$1.00

Simpson

INSTRUMENTS THAT STAY ACCURATE

OPERATOR'S MANUAL

WARNING

For safe usage, it is essential that the operator read this manual carefully before using the instrument for any measurements.

MODEL 715
AC VACUUM TUBE VOLTMETER

SIMPSON ELECTRIC COMPANY

853 Dundee Ave., Elgin, Illinois 60120
Area Code 312, Telephone 697-2260
In Canada, Bach-Simpson, Ltd., London, Ontario

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Printed in U.S.A.
Re-Print 8-76

Part No. 1-118408

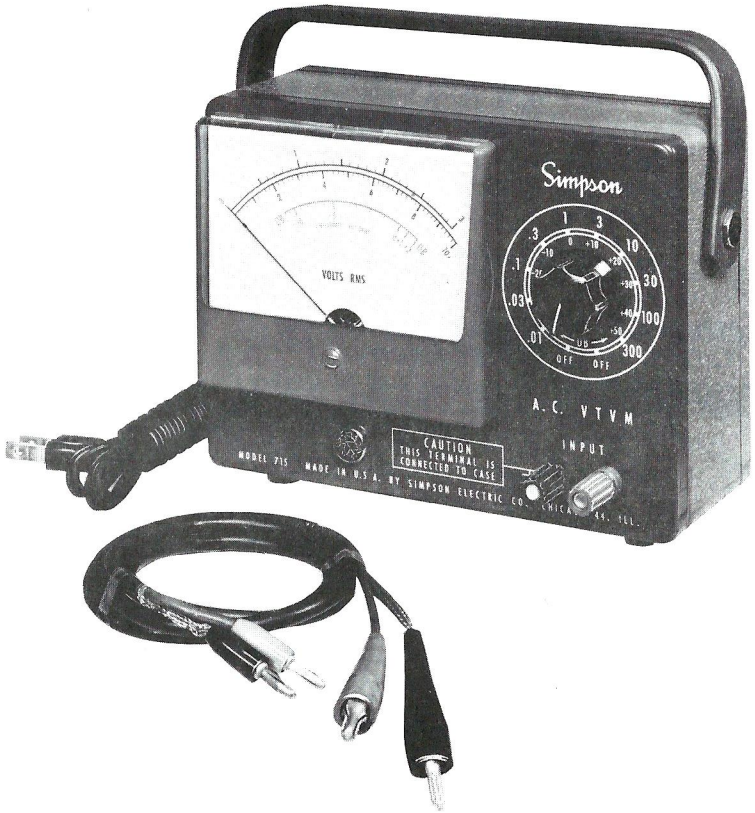

Figure 1-1. Model 715, AC Vacuum Tube Voltmeter

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WARNING

The Model 715 is designed to prevent accidental shock to the operator when properly used. However, no engineering design can render safe an instrument which is used carelessly. Therefore, this manual must be read carefully and completely prior to making any measurements. Failure to follow directions can result in a serious or fatal accident.

SHOCK HAZARD (As defined in Underwriters Laboratories Radio and Television Receiving Appliances Standards for Safety, Twelfth Edition, dated June 25, 1969.)

"Shock hazard shall be considered to exist at any part involving a potential of between 42.4 volts peak and 40 kilovolts peak in the following cases:

A. If the current through a load of not less than 500 ohms exceeds 300 milliamperes after 0.0003 second.
B. If the current through a load of not less than 500 ohms exceeds 5 milliamperes after 0.2 second.
C. If the time required for the current through a load of not less than 500 ohms to decrease to 5 milliamperes is between 0.1 and 0.2 second, and the total quantity of electricity passed through the load up to that time exceeds 4 millicoulombs.
D. If the time required for the current through a load of not less than 500 ohms to decrease to 5 milliamperes is between 0.03 and 0.1 second, and the total quantity of electricity passed through the load up to that time exceeds $75T-350T^2$ millicoulombs, where T is the time in seconds.
E. If the potential is more than 5 kilovolts peak and if the total capacitance of the circuit is more than 3000 micromicrofarads."

