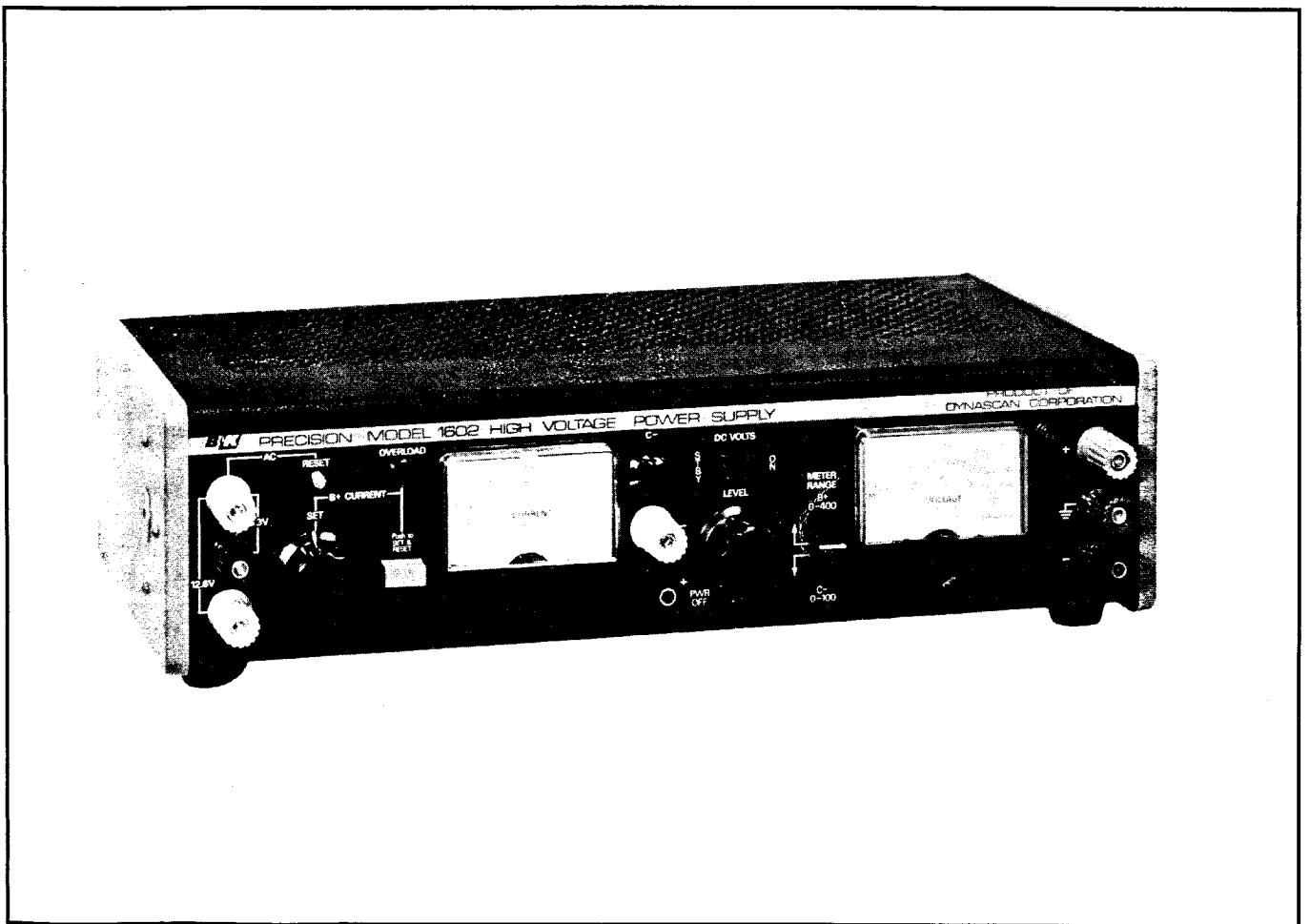


# INSTRUCTION MANUAL

**MODEL 1602**

## SOLID STATE, HIGH-VOLTAGE, REGULATED DC POWER SUPPLY



## — WARNING —

Normal use of test equipment exposes you to a certain amount of danger from electrical shock because testing must often be performed where exposed voltage is present. An electrical shock causing 10 milliamps of current to pass through the heart will stop most human heartbeats. Higher voltages pose an even greater threat because such voltage can more easily produce a lethal current. However, voltage as low as 35 volts DC or AC RMS should be considered dangerous and hazardous since it can produce a lethal current under certain conditions. Your normal work habits should include all accepted practices that will prevent contact with exposed high voltage, and that will steer current away from your heart in case of accidental contact with a high voltage. You will significantly reduce the risk factor if you know and observe the following safety precautions:

1. Don't expose high voltage needlessly. Remove housings and covers only when necessary. Turn off equipment while making test connections in high-voltage circuits. Discharge high-voltage capacitors after removing power.
2. Use an insulated floor material or a large, insulated floor mat to stand on, and an insulated work surface on which to place equipment; and make certain such surfaces are not damp or wet. Where insulated floor surface is not available, wear heavy gloves.
3. Use the time-proven "one hand in the pocket" technique while handling an instrument probe. Be particularly careful to avoid contacting a nearby metal object that could provide a good ground return path.
4. Always use an isolation transformer to power transformerless "hot chassis" equipment, where one side of the AC power line is connected directly to the chassis. This includes most recent television sets and audio equipment. Without an isolation transformer, the chassis of such equipment may be floating at line voltage (120 VAC, 60 Hz in USA), depending upon which way the 2-wire AC power plug is inserted. Not only does this present a dangerous shock hazard if the chassis is touched, but damage to test instruments or the equipment under test may result from connecting the ground lead to some test instruments to a "hot" chassis. The ground lead of most oscilloscopes and most other test instruments with 3-wire power plugs is at earth ground. The B & K-PRECISION Model TR-110 Isolation Transformer is suitable for most applications.
5. On test instruments or any equipment with a 3-wire AC power plug, use only a 3-wire outlet. This is a safety feature to keep the housing or other exposed elements at earth ground.
6. If possible, familiarize yourself with the equipment being tested and the location of its high voltage points. However, remember that high voltage may appear at unexpected points in defective equipment.
7. Also remember that AC line voltage is present on some power input circuit points such as on-off switches, fuses, power transformers, etc., even when the equipment is turned off.
8. Never work alone. Someone should be nearby to render aid if necessary. Training on CPR (cardio-pulmonary resuscitation) first aid is highly recommended.

**INSTRUCTION MANUAL**

**FOR**

**B & K - PRECISION**

**MODEL 1602**

**SOLID STATE, HIGH-VOLTAGE**

**REGULATED DC POWER SUPPLY**

**WARNING**

This power supply produces high voltage output up to 400 volts, which poses a certain amount of danger from electrical shock. The person using this instrument should be a qualified electronics technician or otherwise trained to work safely with high voltage. Turn off power while making connections, and avoid touching the output terminals of the power supply, exposed portions of interconnecting cables, and high voltage points in any equipment being powered. Observe the safety precautions listed on the inside front cover of this manual.

