

# Operation and Service Manual



For Technical Assistance:  
**1-800-504-0055**

## Slaughter

*Instruments for Electrical Test & Measurement*  
Phone: (847) 932-3662 Fax: (847) 932-3665 E-mail: info@hipot.com Web Site: www.hipot.com

# SLAUGHTER

The ProTesters

## OSHA REGULATIONS NOTICE

We have studied the OSHA regulations in great detail and to the best of our knowledge no specific regulations have yet been issued regarding the type of equipment we manufacture. It is our opinion that some sort of regulation will be issued sometime in the future; but until they are, we are somewhat handicapped. It is our judgment that the eventual attitude of OSHA will be similar to that of other agencies in that the evaluation of any particular situation will depend on the matter in which it is used as much as it will on the nature of the equipment itself. To put it another way, high-voltage test equipment of the type that we manufacture, is not in itself hazardous. The hazards come about when the equipment is connected into a test station or test system of some sort.

While we have no way of knowing, we expect that the eventual requirements will be that any electrical test station involving voltages in excess of 42.4 volts peak (approximately 30 volts RMS) will have to be thoroughly

guarded. We have no way of knowing what will be acceptable in the way of guarding. As a generalization, we expect that test stations will have to be shielded in such a manner that operating personnel, as well as casual bystander personnel, cannot come in contact with the test potentials.

The test equipment that we build is arranged to accommodate external interlock switches which will prevent the operation of the equipment if guards are not in place. Our suggestion at this time is that you study your test stations and determine what, if any, guards are needed and install these guards, interlocking them with the equipment in such a manner that the equipment cannot operate unless the guards are in place. We are, of course, willing and anxious to help you in any way possible. If you need technical advice or suggestions regarding this matter, please let us know.

## HAZARD WARNING NOTICE

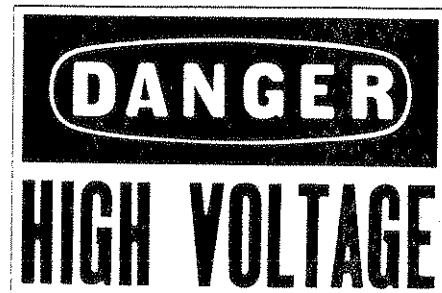
Good safety practice dictates labeling of hazards properly. Since high-voltage testing can be hazardous, the work station should be labeled. Naturally, the location of the label should be carefully selected so that it can be placed in the location that will do the most good.

In some cases, this may be on the test instrument itself, and in others, it may be at a location directly in front of the operator which is somewhat removed from the instrument.

Since this is true, rather than arbitrarily label our instruments, we are supplying two labels that you should apply in accordance with the above suggestions.

If you need a few more labels, please let us know ... we will gladly supply them. If you need a large quantity, these are available at a nominal price.

WARNING LABEL (Full Size)  
Order Part No. 600-197



# SLAUGHTER

The ProTesters

## INTRODUCTION

Series 103, 103-MP, 105, 105-MP, 103/105, and 103/105-MP designates a family of high voltage insulation testers which are of the combination breakdown and leakage type. This family is made in a wide range of ratings and modifications which are described briefly in the technical bulletin following this introduction.

From the instrumentation standpoint, this family is identical. However, the MP family differs operationally in that it features automatic ramping of test voltage, automatic timing of test dwell, and ramp down of test voltage at the conclusion of the dwell. This particular technical manual covers all these current production units in this family manufactured since July 1, 1971. Most such units will bear serial numbers of A112000 or higher, though some units with lower serial numbers of this same construction may occasionally appear, due to retrofitting or unusual production delays.

The units covered by this manual are distinguishable from units built before July 1, 1971 by the characteristic that they are arranged for optional lock up on rejection, requiring manual resetting. Earlier units reset automatically when voltage ramps down.

This manual covers most standard options as well as the basic unit. Although all of the information provided may not apply to the particular unit you have, it has not been deleted because it may be of assistance as general background material.

**CAUTION:** The use of high voltage insulation test equipment can be hazardous to personnel. It is advised that all involved in the use of this equipment be made aware of this fact and that a thorough study be made of any potential hazards involved in the contemplated use of the equipment. Reference should be made to safety material furnished with the unit and to the Basic Facts booklet accompanying this manual, which includes additional information on safety considerations.

# **Automatic Insulation Leakage Testers**

- Automatic Voltage Ramping
- Automatic Dwell Time
- Pre-set Acceptance Limits
- Provides Data for Insulation Analysis
  - Total & Resistive Leakage
  - AC Resistance
  - Capacity
  - Insulation Power Factor
  - Dielectric Strength



**FAST**

fully automatic test cycle

**POSITIVE**

each test cycle is identical

**ACCURATE**

voltage, dwell time, and acceptance limit precisely controlled

## **APPLICATIONS**

Use these testers for high voltage testing of all types of electrical equipment in the engineering lab and on the production line. Use the Series 103-MP tester if only AC testing voltage is required, or the Series 103/105-MP if both AC and DC testing voltages are needed.

## **DESCRIPTION**

This series is an automatic programmed version of the standard Series 103, 103/105 High Voltage Leakage Testers. It is ideal for high production testing of all types of electrical-electronic equipment for leakage, grounds, shorts, and arc-overs to all commercial and military specifications.

Basically, these units apply a known voltage to the insulation under test and measure the current flow as an indication of insulation quality.

In AC testing, the load current often includes an appreciable capacitive component. When this is true, the compensation control may be used to cancel out the major portion of this capacitive current so that the meter reads, essentially, only the resistive component. In DC testing, the capacitive current is transient and compensation is not needed.