NOTE: Additional factors might apply when potentials more than 40 kilovolts peak are present.

SECTION I

INTRODUCTION

1.1.1 The Simpson Model 715 AC Vacuum Tube Voltmeter (AC VTVM), hereafter referred to as Model 715 or simply as the Instrument, is a modern, compact test instrument which measures AC voltages from millivolts through 300 volts RMS (sine wave calibration). The frequency response is from 10 Hz through 400 kHz.

1.1.2 High input impedance usually permits measurements with negligible circuit loading.

1.1.3 The Model 715 meter scale includes a dB arc for applications where readings in terms of decibels are required.

1.1.4 The Model 715 operates on a power input of 120 or 240 volts, 50-60 Hz AC, 10 watts.

1.2 ACCESSORIES AND SUPPLIES

Operator's manual and test leads for the Instrument are furnished and listed in Table 7-1.

1.3 TECHNICAL DATA

Table 1-1 lists the technical specifications for the Model 715.

WARNING

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Table 1-1. Technical Data

1. AC VOLTAGE:

Range	Input Impedance*	Overload Protection To
0-0.1 V	15 MΩ in parallel with 33 pF	150 V
0.03 V		150 V
0.1 V		150 V
0.3 V		150 V
3 V		150 V
10 V	1 MΩ in parallel with 35 pF	600 V
30 V		600 V
100 V		600 V
300 V RMS		

*Measured at the binding posts.

Decibels:	Total range: −52 to +52 dB; 0dB = 1 milliwatt into 600 ohms Scale markings: −12 to +2 dB.
Accuracy:	±5% of full scale
Frequency Response:	0.01 to 100 volt ranges: 10 Hz to 400 kHz, ±1 dB; 300 volt range: 10 Hz to 40 kHz, ±2 dB
Tester Sensitivity:	10 millivolts full scale (lowest range)
Internal Multipliers:	±1% precision resistors
Meter Movement:	Simpson 4-inch Wide-Vue meter, 200 microampere movement
Tube Complement:	One 6C4, two 12AT7
Power Supply:	Power Transformer with selenium rectifier

2. INPUT POWER REQUIREMENTS: 120 volts 50-60 Hz, 10 watts (Domestic), or 240 volts 50-60 Hz, 10 watts (Export)

3. WEIGHT: 3 pounds 12 ounces

4. DIMENSIONS: 5-½ inches high, 7-½ inches wide, 3 inches deep

SECTION II

INSTALLATION

2.1 UNPACKING AND INSPECTION

2.1.1 Prior to unpacking, examine the shipping carton for signs of damage. If there is none, then unpack and inspect the Instrument for possible damage in shipment. Check the electrical performance as soon as possible. If damage is noted, notify the carrier and supplier before using the Instrument. Also check that all items are included (Table 7-1).

2.1.2 Save the shipping carton and packing materials for future storing or shipping of the Instrument.

2.2 POWER SOURCE REQUIREMENTS

CAUTION

Do not insert power cord plug into the power source yet. Check that the designation on the rear panel agrees with the power source to be used.

AC Line Operation: The Model 715 is wired at the factory for 120 VAC (50-60 Hz) operation. For 240 volts VAC operation, consult your nearest Simpson Authorized Service Center. Refer to Service Centers Listings on the last pages of this manual.

WARNING

It is important that the grounding pin of the power plug is securely connected to an earth (power line) ground. Use a 3-wire grounded outlet which conforms to the latest electrical code.

2.3 INSTALLATION

The Instrument may be operated in any position. It can be inclined conveniently by positioning the Adjust-A-Vue Handle.

SECTION III

CONTROLS, CONNECTORS, AND INDICATORS

3.1 GENERAL

All operating and adjustment controls, connectors, and indicators are described in Table 3-1. Become familiar with each item prior to operating the Instrument for the first time.

3.2 FRONT PANEL DESCRIPTION

Table 3-1 lists all front panel controls, connectors and indicators (see Figure 3-1 for identification).

