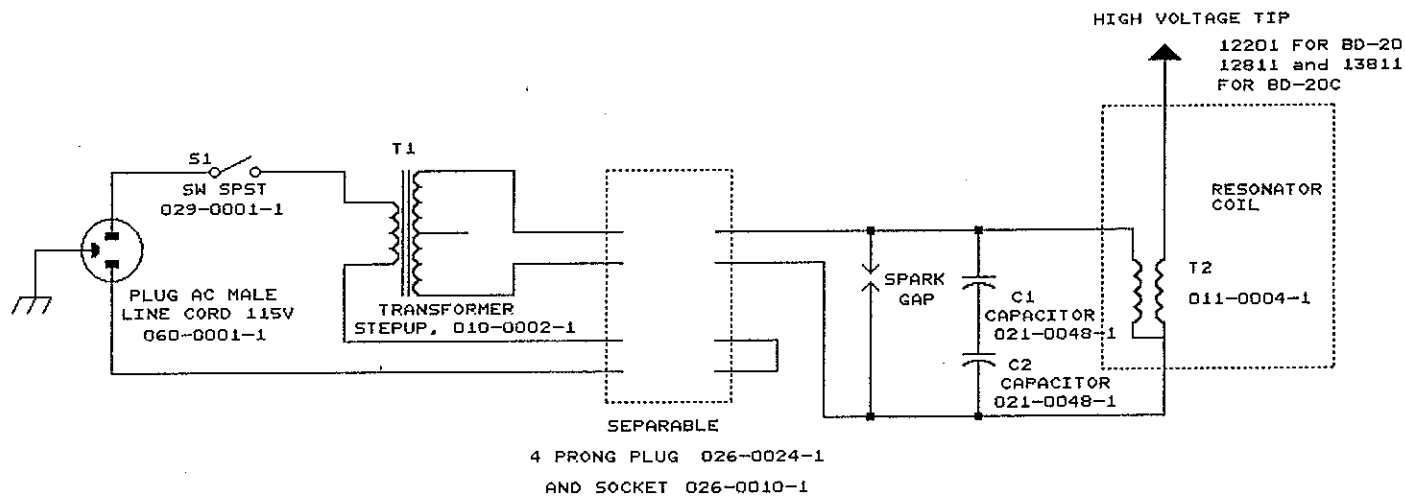
- a) Remove the electrode from the socket.
- b) Carefully remove the recessed hex nut holding the electrode socket to the threaded nylon stud attached to the resonator coil. Remove the electrode socket.
- c) Turn the High Voltage Adjust Knob fully counterclockwise. Place a small wrench on the flattened portion of the shaft to hold it from turning while the knob is turned counterclockwise and removed from the shaft.
- d) Note the number of washers around the shaft, and then remove them. Washers are placed on the shaft to prevent the possibility of the two tungsten contacts inside the housing from shorting whenever the High Voltage Adjust Knob has been turned fully clockwise. The number of washers will vary from unit to unit, from none at all, to as many as three.
- e) Remove the wax covering the two screws on the Generator housing near the High Voltage Adjust Knob and remove the screws.
- f) The Generator housing is in two parts. Grasp the grooved portion and turn the other portion counterclockwise to remove.
- g) Remove the electronic and mechanical assemblies from the grooved portion of the housing. The high voltage cord set attached to the electronics will prevent complete removal of these assemblies.

4.2.4 The factory maintains stock of replacement parts. Consult the Parts List. A Parts Price List is available upon request.

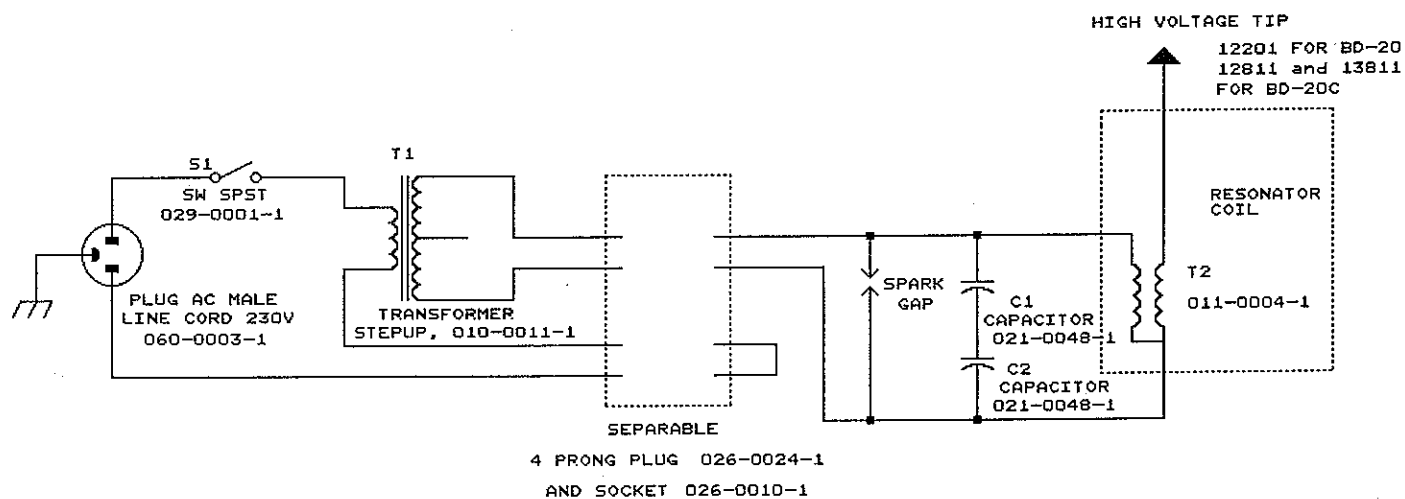
4.2.5 Refer to Section 4.1.2 for assistance in troubleshooting possible failure modes. If the Generator were accidentally dropped on the High Voltage Adjust Knob, it may be necessary to replace Part Number 059-0004-1 Bridge Yolk Assembly to repair the unit.