**BK PRECISION®**

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(714) 237-9220

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## SPECIFICATIONS

INPUT VOLTAGE	105 - 125VAC, 60 Hz
400V DC SUPPLY	
Output Voltage:	0 - 400V, continuously variable.
Output Current:	0 - 200mA.
Current Limit Adjustment/Protection:	10mA to 200mA, continuously variable—sets trip current to shut-down supply output.
Load Regulation:	0.1% at high end.
Line Regulation:	0.1%.
Noise & Ripple:	Less than 10mV peak-to-peak.
100V DC SUPPLY	
Output Voltage:	0 - 100V, continuously variable.
Output Current:	0 - 2mA.
Load Regulation:	1%
Line Regulation:	1%
Noise & Ripple:	Less than 10mV peak-to-peak.
Protection:	Current-limiting resistance.
6.3VAC (Non-Adjustable)	
Output Voltage:	6.3V $\pm$ 5%, full load; 110VAC primary.
Output Current:	3.5A continuous.
Protection:	Thermal circuit-breaker.
12.6VAC (Non-Adjustable)	
Center-Tap Supply	
Output Voltage:	6.3V $\pm$ 5%, full load; 110VAC primary, each side to center-tap.
Output Current:	3.5A continuous.
Protection:	Thermal circuit-breaker.
METERING	
Voltmeter (2 Ranges):	0 to 400V DC (400V supply only), $\pm$ 3%. 0 to 100V DC (100V supply only), $\pm$ 3%. Range selected by switch.
Milliammeter:	0 to 200mA (monitors 400V supply only), $\pm$ 3%.
DIMENSIONS (Overall):	14-1/8" x 3-7/8" x 10" deep.
NET WEIGHT:	11 lbs.

## FEATURES

Fully solid state, utilizing integrated circuits, silicon transistors and diodes and one SCR. Among the advantages of solid state construction are dependability, no warm-up time or stabilization delay, ruggedness, compact size.

**Current Limiting/Overload Protection:** Protects load and instrument against overload. Pre-settable automatic current shutdown, fully adjustable from 10mA to 200mA provided on the B+ output. Resistive limiting protects the C- supply and load. The 6.3VAC and the 12.6VAC heater windings and loads are protected by a resettable circuit breaker.

**Simplified Current Shutdown Setting:** Permits setting B+ current shutdown point without disturbing external load connections or output voltage settings; does not require application of short circuit to output terminals. Simply press the button and adjust the CURRENT SET control to the desired setting on the current meter.

**0-400V, 0-200mA:** Output voltage continuously adjustable over entire range with a single control; no range switching required. Fully regulated output at all levels.

**0-100V, 0-2mA:** Output voltage continuously adjustable over entire range with a single control; independently floating output. Can be used independently of the 0-400V output or can be used with either polarity referenced to the 400V output.

**6.3VAC, 12.6VAC CT, 0-3.5A:** Independently floating AC sources.

**Dual Meters:** Allow B+ supply output voltage and B+ supply current drain to be monitored simultaneously. The voltmeter can also be switched to monitor the bias supply voltage. Both meters have overload protection to prevent damage from excessive loading.

**One Current Range:** Simplifies current shutdown setting by requiring only one adjustment.

**Two Voltmeter Ranges:** 0-400V and 0-100V ranges for the B+ and C- supplies respectively provide maximum resolution with a minimum effort to the user.

**Standby—DC On Switch:** Disconnects the DC supplies from external loads without disturbing voltage or current settings.

**Pilot Lamp:** Lights up to indicate at a glance that the supply is on.

**Mechanical Pre-Regulator:** B+ supply rectifier voltage is increased in progressive steps as output is increased. This improves efficiency as less power is converted to heat at low voltage output.

**Floating Outputs:** Permit referencing the positive or negative outputs of the B+ supply and the C- supply to any external DC potential or grounds.

**Reverse Polarity Protection:** Prevents against accidental damage from reverse polarity connections to an external power source.

**Attractive, Functional Design:** Permits stacking of units when more than one power supply is required.

**Easy to Operate:** All controls are identified and easy to read. Simplified operation helps prevent operator mistakes that might damage equipment.

## INTRODUCTION

The B & K Precision Model 1602 High Voltage Power Supply is a versatile, laboratory quality instrument which provides regulated DC voltages and currents of 0-400V at 0-200mA and 0-100V at 0-2mA; and AC voltages and currents of 6.3 and 12.6VAC at 0-3.5A. The high performance, operating ease, and special features make it an excellent choice for most applications requiring a high voltage DC power source. It is well-suited for powering fully solid state circuits, tube type circuits, and hybrids. Unlike some supplies, the user can rectify the AC source and have 3 independent supplies for powering digital/analog circuits, etc.

Following is a list of some of the most popular applications of 1602:

- **Service Technicians:** Powering high voltage solid state equipment, or individual circuits consisting of transistors, vacuum tubes or both.
- **Factory Technicians:** Powering complete equipment or individual assemblies during testing in the factory.
- **Engineers and Laboratory Technicians:** Powering prototypes and experimental equipment.
- **Electronics Instructors and Students:** Laboratory experiments in basic and advanced electronics.

## OPERATING CONTROLS

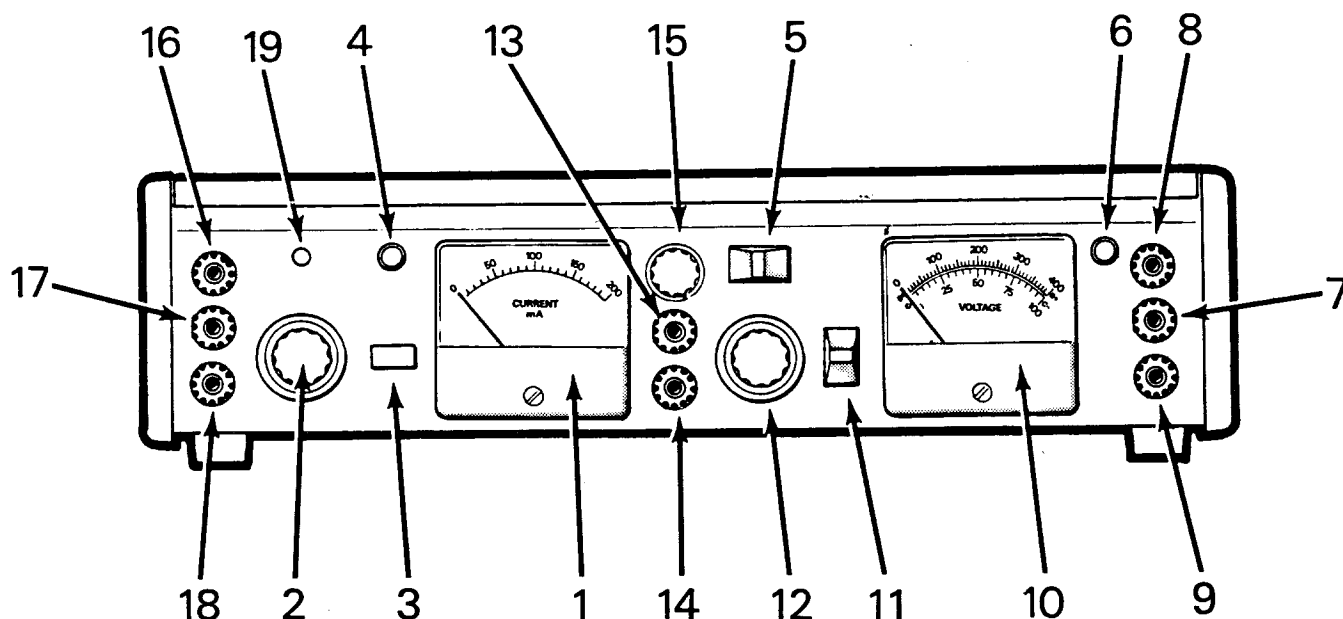


Fig. 1. Controls and Indicators.