AC tests provide data for a complete analysis of the insulation — total leakage, resistive leakage, AC resistance, power-factor, inherent capacity, and dielectric strength. DC tests provide data for insulation resistance in megohms and dielectric strength.

## **HOW IT WORKS**

The test cycle is fully automatic. A momentary switch starts the tester, and test voltage is automatically raised from zero to any pre-set value. When this value is reached, the tester holds the test voltage for the pre-set dwell time, and then returns the voltage to zero. If the device under test fails to meet the pre-set leakage limit, or if a ground or short occurs, the test voltage immediately returns to zero, and the rejection is indicated by both a lamp and buzzer signal.

An accessory plug in the rear of the unit provides for interconnection of external interlock switches, auxiliary automatic starting switches, remote signaling, and control to other equipment, etc.

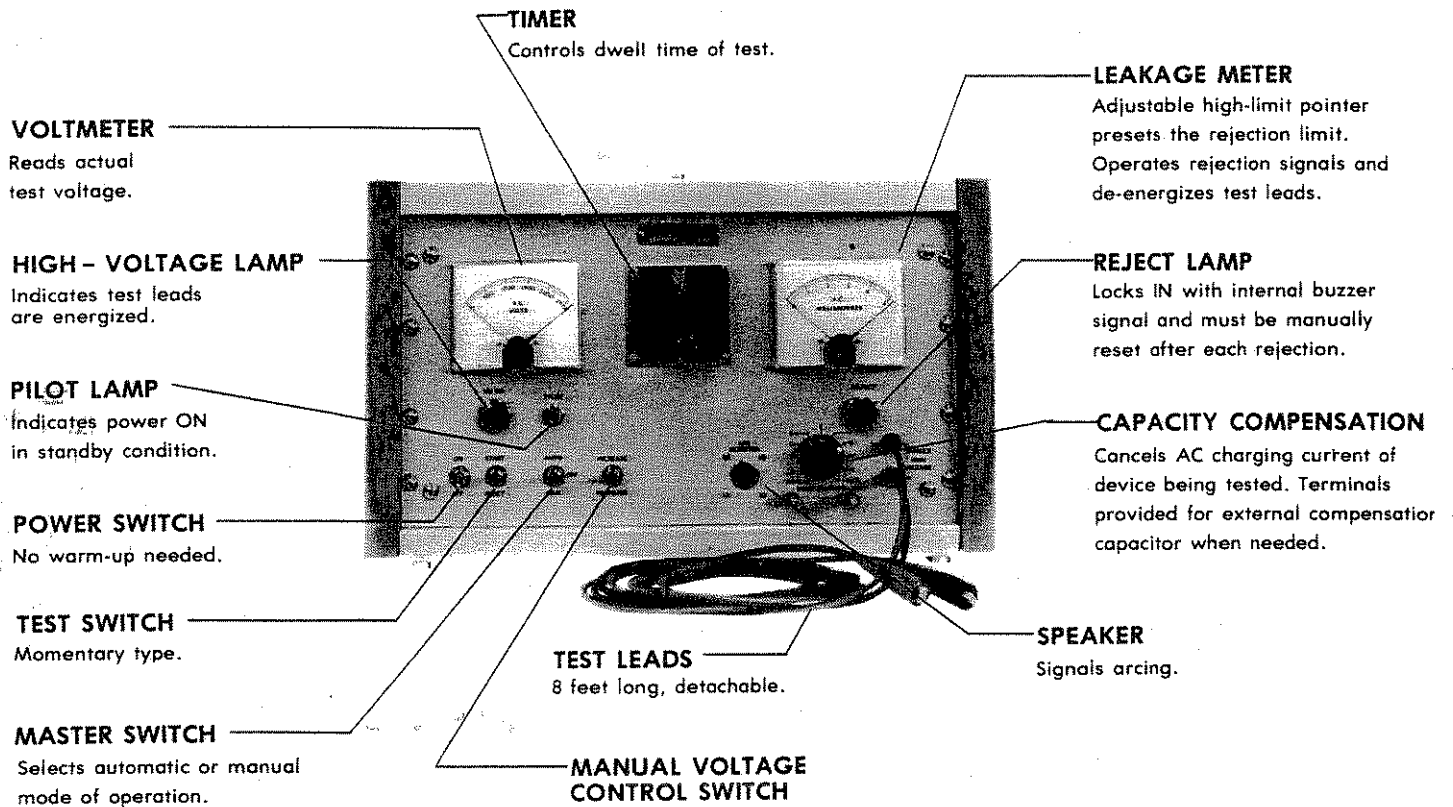
Manual controls permit over-riding the automatic mechanism at any time, permitting the use of the tester in exactly the same manner as the standard Series 103, 103/105.

**Here's the details...**

**SLAUGHTER COMPANY**  
HIGH VOLTAGE TEST EQUIPMENT

P. O. BOX 1805  
ARDMORE, OK 73402  
TELEPHONE: 405-223-4773

# For precision testing...



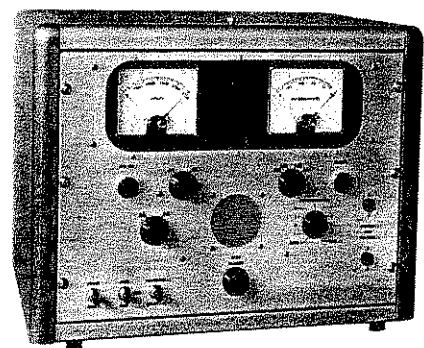
Shown above is the standard 50 VA AC Model 103-MP-2.5. This same construction is used in all Series 103- MP units through 5,000 volt ratings. However an AC-DC Switch and a leakage meter multiplier switch are also included on Series 103/105-MP units.