Table 3-1. Front Panel Description

1. Function Selector Switch

Switch Position	Description
OFF, 0.01, 0.03, 0.1, 0.3, 1, 3, 10, 30, 100, 300	The function selector switch on the front panel selects the range for the tester and controls its operation. When it is set at any of the ten range positions, the switch turns on the power for the tester and selects the desired full-scale voltage range. Power is off when the switch is set at either of its two OFF positions.

Figure 3-1. Front Panel Description

2. Input Connectors

The INPUT connectors, at the lower right side of the front panel, are provided for interconnection of the banana plugs on the input cable.

CAUTION

The terminal in the black INPUT connector is connected to the case; therefore, although polarity is not important when reading AC voltages, use the black connector for the lead which connects to chassis-ground in any circuit being measured.

3. Scale Markings

Two meter arcs are provided for reading voltages. One arc is divided for 0 to 3 units, and the other for 0 to 10 units. The correct reading is obtained by simple decimal point placement, according to the range used.

Each range position also is marked for a decibel value. The decibel is a convenient way of comparing voltages on a logarithmic basis. The arbitrary reference level (0 dB) is 1 milliwatt into 600 ohms (0.775 volts RMS).

SECTION IV

OPERATION

4.1 GENERAL

WARNING

The Model 715 is designed to prevent accidental shock when properly used. However, no engineering design can render safe an instrument which is used carelessly. Therefore, this manual must be read carefully and completely prior to making any measurements. Failure to follow directions can result in a serious or fatal accident.

This section of the manual contains all the information required to use and operate the Model 715 in a safe and proper manner. Special notes and instructions have also been provided for added user safety, and convenience.

4.2 SAFETY PRECAUTIONS

4.2.1 The Model 715 is designed to be used only by personnel qualified to recognize shock hazards and trained in the safety precautions required to avoid possible injury. Refer to SHOCK HAZARD definition on page iv.

4.2.2 Do not work alone when making measurements where a shock hazard can exist. Notify another person that you are, or intend to make, such measurements.

4.2.3 Remember, voltages might appear unexpectedly in defective equipment. An open bleeder resistor can result in a capacitor's retaining a dangerous charge. Remove all power and discharge all

capacitors in the circuit being measured *before* connecting or disconnecting the meter. The Instrument itself is well protected against electrical overload, as noted in Table 1-1. However, the above precautions are wise even in the laboratory, and especially in field usage of the Instrument where many strange or unknown safety hazards might prevail.

4.2.4 Locate all voltage sources and accessibility paths prior to making any measurement or connections.

4.2.5 For your own safety, inspect the test leads for cracks, breaks or crazes in the insulation prods and connectors before each use. If any defects are noted, replace the defective item(s) immediately.

4.2.6 Do not make measurements in a circuit where corona is present. Corona can be identified by a pale-blue color emanating from sharp metal points in the circuit or by a buzzing sound, or by the odor of ozone. In rare instances, such as around germicidal lamps, ozone might be generated as a normal function. Ordinarily, the presence of ozone indicates presence of high voltage, and probably an electrical malfunction.

4.2.7 Hands, shoes, floor and workbench must be dry. Avoid making measurements under humid, damp, or other environmental conditions that could affect the dielectric withstanding voltage of the test leads or the Instrument.

4.2.8 For maximum safety, do not touch test leads, circuit or Instrument while power is applied to the circuit being measured.

4.2.9 Use extreme caution when making measurements in an rf circuit where a dangerous combination of voltages could be present, such as in a modulated rf amplifier.

4.2.10 Do not use test leads of lesser safety than those originally furnished with the Instrument.

4.2.11 Before the Instrument is used, make sure the "third wire"

on the AC power cord is connected to an earth or power line ground.

4.2.12 In this Instrument, circuit "common" and power line ground both are connected to chassis and to case. Therefore, do not attempt to "float" the Instrument away from ground potential.

4.3 PRELIMINARY NOTES AND CHECKS

4.3.1 Prior to operation of the Instrument, review and perform (where applicable) the following notes and checks. These steps can be used also as a general functional check.

4.3.2 Be sure that the power source used matches the requirements of the Instrument as marked on the rear panel and insert the plug into a 3-wire power outlet which conforms to the latest electrical code.