1. **CURRENT METER.** Measures actual B+ output load current during normal operation. Indicates B+ current limit when set/reset switch **3** is pushed.
2. **B+ CURRENT SET.** Provides adjustment of B+ current limit. Continuously adjustable from 10-200mA output current.
3. **B+ CURRENT PUSH TO SET AND RESET (SET/RESET) BUTTON:** When fully depressed and held, connects current meter **1** to read the B+ current limit setting. When pressed and released, resets B+ overload circuit if it has been tripped.
4. **OVERLOAD INDICATOR (RED).** Lights when B+ current limit has been exceeded and the B+ supply has shut down.
5. **STBY ON.** STBY position: Removes power from terminals **8, 9, 13,** and **14,** and voltmeter **10,** but leaves the DC supplies activated and at standby condition. ON position: Applies power to output terminals **8, 9, 13, 14,** and voltmeter **10.**

6. **POWER.** Lights continuously when power supply is turned on.

7. **TERMINAL.** Earth and chassis ground terminal.

### B+ TERMINALS

8. **+ TERMINAL.** Positive polarity of B+ output.
9. **- TERMINAL.** Negative polarity of B+ output.
10. **VOLTMETER.** Indicates output voltage of B+ or C-supplies.
11. **METER RANGE.** B+/0-400 position: Selects full scale range of 400 volts for voltmeter **10** to meter B+ output voltage. C-/0-100 position: Selects full scale range of 100V for voltmeter **10** to meter C- output voltage.
12. **LEVEL (B+).** Turns off power supply at extreme counterclockwise rotation. Clockwise rotation turns on power supply and adjusts B+ output voltage upwards.

## C-TERMINALS

- 13. - **TERMINAL**. Negative polarity output of C- supply.
- 14. + **TERMINAL**. Positive polarity output of C- supply.
- 15. **C- CONTROL**. Adjusts C- output voltage between terminals **13** and **14** from 0 to 100V with clockwise rotation. Output voltage is monitored on Voltmeter **10** when **METER RANGE Switch 11** is in C-/0-100V position.
- 16. & 17. **6.3VAC TERMINALS**. 6.3VAC output terminals. Protected by breaker **19**.

16. & 18. **12.6VAC TERMINALS**. 12.6VAC output terminals. Protected by breaker **19**.

- 19. **AC RESET**. Circuit breaker in series with terminal **16** protects against excessive overloads between terminals **16**, **17** and **16**, **18**.

**NOTE:** At **17** and **18** 6.3VAC is available. This output is protected by an internal fuse. For maximum convenience and minimum down-time due to accidental short-circuits use the breaker-protected AC outputs **16**, **17** and **16**, **18**.

## OPERATING INSTRUCTIONS

- 1. Turn off the power supply before plugging it into an AC outlet, by rotating the **LEVEL control 12** fully counterclockwise, until it "clicks" off.
- 2. Connect the power cord to a 105-125 volt 60 Hz AC outlet.

### WARNING

- a. Use only a polarized 3-wire outlet. This assures that the power supply chassis is connected to a good earth ground and prevents danger from electrical shock. If a 2-wire to 3-wire adapter must be used, be sure the ground wire of the adapter is attached to a good earth ground.
- b. If a circuit under test requires application of a fixed bias, always apply the required voltage using the C- supply first; before applying the B+ voltage (Step 6-d).

- 3. Turn on the power supply by rotating the **LEVEL control 12** slightly clockwise past the "click". The **POWER indicator 6** will light.
- 4. Determine the maximum safe load current for the device to be powered and set the automatic current shutdown for that value as follows:
  - a. Push and hold the set/reset button **3** and adjust the **B+ CURRENT SET control 2** for the desired shutdown current point as read on the **CURRENT meter 1**.
  - b. Release the set/reset button **3**.
  - c. Turn **LEVEL (B+) control 12** to the desired voltage.
  - d. If the maximum safe load current is unknown, start with a low current setting. If the setting is too low, the overload circuit will trip when power is applied to the load in steps 6 and 7. If so, increase the current setting in small steps until the overload circuit does not trip during normal operation.

### NOTE

In certain conditions of high-line voltages or B+ OUTPUT voltages greater than 100V, resetting may not be accomplished by simply pushing the SET/RESET **3** button. (This is due to the Q1-VCE sensing circuitry described under CURRENT-VCE SENSING CIRCUITS, page 13.) Should this occur proceed as follows:

- (a) Set the **STBY/ON 5** switch to the **STBY** position.

- (b) Push the **SET/RESET 3** button in and adjust the **B+ CURRENT SET 2** to at least 50mA on **CURRENT METER 1** if not already, and reset to the desired current limit.
- (c) Release the **SET/RESET 3** button and return **STBY/ON 5** to **ON** position..

If an overload in the circuitry being powered exists, the supply will shutdown as normal.

At very low output currents, decreasing the B+ output voltage between 150V to 400V may activate the Q1-VCE sensing circuit before the desired B+ output is reached on **VOLTMETER 10**. The supply will shutdown and the **OVERLOAD lamp 19** will light. To reset, simply proceed as stated in (a), (b), and (c) above.

- 5. Connect the power supply output to the device being powered with test leads as follows:
  - a. Connect the positive polarity high voltage input of the device being powered to the (+) terminal **8** of the B+ supply.
  - b. Connect the negative polarity high voltage input of the device being powered to the (-) terminal **9** of the B+ supply.
  - c. If the positive polarity of the device being powered is to be the ground reference, jumper the (+) terminal **8** to the ground terminal **7**.  
  
If the negative polarity of the device being powered is to be the ground reference, connect the (-) terminal **9** to the ground terminal **7**.  
  
If neither the positive or the negative polarity input of the device being powered needs to be grounded but the chassis of the device needs grounding, connect a separate test lead from the chassis of the device to the ground terminal **7** of the B+ supply.
  - d. Follow the above procedures for the C- supply, using plus (+) terminal **14** and minus (-) terminal **13**.

### NOTE

The C- supply and the B+ supply are entirely independent of each other. When a circuit requires a bias voltage which is negative with respect to the circuit reference, the (+) terminal **14** of the C- supply is connected to this reference. Refer to Fig. 2.

- e. Connect the AC voltage sources (terminals **16**, **17** and/or **16**, **18**) to the device if required.