## HIGHER RATINGS

In ratings above 5,000 volts, the construction shown here is used. The cabinet is larger, and meters are recessed behind a safety shield of clear plastic.

High Voltage circuitry is isolated from ground on all units rated 500 VA and less. All units rated above 500 VA have one side of high voltage internally grounded.

All units rated above 500 VA are supplied in floor style console. This console is mounted on free rolling casters for convenience.



**SLAUGHTER COMPANY**  
HIGH VOLTAGE TEST EQUIPMENT

ARDMORE, OKLAHOMA

# leakage . . . breakdowns . . . grounds

## APPLICATION NOTES

These units are suitable for UL applications requiring lock-out and manual reset action when rejection occurs.

Stock units are available in 50 VA and 500 VA ratings. The 50 VA rating is sufficient for most applications, in which the inherent capacity to ground of the product under test does not exceed 0.005 MFD if a 2500-volt tester is to be used, 0.002 MFD if a 5,000-volt tester is to be used, and 0.001 MFD if a 10,000-volt tester is to be used. This corresponds to equipment ratings of about 5 hp., 3 hp. and 1½ hp. The standard 500 VA rating is suitable for loads of 0.2 MFD for 2500 volt units, 0.05 MFD for 5,000 volt units, and 0.012 MFD for 10,000 volt units. This corresponds to equipment ratings of about 150 hp., 75 hp., and 35 hp.

For larger equipment, an investigation should be made of the inherent capacitive characteristics of the equipment and tester KVA rating selected accordingly. If the inherent capacity to ground of the largest item to be tested is known, the required VA capacity can be calculated thus:

$$\text{VA rating required} = 400 \times \text{Capacity in MFD} \times (\text{KV})^2$$

If the inherent capacity is not known, a rough approximation may be accomplished by using the figure of 0.001 MFD per horsepower for motors, generators, transformers, etc. and a figure of 0.000020 MFD per foot can be used for ordinary hook-up wire. Rate of voltage rise is controlled by a synchronous motor driven voltage control. Rate of rise furnished as standard is indicated in the tabulations. Other rates of rise are available on special order. Contact factory for information. Voltage cut off can be at a rate of fall corresponding to the initial rate of rise, or instantaneous at time out, as desired by the user. Selection of this mode is by means of an internal jumper connection.

Automatic dwell timer provided in standard units may be preset as desired to any value between 3 seconds and 3 minutes. Other dwell time arrangements are available on special order. Contact factory for information.

Standard units are connected to lock out on reject, requiring manual reset action to cancel the rejection signals. This is in conformance with typical UL requirements for manual test stations. For automatic test stations where such action is needed, these units can easily be reconnected to reset automatically when voltage control returns to the zero position after a reject.

## OPTIONAL FEATURES

The various optional features listed below are actually standard on some units. In such cases, these are identified by means of the corresponding suffix letter in the model number on the tabulation of standard units. Generally speaking, if the unit selected does not incorporate the desired optional feature, it can be supplied on special order. However, certain combinations of optional features and some multiple combinations of options are not available, and hence factory contact is suggested, particularly when multiple combinations are involved.

**RACK AND PANEL MOUNTING**— Specify Option C for this type of construction. This is available on all units in the tabulation showing an EIA dimension entry. The EIA dimensions on the tabulation are the actual dimensions of front panel and clearance dimensions. All panels are standard flat style, and finished in smooth gray, with black lettering.

**ZERO START INTERLOCK**— This feature, Option D, is standard on all units. Construction of all units is such that the voltage control must always be returned to the zero voltage position before an automatic cycle can be started, regardless of whether the unit is in the AUTOMATIC or MANUAL mode of operation.

**DUAL RANGE VOLTMETER**— Designated Option E, this feature is standard on all 5,000 and 10,000 volt units. It is available as an extra cost option on 2500 volt units, with ranges of 0/1250/2500.

**AUTOMATIC CAPACITY COMPENSATION**— Designated Option "N", this feature is standard on all units rated 1 KVA and larger and is optionally available on smaller units with leakage meter ranges of 5 MA or more. It is not available on combination AC-DC units. It is a particularly useful option on applications requiring the testing of mixed models with varying capacitance characteristics as it permits the rejection limit setting to be made on the basis of insulation quality instead of on a compromise basis. See page 7 for technical notes on this feature.

**INTERMITTENT ARC REJECTION**— As supplied, standard units will not reject on intermittent arcs whose magnitude is insufficient to trip the over current detection circuits. Such arcing is generally not considered to be a failure because it is usually "self healing". On those cases where it is desirable to reject on such arcing, Option "R" is available. Higher voltage units fitted with Option "R" can also be adjusted to reject on excessive corona, but no provision is made for calibration of the trip. Option "R" is not available on combination AC-DC units, and physical limitations limit the availability of Option "R" on certain other units. Contact factory for information.