4.4 ZERO ADJUSTMENT

4.4.1 With power turned off, check to see that the indicating meter reads zero (0) when the tester is in its operating position. If it does not read zero, slowly turn the meter-adjust screw (located on the front of the meter just below the center of the dial) in either direction until the pointer rests over the 0 mark on the voltage arcs. Back-off the screw slightly to release pressure from the adjusting fork.

4.5 AC VOLTAGE MEASUREMENT

WARNING

The black INPUT terminal is internally connected to earth ground. Be certain that the chassis, or circuit to which it is connected, is not at power line potential.

a. Review and comply with the Preliminary Notes and Checks, paragraph 4.3.

b. Connect the power cord into a source of 120 volts (240 volts for export Model 715) 50 or 60 Hz.

c. Allow two or three minutes warm-up time before using the Instrument.

d. Connect the test lead from the black INPUT connector of the Model 715 to the chassis of the circuit to be measured.

e. Connect the other test lead to the side of the circuit to be measured.

f. Set the function selector switch for the desired range.

CAUTION

When the voltage to be measured is not known, set the function selector switch for a generously high range for protection of the Instrument. The range may be set lower after meter indications show the signal voltage to be within a lower range.

g. Read the meter indication.

4.6 MEASURING DECIBELS

4.6.1 The decibel input is an indication of a power ratio. As long as the comparisons are made between measurements across identical impedances, decibels also may be an indication of voltage ratios. With the Model 715 measurements, decibel indications assume that the circuit in which each measurement is made has a 600 ohms impedance. When this is true, each dB reading shows a relation to 0.775 volt for 0 dB (1 milliwatt into 600 ohms). When a reading is "−", its level is below 0.775 volt. When the reading is "+", its level is above 0.775 volt.

For example: A voltage measurement of 0.775 volt is the same as 0 dB. A voltage measurement of 0.387 volt is the same as −6 dB. A voltage measurement of 7.75 volts is the same as +20 dB.

4.6.2 When two levels are merely compared, it is not necessary that their impedance be 600 ohms, but rather that the same impedance prevail in each of the two circuits. The algebraic difference between the two dB readings will be the correct difference between the two levels.
For example: Suppose the relative levels in two circuits are to be compared and the circuit impedance is 500 ohms in both circuits. The Model 715 shows a +3 dB for one of the circuits, and −2.5 dB for the other circuit. The algebraic difference between the two readings is 5.5 dB [(+3 dB) − (−2.5 dB) = 5.5 dB]. The circuit with the higher reading is said to be at a level which is 5.5 dB above the level in the other circuit. The circuit with the lower reading is said to be 5.5 dB below the other circuit.

4.6.3 Proceed as follows for measuring dB:

a. Repeat steps a. through g. of the instructions for measuring AC voltages. Refer to paragraph 4.5.

b. Turn on the power in the circuit to be measured. Read the meter indication on the dB arc of the Model 715. Add algebraically the amount shown at the switch position being used for the measurement.

c. For example: Suppose the meter reads −5 dB when the switch is set at the 0.01 volt range; this position also is marked −45 dB.

d. Turn off the power for the circuit being measured, and then disconnect the test lead connections.

4.7 RESIDUAL READINGS

4.7.1 With the input terminals of the Model 715 shorted together, electrical noise of internal circuit origin amounts typically to 0.4 mV. A phenomenon of this nature is typical of sensitive wideband voltmeters, and has negligible effect upon accuracy in most measurements.

4.7.2 The very high input impedance of the Model 715 permits meaningful measurements in high impedance, low-level circuitry. On the 10 volt and higher ranges, the input impedance is reduced to 1 megohm as noted in Table 1-1.

WARNING

Never touch a test point at power line potential with ground test lead of the Model 715.

CAUTION

When making measurements on line powered circuits, check the circuit ground to be sure it is isolated from the line ground. If it is not, orient the circuit ground so it is at the same potential as line ground.