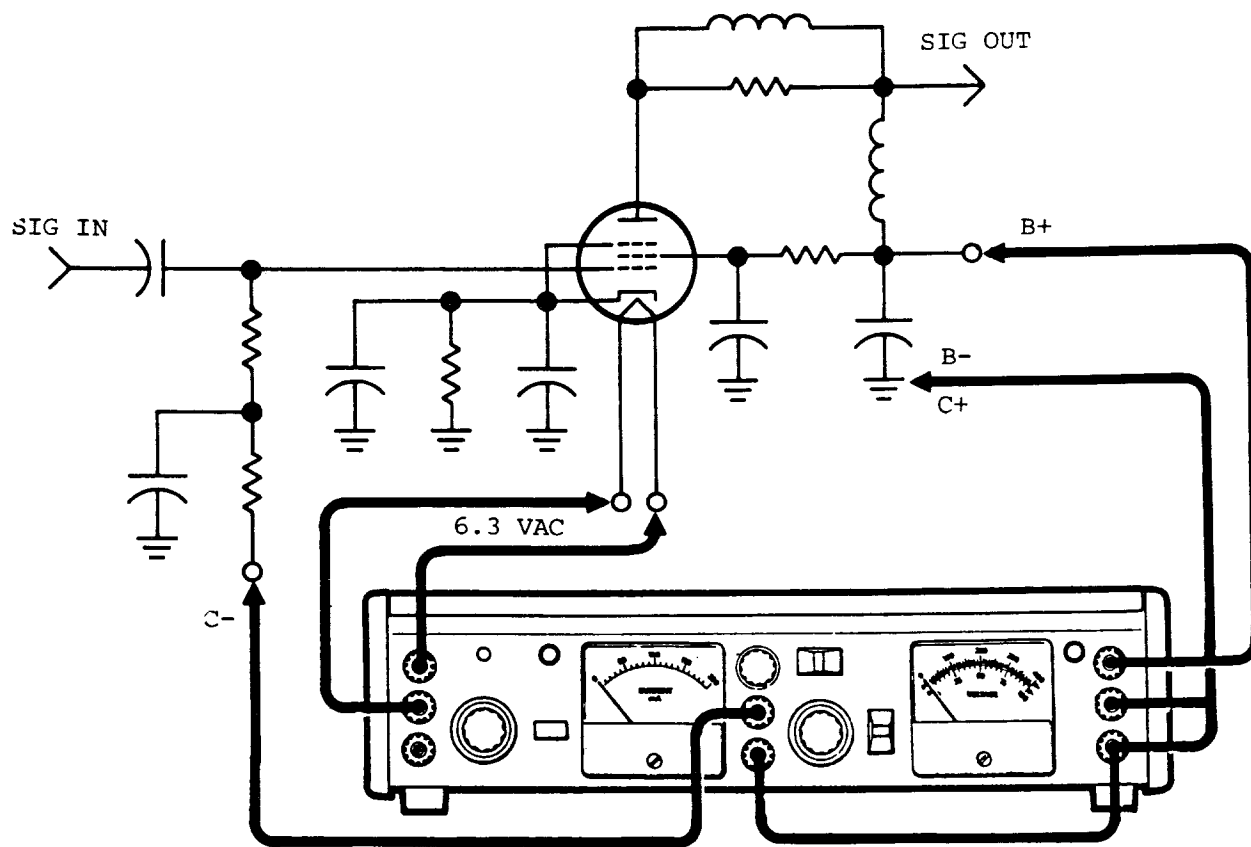


Fig. 2. Typical Vacuum Tube Circuit Application.

6. Return the STBY-ON Switch **5** to the ON position and set the output voltage as follows:
  - a. Set METER RANGE Switch to C-/0-100V when adjusting C- supply output.
  - b. Turn C- control **15** until desired voltage is reached.
  - c. Set the METER RANGE switch **11** to B+/0-400V when adjusting B+ supply output.
  - d. Turn LEVEL control **12** clockwise until voltage is reached.

#### NOTE

When a fixed bias is required for a circuit under test, always perform Steps a and b first. (C- bias level.)

7. If the B+ load current exceeds the current shutdown point, the overload lamp **4** will light, and the B+ supply will shut down (current meter **1** and volt-meter **10** will drop to zero). Restore the power supply to normal operation as follows:
  - a. To reset the power supply, press and release the set/reset button **3**. If the overload was intermittent, this will restore normal operation.
  - b. If the overload lamp remains lit, use one of the following techniques before resetting the power supply again.
    - (1) Reduce the load current.
    - (2) Reduce the voltage slightly with the LEVEL control **12**.

- (3) Increase the shutdown point slightly with the B+ CURRENT SET control **2**. If the normal load current is unknown, this technique may be used, but, if the current limit is already set for the maximum safe load current, do not increase the current limit further.
- (4) Check the bias setting to determine if it is incorrectly set.
- (5) Refer to NOTE under 4-d, page 5.

#### NOTE

Some equipment has a highly capacitive input, which results in a surge current when power is initially applied. When powering such equipment, the overload circuit may activate when the STBY-ON switch is placed in the ON position with full operating voltage previously set. If this occurs, reduce the voltage setting before resetting the overload and then bring the output level up gradually to allow the capacitors in the equipment to charge; this eliminates the surge current.

- c. If the power supply continues to shut down at the correct current setting, check the load circuits to determine the reason for the overload.
- d. To remove power from the load without disturbing the voltage or current shutdown settings, set the STBY-ON switch **5** to the STBY position.
- e. Refer to NOTE under 4-d, page 5.



## APPLICATIONS

### General

This instrument may be used to power a vast assortment of circuits and devices in the fields of electronics servicing, electronics manufacturing, electronics design engineering, and electronics education. The B+ and C- supply outputs are fully adjustable over their full range, while the low voltage AC source remains fixed. This flexibility makes it suitable for most applications requiring a single or multiple output high voltage supply.

### Powering Tube Type Circuits

Fig. 2 shows the 1602 being used to supply the operating voltages in a typical vacuum tube RF amplifier stage.

1. Connect the filament of the tube to terminals **16** and **17** for 6.3VAC heater operation or to **16** and **18** if 12.6VAC heater voltage is required.
2. Connect the grid resistor to the (-) terminal **13** of the C-supply.
3. Connect the (+) terminal **14** of the C- supply to the (-) terminal **9** of the B+ supply.

4. Connect the B+ lead to the (+) terminal **8** of the B+ supply to provide power for the plate and screen grid of the tube.
5. Connect the common lead to the (-) terminal **9** of the B+ supply. This point is also normally connected to the ground terminal **7**, for shock hazard prevention. The connection between ground and the (-) terminal **9** of the B+ supply may not be used during some types of experiments, such as positive grounds and floating supply inputs.

With the meter switch in the C-/0-100V position, adjust the C- control for the desired bias level.

Before the B+ output voltage is adjusted, press the B+ current set/reset button and adjust the B+ CURRENT SET control for the maximum output current desired. Now the B+ voltage level may be increased to the required level. If the current overload circuit shuts down the B+ output, either increase the B+ current set, or decrease the output current drain by increasing the C- output voltage. (Also refer to NOTE under 4-D, page 5.)