**OVER** 

**SLAUGHTER COMPANY**  
HIGH VOLTAGE TEST EQUIPMENT

**ARDMORE, OKLAHOMA**

## SPECIFICATIONS

Model #	Voltage Range	Approx. Rate of Rise Volts/Sec.	VA Rating	Limit Meter Ranges	Comp. Range MFD	Approx. Max. SC Current	Approx. Dims W x H x D	Approx. Shipping Wt.	Approx. E.I.A. Dims. W x H x D (Rack Mounting)
<b>SERIES 103MP AC AUTOMATIC INSULATION TESTERS</b>									
103 MP-2.5 D	0/2500	300/500	50	0/5/ MA	0/005	10 MA	21¼ x 13¼ x 18	60	19 x 10½ x 15
103 MP-2.5 DJ	0/2500	300/500	50	0/100/1000/5000 UA	0/005	10 MA	21¼ x 13¼ x 18	62	19 x 10½ x 15
103 MP-2.5 DJU	0/2500	300/500	500	0/5/50/250 MA	0/0.2	2.5 A	21¼ x 12¼ x 18	95	19 x 10½ x 15
103 MP-5.0 DE	0/2500/5000	600/1000	50	0/5 MA	0/002	10 MA	21¼ x 13¼ x 18	75	19 x 10½ x 15
103 MP-5.0 DEJ	0/2500/5000	600/1000	50	0/100/1000/5000 UA	0/002	10 MA	21¼ x 13¼ x 18	77	19 x 10½ x 15
<b>SERIES 103/105 MP AC/DC AUTOMATIC INSULATION TESTERS</b>									
103/105 MP-2.5 D	0/2500	150/300	50	0/100/1000/5000 UA	0/005	10 MA	21¼ x 13¼ x 18	70	19 x 10½ x 15
103/105 MP-5.0 DE	0/2500/5000	300/500	50	0/100/1000/5000 UA	0/002	10 MA	21¼ x 13¼ x 18	80	19 x 10½ x 15
103/105 MP-10.0 DE	0/5000/10000	300/500	50	0/100/1000/5000 UA	0/001	10 MA	21¼ x 17 x 18	110	S/O - C/F

## SPECIFICATIONS

Model #	Voltage Range	VA Rating	Limit Meter Ranges	Comp. Range MFD	Approx. Max SC Current	Approx. Dims. W x H x D	Approx. Shipping Wt.	Approx. EIA Rack Dimensions W x H x D
<b>SERIES 103 AC HIGH VOLTAGE INSULATION TESTERS</b>								
103-2.5	0/2500	50	0/5 MA	0/005	10 MA	18½ x 12 x 11	34	19 x 10½ x 15
103-2.5 J	0/2500	50	0/100/1000/5000 UA	0/005	10 MA	18½ x 12 x 11	36	19 x 10½ x 15
103-2.5 JU	0/2500	500	0/5/50/250 MA	0/0.2	2.5A	21¼ x 13¼ x 18	85	19 x 10½ x 15
103-5.0 E	0/2500/5000	50	0/5 MA	0/002	10 MA	21¼ x 13¼ x 18	60	19 x 10½ x 15
103-5.0 EJ	0/2500/5000	50	0/100/1000/5000 UA	0/002	10 MA	21¼ x 13¼ x 18	65	19 x 10½ x 15
103-5.0 EJU	0/2500/5000	500	0/5/25/100 MA	0/05	1.0A	21¼ x 13¼ x 18	90	S/O - C/F
<b>SERIES 103/105 AC/DC HIGH VOLTAGE INSULATION TESTERS</b>								
103/105-2.5	0/2500	50	0/100/1000/5000 UA	0/005	10 MA	18½ x 12 x 11	38	19 x 10½ x 15
103/105-5.0 E	0/2500/5000	50	0/100/1000/5000 UA	0/002	10 MA	21¼ x 13¼ x 18	70	19 x 10½ x 15

Current price lists will be forwarded on request.

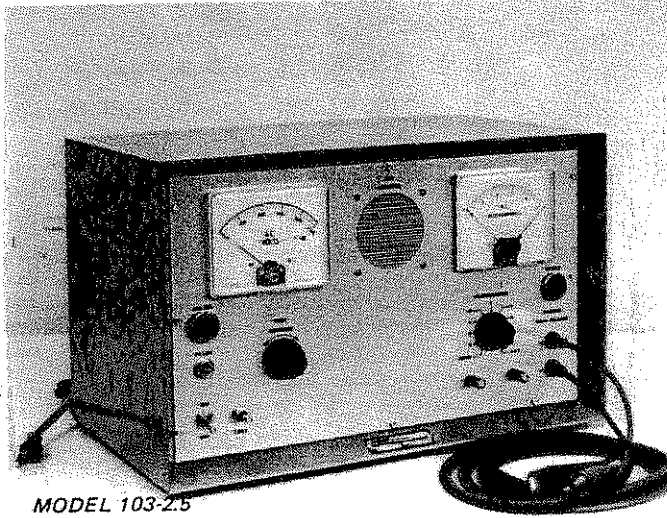
**SLAUGHTER COMPANY**  
HIGH VOLTAGE TEST EQUIPMENT

P. O. BOX 1805  
ARDMORE, OK 73402  
TELEPHONE: 405/223-4773

# INSULATION LEAKAGE TESTERS

Provides data for complete insulation analysis.

- Total Leakage
- Resistive Leakage
- AC Resistance
- Insulation Power Factor
- Capacity
- Dielectric Strength



MODEL 103-25

## APPLICATIONS

Use these testers for high voltage testing of all types of electrical equipment in the engineering lab and on the production line. Use the Series 103 tester if only AC testing voltage is required, or the Series 103/105 if both AC and DC testing voltages are needed.

## DESCRIPTION

Basically, these units apply a known voltage to the insulation under test, and measure the current flow as an indication of insulation quality.

In AC testing, the load current often includes an appreciable capacitive component. When this is true, the compensation control may be used to cancel out the major portion of this capacitive current so that the meter reads essentially only the resistive component. In DC testing, the capacitive current is transient, and compensation is not needed.

AC tests provide data for a complete analysis of the insulation — total leakage, resistive leakage, AC resistance, power-factor, inherent capacity, and dielectric strength. DC tests provide data for insulation resistance in megohms, and dielectric strength.