4.7.3 For tests of line voltages use a conventional nonline powered VOM, such as the Simpson 260.

SECTION V

THEORY OF OPERATION

5.1 OVERALL SYSTEM

5.1.1 The basic system diagram for the Model 715 is shown in Figure 5-1.

5.2 INPUT CIRCUIT

5.2.1 For the lower ranges, 0 to 0.01 through 0 to 3 volts, the voltage to be measured is coupled through a capacitor to the grid of V1, a 6C4 cathode follower, and from its cathode through another capacitor to a voltage divider network. For the higher ranges 0 to 10 through 0 to 300 volts, the voltage is coupled through a capacitor directly into a high-impedance voltage divider. Either of these input circuits offers a high impedance across the input jacks to any voltage which is to be measured.

5.2.2 The range selector switch connects a proportional part of the input voltage to the grid of a cascode amplifier, V2.

5.2.3 Amplified voltage is applied to a full-wave bridge rectifier, which yields DC to operate the meter. Linearizing feedback causes meter pointer deflection to be closely proportional to the input AC voltage. The scales are calibrated in RMS for a sine wave input signal.

5.2.4 Calibration of the tester is accomplished by varying the feedback around the amplifier.

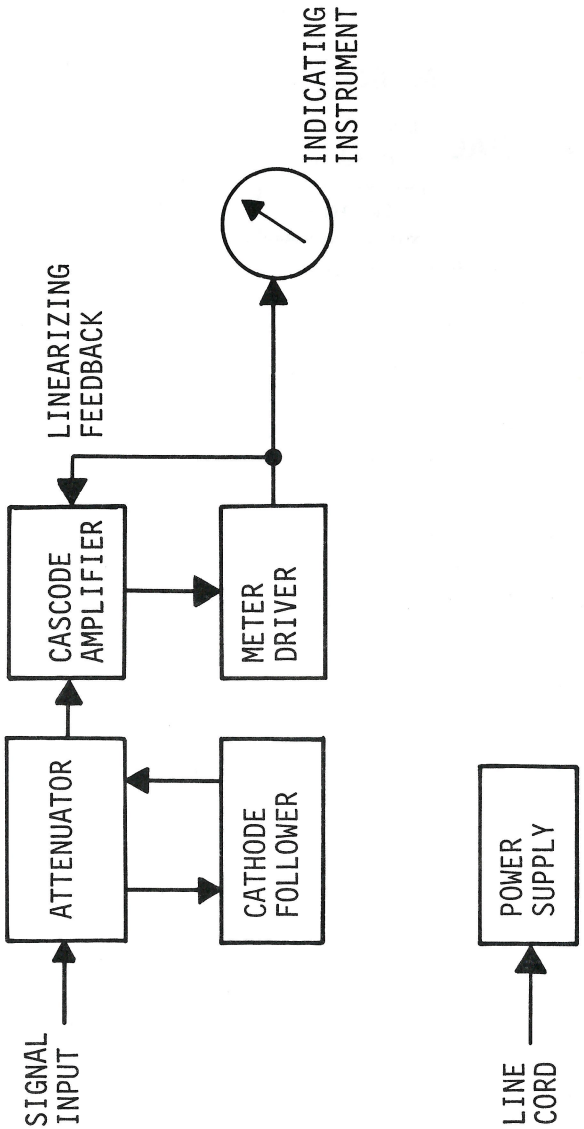

Figure 5-1. Basic System Diagram

SECTION VI

MAINTENANCE

6.1 GENERAL

WARNING

This Instrument contains internal voltages which constitute a SHOCK HAZARD. Review what constitutes a SHOCK HAZARD as explained in page iv. Before attempting to adjust, calibrate or repair this Instrument, review and comply with the SAFETY PRECAUTIONS outlined in paragraph 4.2. Preferably, only Simpson Authorized Service Centers or factory personnel will disassemble any part of the Instrument.

The Simpson 715 is carefully designed and constructed with high quality components. By providing reasonable care, and following the instructions in this manual, the user can expect a long, useful service life from his Instrument.

6.2 WARRANTY

The Simpson Electric Company warranty policy is printed on the inside back cover of the manual. Read carefully prior to requesting a warranty repair.