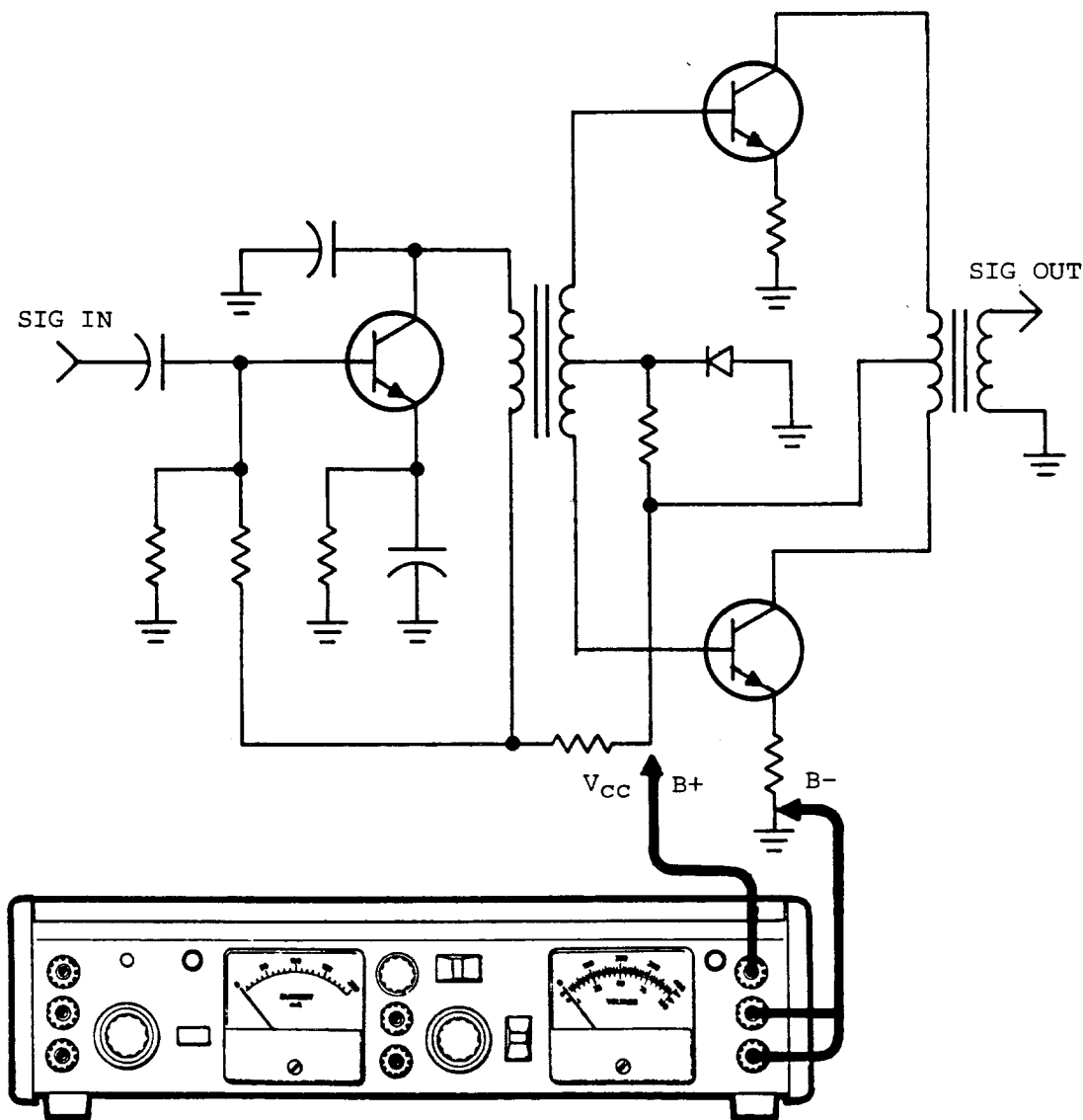


Fig. 3. Typical Transistor Circuit Application.

### Powering Transistor Type Circuits

Fig. 3 shows the 1602 Power Supply being used to power a transistor amplifier circuit.

1. Connect the  $V_{CC}$  lead of the circuit to the (+) terminal 8 of the B+ supply.
2. Connect the common lead of the circuit to the (-) terminal 9 of the B+ supply and to the ground terminal 7.

In some circuits the chassis is connected to the positive  $V_{CC}$  line which means the ground terminal should be connected to the (+) terminal 8 of the B+ supply. Fig. 4 shows the various methods to connect the 1602 to accommodate different equipment power/ground configurations. If there is any doubt which supply lead is common to the chassis, no damage will result if a separate lead is connected from the chassis to the ground terminal 7.

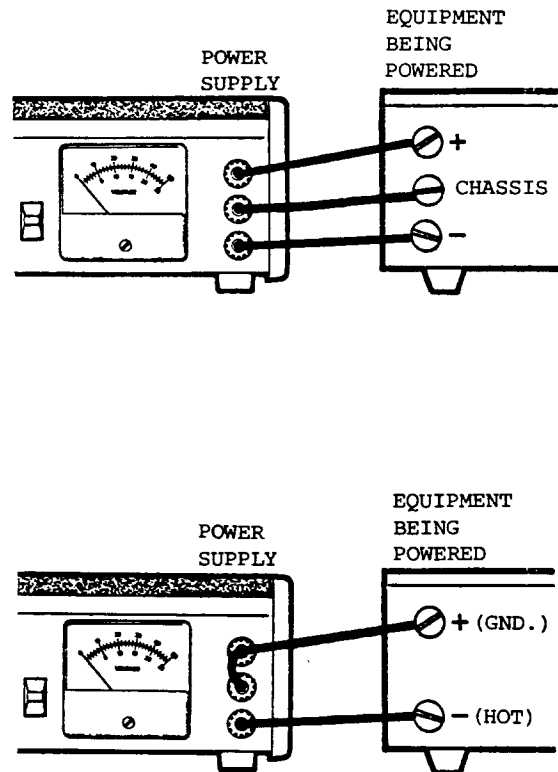
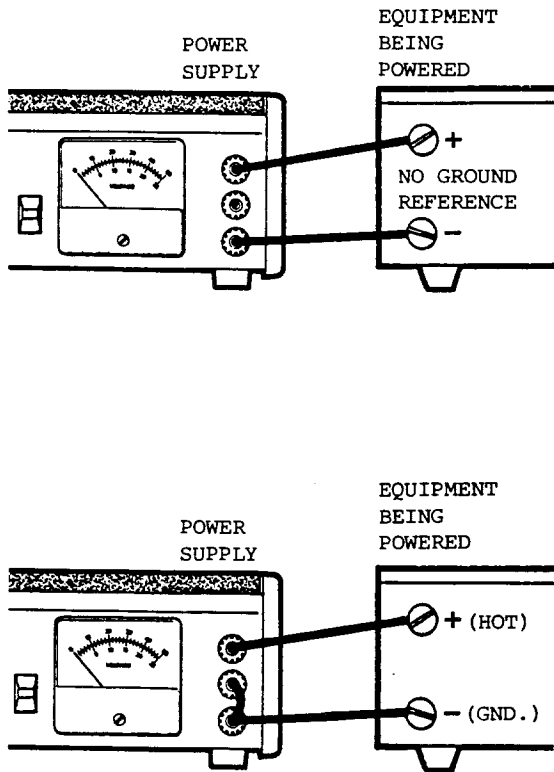


Fig. 4. Power Supply Output Situation.

### Other Educational Uses

The student in an electronics course may use the power supply for powering equipment and circuits as previously described for all other applications. In addition, the power supply can be used to conduct experiments in fundamental electronics. In learning Ohms law, for example, the relationships of resistance, voltage and current are easily demonstrated with the supply. Being able to observe both voltage and current simultaneously is a great aid in such experiments. Fig. 5 shows some examples of the types of experiments that may be conducted.

### Using Two Supplies for Two B+ Voltages

When two separate B+ voltages are required simultaneously for testing equipment, two supplies may be used. Set the voltage and current limit for each supply independently as required by each load requirement. Only the circuit reference point must be common between the two supplies.

Fig. 6 shows some typical examples of proper power supply connections when using two units. Take extra precautions to prevent reverse polarity connections in such situations. The numerous connections can become confusing. Additional colors for the test leads will be helpful. The power supplies are protected from reverse polarity damage from an external voltage source such as the other power supply.

Although two supplies may be used safely in the above situations, it is not recommended that the supplies be operated in series for voltages higher than 400V. Also, to avoid shock hazards, do not connect both ground terminals to the power supply output terminals; doing so may place the entire power supply chassis at a high potential.