## **EASY TO USE**

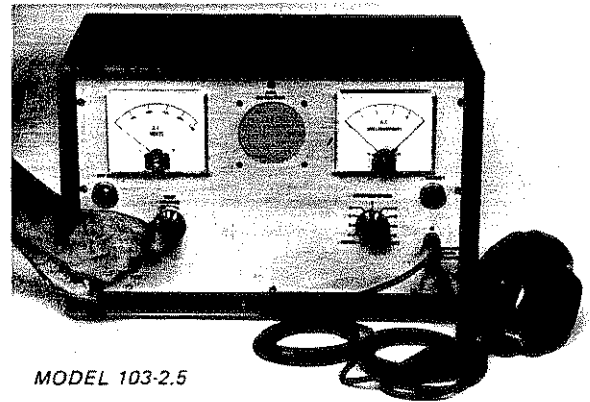
Buzzer signal lets you watch what you are doing

## **SAFER**

Non-destructive,  
Limited energy.

## **ACCURATE**

Capacity compensation  
on a.c. tests.



MODEL 103-2.5

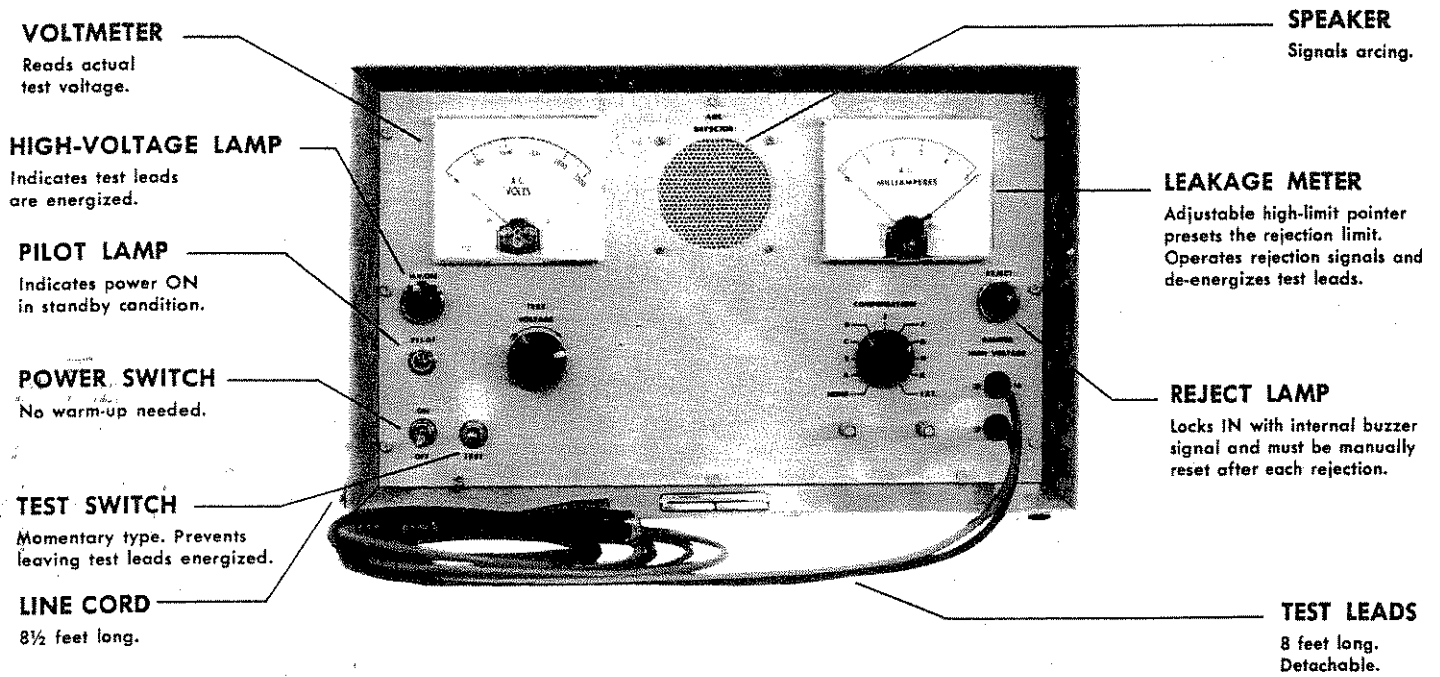
**Here's the details . . .** 

**SLAUGHTER COMPANY**  
HIGH VOLTAGE TEST EQUIPMENT

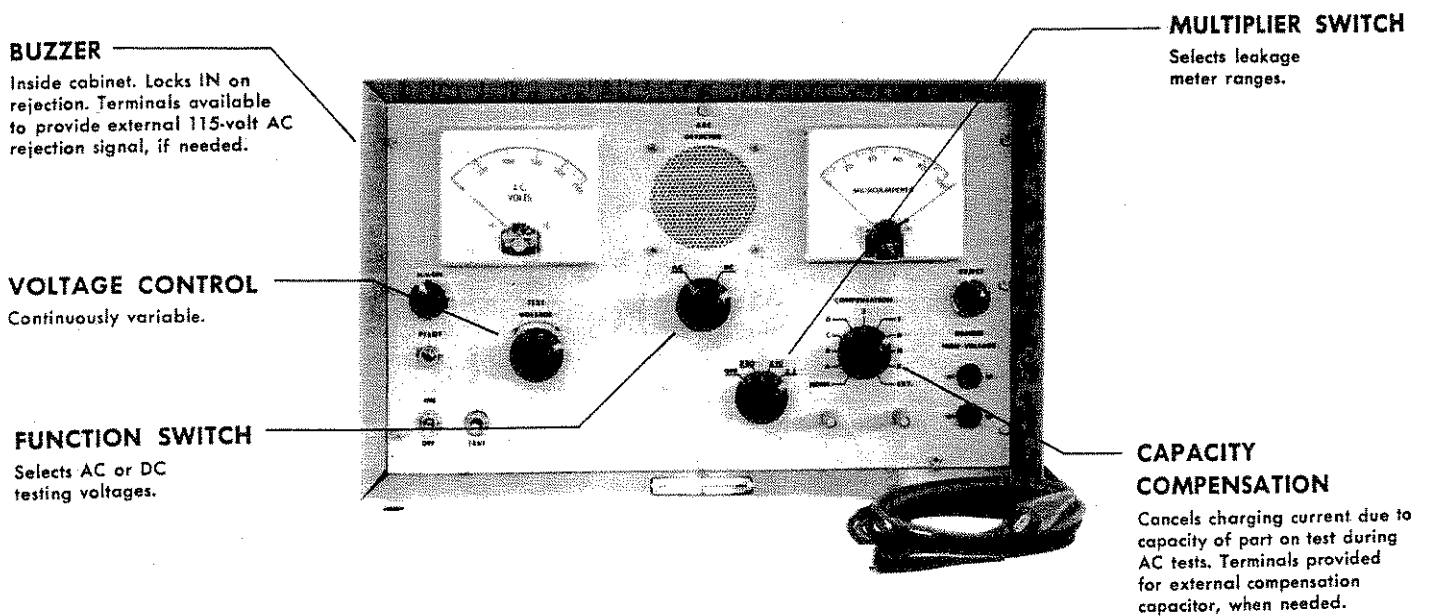
P. O. BOX 1805  
ARDMORE, OK 73402  
TELEPHONE: 405/223-4773



# Better production testing - Watch



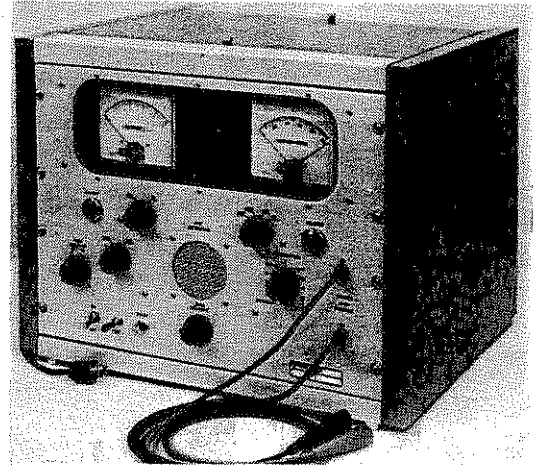
Shown above is the standard 50 VA Model 103-2.5. The same general construction is used in all Series 103 units in ratings through 5000 volts and 500 VA. Series 103/105 units are made only in 50 VA ratings, and construction illustrated below is typical of these units in ratings through 5000 volts.



**SLAUGHTER COMPANY**  
HIGH VOLTAGE TEST EQUIPMENT

**ARDMORE, OKLAHOMA**

# your product and hear the test -



## HIGHER RATINGS

In ratings above 5000 volts, through 500 VA, bench cabinets with the general construction shown here is used. The cabinet is larger, and the meters are recessed behind a safety shield of clear plastic. Retracting safety prods which are optionally available (Option H) in ratings through 5000 volts are not available for ratings above 5000 volts.

High voltage circuitry is isolated from ground on all units rated 500 VA and less. All units rated above 500 VA have one side of high voltage internally grounded.

All units rated above 500 VA are supplied in floor style console. This console is mounted on free rolling casters for convenience.

## APPLICATION NOTES

These units are suitable for UL applications requiring lock-out and manual reset action when rejection occurs.

Stock units are available in 50 VA and 500 VA ratings. The 50 VA rating is sufficient for most applications, in which the inherent capacity to ground of the product under test does not exceed 0.005 MFD if a 2500-volt tester is to be used, 0.002 MFD if a 5,000-volt tester is to be used, and 0.001 MFD if a 10,000-volt tester is to be used. This corresponds to equipment ratings of about 5 hp., 3 hp., and 1½ hp. The standard 500 VA rating is suitable for loads of 0.2 MFD for 2500 volt units, 0.05 MFD for 5,000 volt units, and 0.012 MFD for 10,000 volt units. This corresponds to equipment ratings of about 150 hp., 75 hp., and 35 hp.