NOTE: For assistance of any kind, including help with the Instrument under warranty, contact your nearest Authorized Service Center for instructions. These centers are listed on the last pages of this manual. If you wish to contact the factory directly, give full details of the difficulty and include the instrument model number, serial number and date of purchase. Service data or shipping instructions will be sent to you promptly. If an estimate of charges for non-warranty or other service work is required, a maximum charge estimate will be quoted. This charge will not be exceeded without your prior approval.

6.3 SHIPPING

6.3.1 Pack the Instrument carefully and ship it prepaid to the proper destination. Insure the Instrument.

6.4 CASE REMOVAL

WARNING

Remove all power and input connections to the Instrument prior to removing the back cover. Use extreme caution when making internal adjustments when the back cover is removed.

6.4.1 To remove the tester from its case, remove the two screws located on the rear of the case. All components are attached to the front panel and will be removed with it.

6.5 CALIBRATION

6.5.1 Potentiometer P1, located on the bridge rectifier terminal board inside the case, is the calibration adjustment. If need for calibration is suspected, obtain a voltage measuring standard and a 1 kHz voltage source. Connect the Model 715 and the voltage measuring standard across the voltage source. For optimum accuracy, set the voltage source to 10 volts, as indicated on the voltage measuring standard. Set the Model 715 function switch for the 10 volt range. Adjust P1 until the Model 715 indication is the same as that of the standard. Do not attempt any adjustment of this potentiometer unless the proper equipment is available and the foregoing instructions are followed.

6.6 REPLACEMENT OF PARTS

6.6.1 All of the components in the Model 715 have been en-

gineered for many years of useful life. However, there are conditions under which parts might become damaged or faulty and replacement is necessary. Either return the Instrument to the nearest Repair Station or order the necessary parts from the nearest Parts Depot. Use the Simpson Part Number and the complete part description for each item to assure proper replacement of parts.

6.7 PREVENTIVE MAINTENANCE

WARNING

Do not attempt to clean this instrument with the test leads connected to a power source or when it is connected to the AC power line.

6.7.1 Daily Care:

a. Immediately clean all spilled materials from the Instrument and wipe dry.

b. Whenever possible, avoid prolonged exposure or usage of the Instrument in areas which are subject to extreme temperature and humidity, vibration or mechanical shock, dust or corrosive fumes, or strong electrical or electromagnetic interferences.

6.7.2 Monthly Care:

Verify Instrument calibration by performing operational checks using known value sources. If proper calibration equipment is not available, contact your nearest Authorized Simpson Service Center.

6.7.3 Annual Care:

It is recommended that the Instrument be returned annually to a

Simpson Authorized Service Center for complete overall check, adjustment, and calibration.

6.7.4 STORAGE:

When the Instrument is not in use, store it in a location free from temperature extremes, dust and corrosive fumes, and mechanical vibration or shock.

6.8 TROUBLESHOOTING

6.8.1 If the Instrument does not yield satisfactory results, follow this procedure, prior to attempting maintenance of the Instrument, or returning it to a Simpson Authorized Service Center.

a. Review and comply with the Preliminary Notes and Checks, listed in paragraph 4.3.

b. Check that the function selector switch is positioned correctly for the range of voltage being measured and that signal voltage and frequency are within the ratings of the Instrument.

c. Be sure that the power source is within the Instrument specifications, and free from excessive fluctuations and transients.

d. Be sure that the environment in which the Instrument is being used is within the Instrument specifications.

e. Inspect the device being measured, and the measurement test set-up, to be sure that proper shielding and grounding techniques have been used.