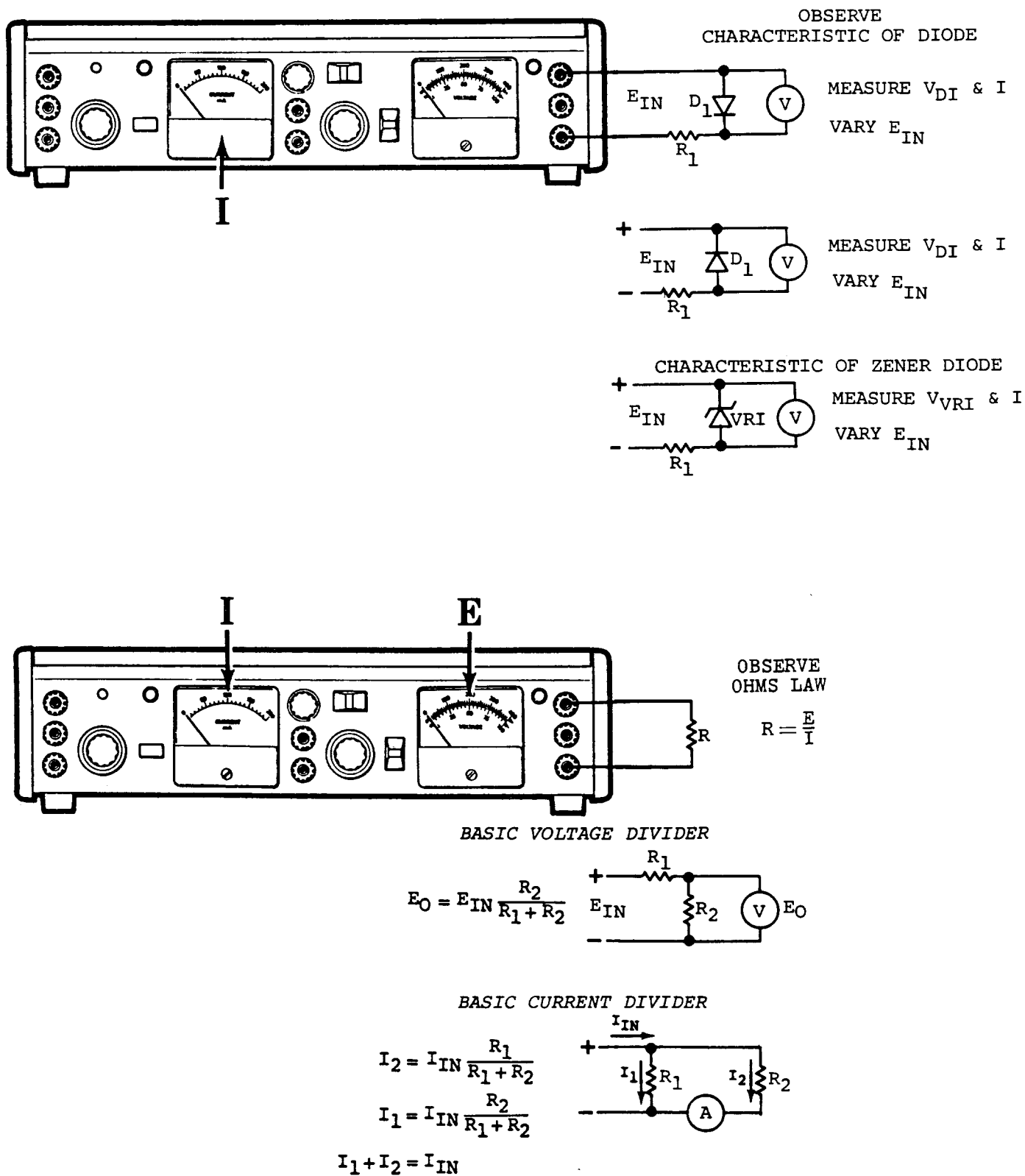


Fig. 5. Typical Laboratory Classroom Experiments Using the 1602 Power Supply.

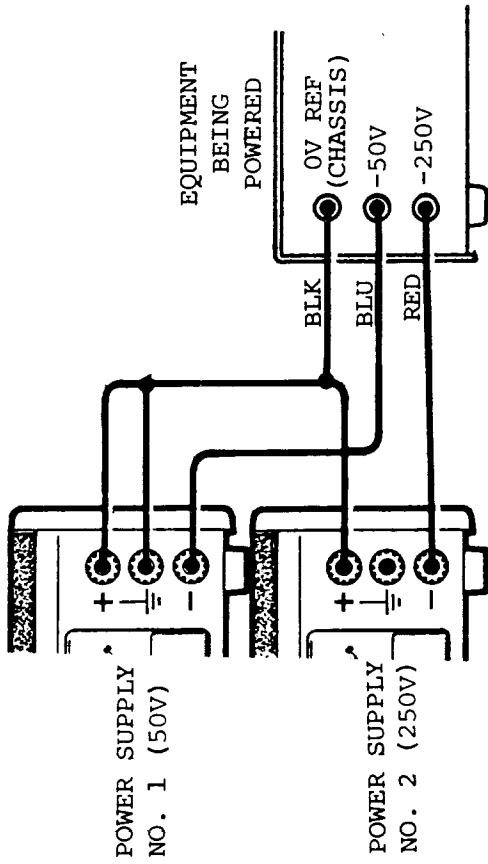
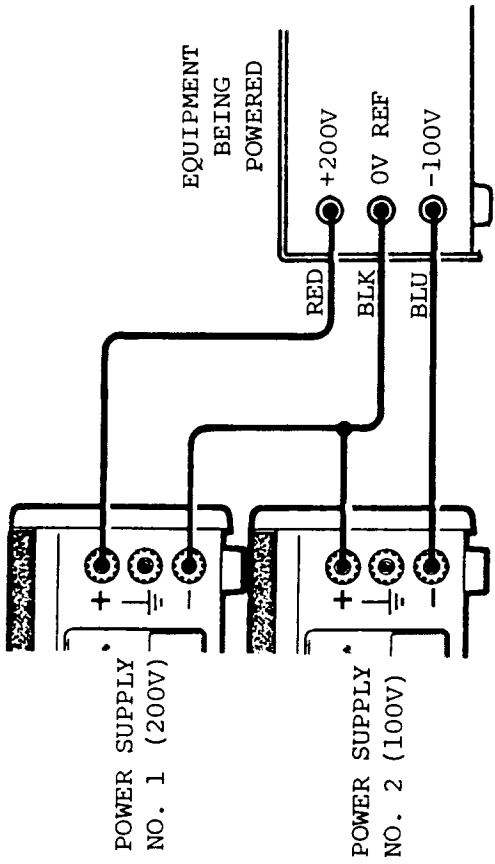
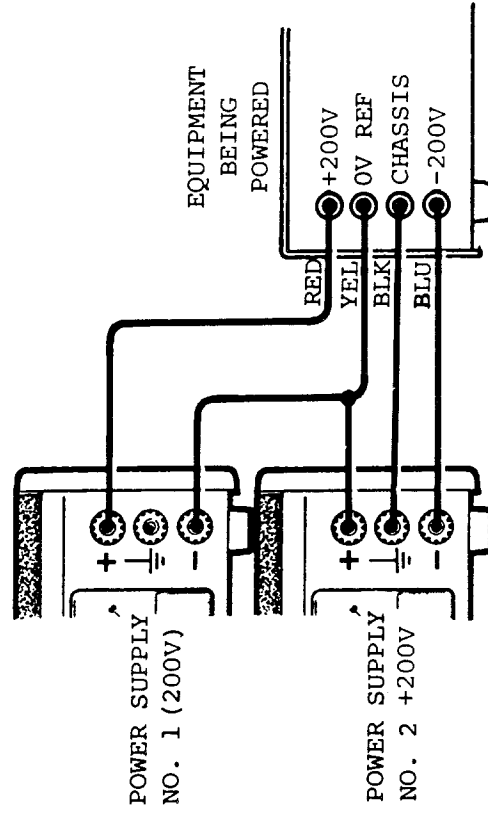
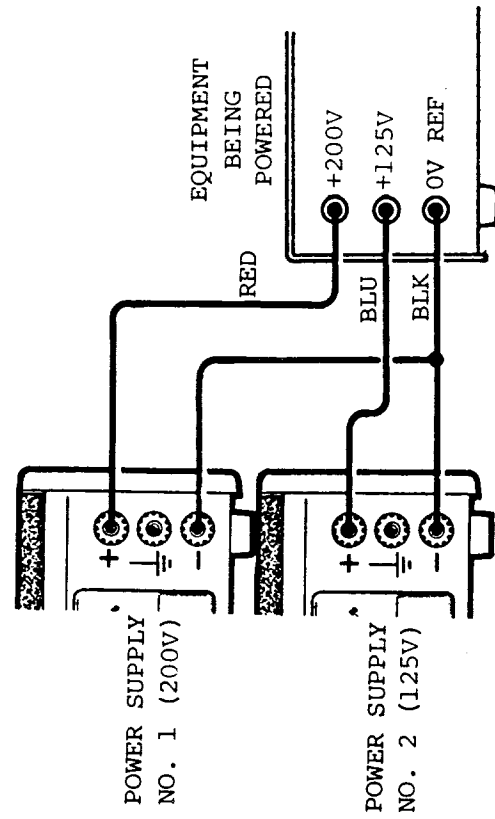