For larger equipment, an investigation should be made of the inherent capacitive characteristics of the equipment and tester KVA rating selected accordingly. If the inherent capacity to ground of the largest item to be tested is known the required VA capacity can be calculated thus:

$$\text{VA rating required} = 400 \times \text{Capacity in MFD} \times (\text{KV})^2$$

If the inherent capacity is not known, a rough approximation may be accomplished by using the figure of 0.001 MFD per horsepower for motors, generators, transformers, etc. and a figure of 0.000020 MFD per foot can be used for ordinary hook-up wire.

## OPTIONAL FEATURES

The various optional features listed below are actually standard on some units. In such cases, these are identified by means of the corresponding suffix letter in the model number on the tabulation of standard units. Generally speaking, if the unit selected does not incorporate the desired optional feature, it can be supplied on special order. However, certain combinations of optional features and some multiple combinations of options are not available, and hence factory contact is suggested, particularly when multiple combinations are involved.

**AUTOMATIC DWELL TIMING**— This modification automatically controls the duration of time that the test voltage is applied. Desired duration is preset on a timer, and operation of the test switch initiates the timing cycle which applies test voltage for this period. However if a rejection occurs, test voltage is cut off, and manual reset of the unit is required to cancel reject signals. Specify Option "A" if a timing period of between 0.1 and 6 seconds is required, Option "B" if the period is between 3 seconds and 3 minutes. Timers may be easily preset to any period within these ranges.