SECTION VII

ORDERING INFORMATION, SCHEMATIC DIAGRAM, AND AUTHORIZED SERVICE CENTERS

Table 7-1. Items Furnished With Instrument

Quantity	Description	Part No.
1	Test Lead Set: One black and one red insulated lead with alligator clips (One red and one black supplied).	10-860100
1	Operator's Manual	1-118408

Table 7-2. Replacement Parts List

Quantity	Description	Part No.
	Replacement Meter	15-AC2715
	Lamp, Panel 6 V bayonet	1-113747
C1	Capacitor, 0.047 μF, ±10%, 600 V	1-118406
C2	Capacitor, 0.033 μF, ±10%, 600 V	1-118623
C3	Capacitor, 20μF, −10%, +100%, 150 V	1-114105
C4	Capacitor, 20-20 μF, −10%, +100%, 150 V	1-118404
C5	Capacitor, 2200 pF, ±10%, 600 V	1-116557
C6	Capacitor, 10 μF, −10%, +100%, 50 V	1-115506
C7	Capacitor, 100 μF, −10%, +100%, 50 V	1-118407
C8	Capacitor, 0.01 μF, +10%, 500 V	1-114872
C9	Capacitor, 2 μF, +10%, 200 V	1-118405
C10	Capacitor, 220 pF, +10%, 500 V	1-113854
D1	Rectifier, selenium, 65 ma	1-118403
D2	Diode, Germanium, 1N295	1-117645
P1	Potentiometer, 10Ω±10%, wire wound	1-118386
R1	Resistor, 2.2 MΩ±10%, ½ W	1-114683

R2	Resistor, 2.2kΩ±10%, ½ W	1-113941
R3	Resistor, 47kΩ±10%, ½ W	1-114881
R4	Resistor, 21,620Ω±1%, ½ W	1-118394
R5	Resistor, 6838Ω±1%, ½ W	1-118395
R6	Resistor, 2162Ω±1%, ½ W	1-118396
R7	Resistor, 683.8Ω±1%, ½ W	1-118390
R8	Resistor, 216.2Ω±1%, ½ W	1-118391
R9	Resistor, 100Ω±1%, ½ W	1-118397
R10	Resistor, 1.1 MΩ±1%, ½ W	1-118389
R11	Resistor, 683.8Ω±1%, ½ W	1-118390
R12	Resistor, 216.2Ω±1%, ½ W	1-118391
R13	Resistor, 68.38Ω±1%, ½ W	1-118392
R14	Resistor, 31.62Ω±1%, ½ W	1-118393
R15	Resistor, 10kΩ±10%, 1 W	1-114554
R16	Resistor, 47Ω±10%, ½ W	1-113921
R17	Resistor, 47Ω±10%, ½ W	1-113921
R18	Resistor, 100kΩ±10%, ½ W	1-113949
R19	Resistor, 220kΩ±10%, ½ W	1-114226
R20	Resistor, 2.2 MΩ±10%, ½ W	1-114683
R21	Resistor, 680Ω±10%, ½ W	1-118399
R22	Resistor, 30Ω±10%, ½ W	1-118402
R23	Resistor, 47kΩ±10%, ½ W	1-114881
R24	Resistor, 470Ω±10%, ½ W	1-113940
R25	Resistor, 150kΩ±10%, ½ W	1-113677
R26	Resistor, 3.3 MΩ±10%, ½ W	1-114348
R27	Resistor, 1kΩ±10%, ½ W	1-111689
S1	Switch, Function Selector	1-118353
T1	Transformer, power, dual voltage type	5-111772
V1	Tube, type 6C4	1-113975
V2	Tube, type 12AT7	1-115466
V3	Tube, type 12AT7	1-115466