Fig. 6. Using Two Power Supplies for Two Output Voltages (Typical Examples).

## CIRCUIT DESCRIPTION

### General

The power supply converts a 117VAC input to a highly regulated and filtered DC output that is fully adjustable from 0 to 400 volts at 0-200mA at the B+ terminals; and 0-100V at 0-2mA at the C- terminals. The supply also converts its AC input to a 12.6VAC center-tapped output at 0-3.5A. The circuits that accomplish this action may be divided into 4 main groups as follows:

1. Unregulated DC and AC sources: Converts the AC input to raw DC for the B+ and C- control and filter circuits; and steps down the AC input for the 12.6VAC filament windings.
2. Control circuits: Control the unregulated B+ and C- sources to provide the highly regulated, adjustable outputs.
3. Current sensing circuits: Establish the B+ current limit, sense the B+ load current, and activate an overload detector that shuts down the B+ supply if the current limit is exceeded.
4. Metering: Monitors the B+ or C- voltage, and the B+ output current. Refer to Fig. 7, the functional diagram and to the schematic diagram. Circuit descriptions make constant reference to these diagrams.

**NOTE:** The voltages in the following circuit descriptions and on the diagrams are measured with respect to the regulated B+ output, the + terminal, or the C- output, and - terminal. Note that these points are floating independently of the chassis of the power supply.

### Unregulated DC and AC Sources

There are three unregulated DC sources and one unregulated AC source in the supply. The most important unregulated supply is the B+ source. This source converts 117VAC to a raw unregulated B+ output. Later, the control and filter circuits convert this to the regulated B+ output of the power supply.

The unregulated B+ output level is pre-regulated in coarse steps. As the LEVEL control is rotated clockwise from zero to maximum, the unregulated B+ changes from its lowest to its highest value in four steps. This minimizes the difference between the unregulated B+ and the regulated B+ output, which always keeps power dissipation within safe limits.

The main components which make up this circuit are winding No. 1 of power transformer T1, pre-regulator switch assembly S2, rectifiers D5, 6, 7, 8, and filter capacitor C8.

The AC input is applied to the unregulated B+ circuit through on-off switch S4 (which is part of the level control) across neon lamp NE1 (which glows continuously as a pilot lamp to show that power is on) to power transformer T1.

Transformer T1 has four taps in its output winding No. 1. At the lowest voltage setting, only the low voltage portion of the winding is connected to the rectifiers (this is the condition shown on the schematic diagram). As the LEVEL control is rotated clockwise, cams operate microswitches S2C, then S2B, and finally S2A. Each cam-operated microswitch selects another tap on this secondary of the transformer and sequentially steps the rectifier input voltage to a higher value.

Rectifier diodes D5, 6, 7, and 8 convert the AC to full wave DC, which is filtered by C8. The unregulated B+ output at C8 is regulated and filtered by the control circuits.

The C- and CONTROL unregulated DC sources are fairly standard and straightforward.

Secondary winding No. 2 provides power for the comparator IC1 and voltage reference and error amplifier IC2. This supply is designed to be free of influence from the unregulated B+ supply. The 20 volt AC output from secondary winding No. 2 is converted to +15V and -15V by full wave rectifiers D1 and 2. Both the V+ and V- voltages float with respect to the regulated output and the unregulated B+ supply variations.

Secondary winding No. 3, diode D9 and C11 provide half wave filtered DC for the C- control and filter circuits.

### B+ and C- Control Circuits

The B+ control circuit converts the unregulated B+ supply into the regulated B+ output voltage. The control circuit establishes the regulated B+ output voltage in response to the setting of the LEVEL control R22. When R22 is set for 0 volts, the following circuit conditions exist:

1. Voltage reference IC2A provides a stable +7V reference at IC2-6.
2. The +7V reference is divided across R10 and R11 to place +3.5V at pin 4, IC2, the inverting input of error amplifier IC2B.
3. The regulated B- voltage is 0V.
4. The +7V reference is divided across current Path I, which consists of R23, R12, R30, and R21 (R22 is approximately 0 ohms at this time). This places approximately +3.5V on IC2-5, the non-inverting input of error amplifier IC2-13.
5. Error amplifier IC2B will produce whatever output is necessary to keep the difference voltage at its inputs, pins 4 and 5, very close together. Therefore, with R22 at about zero ohms, just enough drive will be applied to series pass regulator Q1, Q2 to maintain a zero volt B- output.
6. The series pass transistors are being slightly driven at 0V output to avoid non-linearities at low output voltages (jumps in output, poor regulation, etc.).

When LEVEL control is increased to a higher voltage level the following circuit action occurs:

1. The resistance of R22 is added to the voltage divider network, decreasing current I1.
2. The voltage at IC2-5 increases (less drop across R23, 12), and error amplifier IC2B increases its output to drive series pass transistor Q1, Q2 into heavier conduction.
3. The regulator allows some of the B+ supply to pass to the output, and the output voltage rises.
4. As the output voltage rises the B- supply becomes more negative with respect to the B+ terminal.
5. Current I1 increases as the B- becomes more negative, and the voltage at IC2-5 decreases until balance is achieved.

When LEVEL control R22 is decreased, the opposite action occurs. Once R22 is set and balance is achieved, any load current changes that tend to change the output voltage are sensed and corrected.