4.2.6 Once repair is completed, carefully reassemble the Power Supply cover and Generator housing.

- a) Reinstall the proper number of washers on the shaft of the Generator. When any of the mechanical components of the Generator are replaced, the number of washers required after repair may be different than before. Use a sufficient number of washers to preclude the possibility of the tungsten contacts from shorting.
- b) Replace the protective wax over the two screws on the Generator housing.



Model BD-20, 115 V



Model BD-20V, 230 V

Figure 4.1 Electrical Schematic Diagrams

BD-20 SERIES HIGH FREQUENCY TESTERS

PRODUCT NUMBER	DESCRIPTION	PRICE EACH
1192C1 1192W1	Fixed Labor Charge, BD-20 or BD-20A Models Warranty Labor, BD-20 or BD-20A Models	\$40.00 NC

PARTS PRICE LIST

PRODUCT NUMBER	DESCRIPTION	PRICE EACH
12201	Electrode Tip, Spring, BD-20	\$12.50
12811	Electrode, Round, 1 in. Diameter	40.00
13811	Electrode, Field-Effect, 3 in., 1 wire,	60.00
001-0009-1	Screw, Nylon, Resonator, 10-32 x 1-1/2	0.27
002-0005-1	Nut, 10-32, Hex, for Electrode Socket	0.19
010-0002-1	Transformer, 115 V	96.68
010-0011-1	Transformer, 230 V	102.88
011-0004-1	Resonator Coil	20.02
021-0057-1	Capacitor, 0.0025 uF, 10 kV	13.43
025-0002-1	Printed Circuit Board	4.81
025-0003-1	Printed Circuit Board and Capacitor Assembly	32.52
026-0006-1	Plug, Male, 4-Pin, for Model BD-20	6.38
026-0007-1	Cap, for Plug, for Model BD-20	4.44
026-0024-1	Four Pin Male Plug Assembly, for Model BD-20	7.05
029-0005-3	Switch, Toggle, SPST	5.10
035-0002-1	Complete Top Mechanical Assembly	46.68
035-0003-1	Top Spring Rivet Contact Assembly	4.85
035-0004-1	Bottom Contact Assembly	9.22
035-0005-1	Bridge w/Posts, Ratchet Spring, Adjusting Screw (Top Assembly)	17.26
040-0004-1	Bracket, Right Angle, for Circuit Board	1.49
044-0003-1	Top Housing, Cone	10.42
044-0005-1	Adjusting Knob	2.06
044-0006-1	Top Mechanical Assembly Base	14.86
044-0018-1	Bottom Housing	14.08
045-0003-1	Electrode Socket	3.62
049-0025-1	Nut Driver, 5/16 in.	21.68
050-0010-1	Contact Bushing	7.40
050-0037-1	Tungsten Screw Contact	2.81
059-0004-1	Bridge Yoke and Bushing	4.72
059-0008-1	Adjusting Screw Assembly	7.74
060-0002-1	Line Cord Set, 3 Conductor, 115 V	11.09
060-000X-1	Line Cord Set, 3 Conductor, 230 V, Specify Type	18.00
060-0012-1	High Voltage Cord Set	23.00
080-1201-1	Generator, w/o Power Supply, BD-20, 4-Pin Plug	165.00
080-1203-1	Generator, w/o Power Supply, BD-20A, w/Terminals	165.00
080-1205-1	Power Supply, BD-20A, 115 V, w/ Internal Terminals	165.00
080-1206-1	Power Supply, BD-20A, 230 V, w/ Internal Terminals	190.00
083-0007-1	Power Supply Cabinet	26.63
083-0010-1	Housing, Bakelite	19.65