**RACK AND PANEL MOUNTING**— Specify Option "C" for this type of construction. This is available on all units in the tabulation showing an EIA dimensions entry. The EIA dimensions on the tabulation are the actual dimensions of front panel and clearance dimensions. All panels are standard flat style, and finished in smooth gray, with black lettering.

**ZERO START INTERLOCK**— This feature, Option "D", is standard on all 10,000 volt units. With this option, voltage control must always be returned to the zero voltage position before test can be started.

**DUAL RANGE VOLTMETER**— Designated Option "E", this feature is standard on all 5,000 and 10,000 volt units. It is available as an extra cost option on 2500 volt units, with ranges of 0/1250/2500.

**AUTOMATIC RESET**— Function of this feature is to automatically cancel and reset rejection signals after a dwell of about 1 second. If the fault still exists after reset, the cycle will repeat. This option is normally utilized only when the tester is fitted into an automatic test station. In this case, customer furnished equipment can be connected to properly mark or dispose of rejects during the dwell period provided. At the end of the dwell period, tester returns to normal standby condition. This particular feature is not recommended for manual testing, and is not compatible with Option "D".

**AUTOMATIC CAPACITY COMPENSATION**— Designated Option "N", this feature is standard on all units rated 1 KVA and larger and is optionally available on smaller units with leakage meter ranges of 5 MA or more. It is not available on combination AC-DC units. It is a particularly useful option on applications requiring the testing of mixed models with varying capacitance characteristics as it permits the rejection limit setting to be made on the basis of insulation quality instead of on a compromise basis. See catalog page 2.22A for technical notes on this feature.

**INTERMITTENT ARC REJECTION**— As supplied, standard units will not reject on intermittent arcs whose magnitude is insufficient to trip the over current detection circuits. Such arcing is generally not considered to be a failure because it is usually "self healing". On those cases where it is desirable to reject on such arcing, Option "R" is available. Higher voltage units fitted with Option "R" can also be adjusted to reject on excessive corona, but no provision is made for calibration of the trip. Option "R" is not available on combination AC-DC units, and physical limitations limit the availability of Option "R" on certain other units. Contact factory for information.

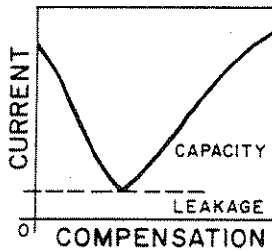
**SLAUGHTER COMPANY**  
HIGH VOLTAGE TEST EQUIPMENT

**ARDMORE, OKLAHOMA**

# SLAUGHTER

The ProTesters

## CAPACITY COMPENSATION



The current during an AC high voltage test is due to leakage of the insulation, plus a charging current due to the electrostatic capacity of the device being tested. By inserting a compensating capacitance into the circuit, only the leakage current will remain.

In the Leakage Tester this is done by adjusting the capacity compensation knob to obtain the lowest current reading on the milliammeter, thereby "tuning-out" the capacity current as shown at the left.

The resultant milliammeter reading is the approximate net resistive component of the total current through the insulation under test. This reading may be used to establish the approximate AC insulation resistance by means of the classical formula:

$$\text{AC Insulation Resistance in Megohms} = \frac{\text{AC Test Voltage}}{\text{Microamps, Compensated}}$$

If the capacity compensation control is set to none, then the reading on the milliammeter will be the total current through the insulation under test. This reading, together with the compensated reading yields additional useful information, thus:

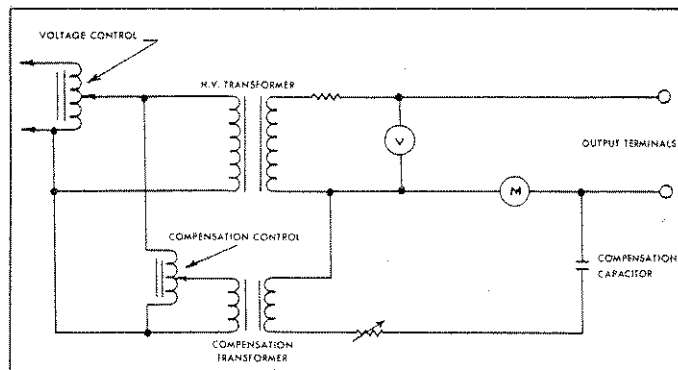
$$\text{Approximate Insulation P.F.} = \frac{\text{Microamps with Compensation}}{\text{Microamps with No Compensation}}$$

## CIRCUIT THEORY

The circuitry utilized to accomplish capacitive compensation is shown here in simplified form. From examination of this circuitry it will be seen that the current flow in the compensation loop is essentially capacitive and since the voltage source in this loop is 180° out of phase with the voltage source in the main test loop, the compensation current will be out of phase with the capacitive component of the load current.

The adjustment needed to compensate a particular test part is accomplished either by varying the value of the compensation capacitor, or by varying the magnitude of the compensation voltage source, or both. In standard 50 VA Series 103 and Series 103 MP units adjustment is by means of a step type compensation capacitor decade. Since this is a step type adjustment it is rarely possible to adjust this to a true null. Therefore, for high precision tests, the use of an external capacitor decade is recommended. This can be connected to the blue terminals provided on the unit, and the compensation selector set to the external position. The external decade can then be adjusted in the same manner as the internal decade to obtain the null reading on the milliammeter.

Step type compensation is not practical over a wide current range. For this reason all units supplied in the 500 VA rating are fitted with stepless continuous compensation control. Compensation is accomplished by using a separate transformer for the compensation loop and varying the compensation voltage with a primary control on the compensation transformer. In addition, in such units the value of the compensation capacitor is changed automatically when the milliammeter is switched to a different range.