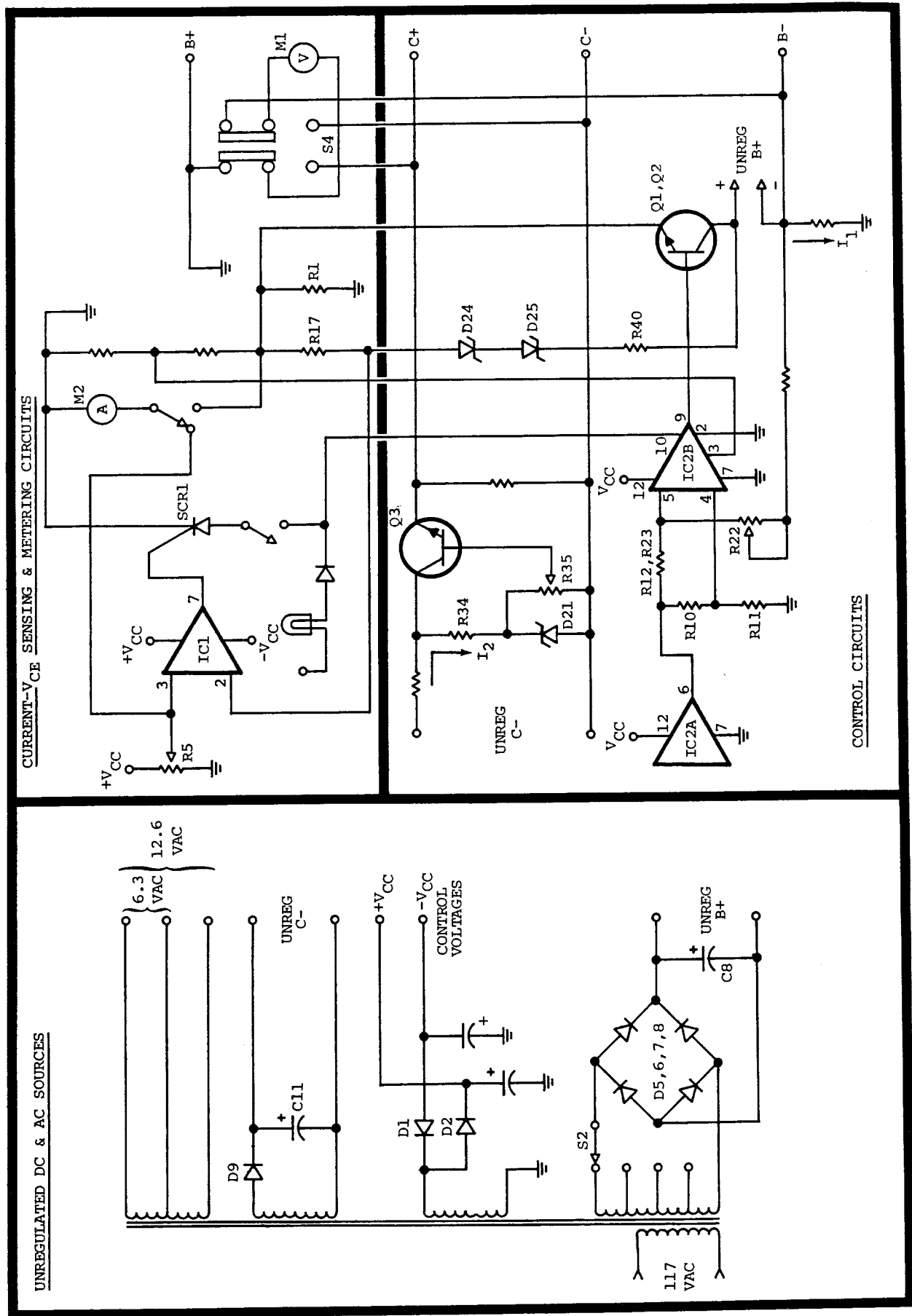


Fig. 7. Functional Diagram.

#### 100V METER CAL (R26)

1. Connect an accurate, calibrated voltmeter to the output terminals **13** and **14**, capable of 100V reading.
2. Set the METER RANGE switch **11** of the power supply to the C-/0-100 position.
3. Adjust the C- control **15** for exactly 100V on the external voltmeter.
4. Adjust 100V CAL potentiometer (R26) for exactly 100V on the voltmeter of the 1602 power supply.

#### MAX. OUTPUT ADJ. (R23)

1. Connect an accurate, calibrated voltmeter to the output terminals **8** and **9**, capable of 400V reading.
2. Set the LEVEL control **12** of the 1602 power supply to MAXIMUM.
3. Adjust the MAX. OUTPUT ADJ. potentiometer (R23) for exactly 402 Volts on the external voltmeter.

#### 400V METER CAL (R31)

1. Connect an accurate, calibrated voltmeter to the output terminals **8** and **9**, capable of 400V reading.
2. Set the METER RANGE switch **11** to the 0-400 position.
3. Set the LEVEL control **12** of the 1602 power supply to read exactly 400 Volts on the external voltmeter.
4. Adjust 400V CAL potentiometer (R31) for exactly 400 Volts on the voltmeter of the 1602 power supply.

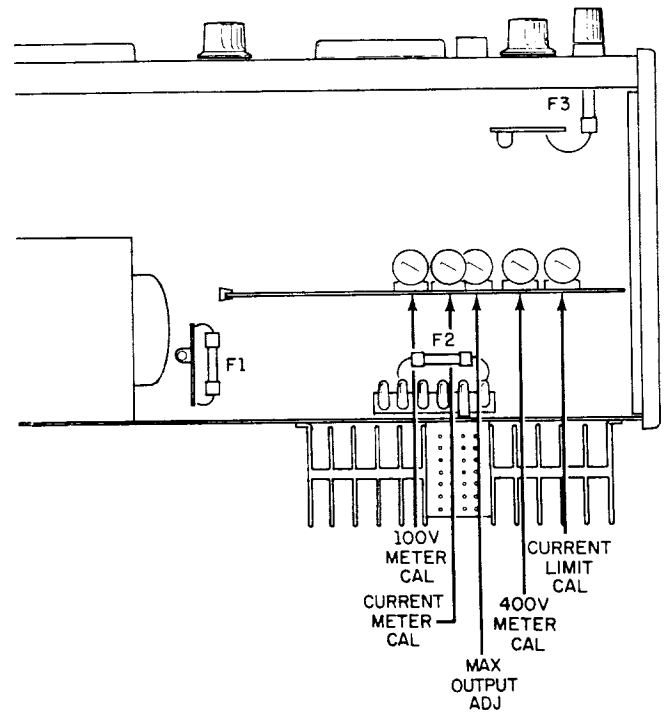
#### CURRENT METER CAL (R27)

1. Reduce the 1602 LEVEL control **12** to minimum.
2. Connect an accurate, calibrated ammeter capable of 200mA in series with an appropriate load (250 ohms, 10 watts) to the output terminals **8** and **9** of the 1602 power supply.
3. Adjust the LEVEL control **12** for exactly 200mA on the external ammeter.
4. Adjust CURRENT METER CAL. potentiometer (R27) for exactly 200mA on the current meter of the 1602 power supply.

#### CURRENT LIMIT ADJ (R39)

**NOTE:** No load connected for this adjustment.

1. Set **2** adjusted to full C. W.
2. Press button **3** and adjust R39 for exactly 200mA on the current meter of the 1602 power supply, then release button **3**.



**Fig. 8.** Location of Calibration Adjustments and Fuses.

#### NOTE

If the unit has just been serviced, reconnect the load used in Step 2, to check the current limit. Adjust LEVEL **12** for 50mA on the current meter. Rotate B+ CURRENT SET C.C.W. until "OVERLOAD" LIGHTS. Press button **3** to check accuracy. If OVERLOAD DOES NOT LIGHT, CURRENT LIMIT CIRCUIT IS BAD. Also refer to NOTE under 4-d, page 5.

#### FUSE REPLACEMENT

If there is no power supply output, and the POWER lamp does not light, check fuse F1. If the POWER lamp lights, but there is no output from the main 400V supply, check Fuse F2.

If the POWER lamp lights, but there is no 12.6VAC output after resetting **18** on the 1602 front panel check F-3.

All fuses are 3AG pigtail type, and locations shown in Fig. 8.

All fuses are accessible by removing the top cover. To do this, remove 3 screws at the rear, lift the top cover at the rear, and slide the front lip of the cover from the retaining bosses on the front panel.