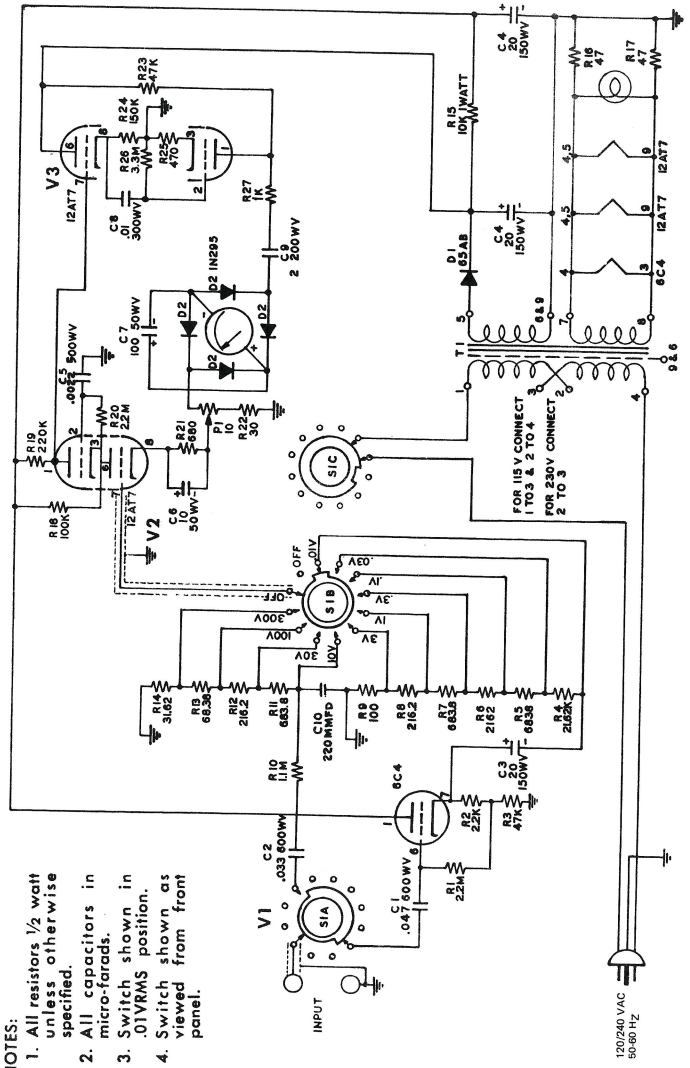

Figure 7-1. Model 715, Schematic Diagram

SIMPSON ELECTRIC COMPANY

853 Dundee Avenue, Elgin, Illinois 60120 — Phone: (312) 695-1121

AUTHORIZED SERVICE CENTERS

*Authorized Parts Sales & Repair Service Only
**Authorized Parts, General Test Equipment & Panel Instrument Sales & Service
⁂Same Service As (**) Above Plus Authorized Panel Instrument Modification
□ Additionally Authorized for Service on Recorders, Controllers, Digital Products and Lab Portables

* **ALABAMA, MOBILE 36617**
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* **ARIZONA, PHOENIX 85034**
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** Metermaster, Inc.
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Tel. (213) 685-4340

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Metermaster, Inc.
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Tel. (415) 968-0313

* **CALIFORNIA, SAN DIEGO 92123**
** Metermaster/San Diego
□ 8797 Balboa Avenue
Tel. (714) 278-2112

* **CALIFORNIA, SAN FRANCISCO 94105**
** Pacific Electrical Inst.
111 Main Street
Tel. (415) 421-7185

* **COLORADO, DENVER 80223**
** Meter Master Instrument Corp.
□ 1165 S. Cherokee
Tel. (303) 722-5766

* **CONNECTICUT, MIDDLETOWN 06457**
** The Mancib Company
□ Randolph Road and Coe
Tel. (203) 347-5629

FLORIDA, MIAMI 33136
** Florida Precision Instrument Co.
800 N.W. 7th Avenue
Tel. (305) 374-1731

* **FLORIDA, ORLANDO 32806**
** Brownell Electro Inc.
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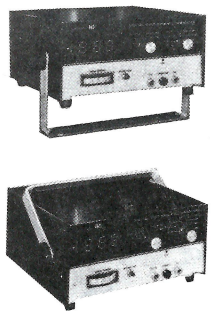

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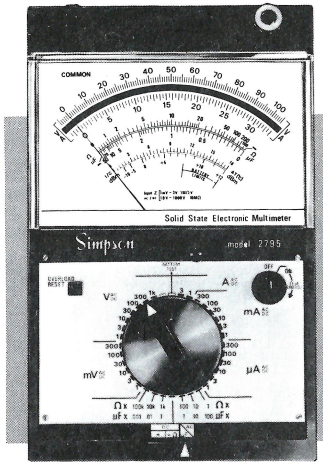

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