SIMPLIFIED DIAGRAM - CONTINUOUS COMPENSATION CONTROL

## CAPACITY COMPENSATION (CONT'D)

For automatic compensation control, an electronic "black box" technique is utilized. With this technique, the milliammeter will always display the resistive component of the load current when the compensation control switch is in the "Real Current" position. When the switch is in the "Total Current" position, the milliammeter displays the total current through the insulation under test. These readings may then be used in the same manner as those obtained with the bridge type compensation described.

Bridge type continuous compensation which is used on 500 VA units is about 90% effective. This means that the compensation can be expected to cancel up to 90% of the capacitive component of the load current. The amount of degradation of the resultant reading of resistive component, of course, depends upon the overall relationship of resistive to capacitive components. Automatic compensation is somewhat more effective, and can be expected to cancel up to 95% of the capacitive component of the load current. In addition, units fitted with automatic compensation control will generally provide somewhat better readability of the resistive current component than standard units. Automatic compensation is designated by Option N, and is available as an option on all 50 VA rated Series 103 and Series 103MP units. Option N is standard on all units rated 1 KVA and larger.

## CONTROL AND PROGRAMMING

Series 103 insulation testers, shown on pages 3 thru 7, are adaptable to automatic and semi-automatic test installations.

Circuitry of the basic units listed is arranged so that it is a simple matter to control these units remotely by means of relays or switches. In addition, circuitry provided can be used to operate remote signaling devices, or associated equipment. These are 117 VAC circuits.

For more sophisticated systems, the standard Series 103 and Series 103MP instrumentation is available in Series 720 modular form component test panels which incorporate logic circuitry which is compatible with most standard systems of this type.

For more highly complex systems, Series 103 and Series 103MP instrumentation is available in remotely programmable forms which have provision for remotely programming voltage setting, limit setting, dwell time, etc., as well as provision for remote control. Contact factory for information.

For multiple point testing on an automatic or semi-automatic basis, Series 103 and Series 103MP instrumentation is available in Series 720 Scanning Systems.

# SLAUGHTER

The ProTesters

## CONTROLS AND INDICATORS 103, 105, 103/105

### 1. POWER SWITCH AND PILOT LAMP

The Power Switch is used to turn the unit ON to standby condition. The associated Pilot Lamp indicates that line voltage is turned ON.

Standard units are connected for "lock up on rejection". This means that the Power Switch must be recycled — turned OFF momentarily — to reset the reject circuits and cancel reject signals after a rejection occurs.

This recycling is not necessary if the unit has been reconnected to eliminate the lock-up feature as outlined in Technical Note 13 on Page 23.

### 2. TEST SWITCH

The Test Switch controls the application of high voltage. This is a 3-position switch. Center position is OFF. When the switch is held down, test voltage is turned ON.

The upper, locking position of this switch is normally not connected. However, in units supplied with Option "H" (combination test leads and prods), this position is used to turn the voltage ON when it is desired to use the test prods instead of the regular test clip leads. See Technical Note 10, Page 22.

Units featuring the Option "L" function to automatically reset the rejection signals after a dwell of approximately two seconds. This cycle will repeat if fault still exists after automatic reset. The design feature of Option "L" is provided so that the unit may be fitted into an automatic test station. Customer furnished equipment can be connected to mark or dispose of rejects, as desired. See Technical Note 14, Page 23.

In standard units, the tester will remain ON as long as the Test Switch is depressed. In units supplied with Option "A" or "B" (Automatic Dwell Timing), the start switch is used only to initiate the automatic time cycle. When the preset time cycle is completed, the tester will be turned OFF. However, if the switch is held in the START position, this will override the timer and the unit will remain ON until the switch is released.

In units supplied with Option D (Zero Start Interlock), the voltage control MUST be MANUALLY HELD in the zero or extreme counter-clockwise position for the test switch to be effective in turning the high voltage ON.

### 3. HIGH-VOLTAGE LAMP

The High-Voltage Lamp illumination indicates that the test voltage is ON and contact with test leads or circuits under test can be hazardous.

# SLAUGHTER

The ProTesters

## 4. VOLTMETER

The Voltmeter mounted on the upper left of the panel, indicates the test voltage at the output terminals of the unit at all times. Note that when a short occurs, this indicator will fall to zero, indicating zero voltage at the output. However, the tester may still be ON, producing test voltage which is absorbed by limit resistors within the unit. When this is the case, the High-Voltage Lamp will remain ON, unless the resulting current flow exceeds the leakage meter limit.

## 5. VOLTAGE CONTROL

Mounted near the center of the panel, this knob is used to adjust the testing voltage. To increase the test voltage, rotate clockwise.

## 6. AC/DC SWITCH

Used only on Series 103/105 units, this switch selects AC or DC testing voltage. Voltage control should be at zero or unit should be OFF before transferring position of this switch.

## 7. COMPENSATION CONTROL

This knob is used to adjust the amount of internal compensation applied to balance the capacitive charging current in the device under test. To increase compensation, rotate clockwise. In the extreme counter-clockwise position, no compensation is applied. In units supplied with step-type (tap switch) compensation control, an extreme clockwise position is provided in which the internal compensation capacitors are removed from the circuit and terminals provided for external compensation capacitors become active. "WARNING" These terminals may have up to 500 volts across them when active. In units featuring continuous compensation, the external terminals are omitted. In units featuring Option "N", compensation is controlled by a real current/total current switch.

Series 105 units are straight DC testers and hence, do not have this compensation control.

## 8. LEAKAGE METER

This meter, mounted on the upper right of the panel, indicates current drawn by the device under test. If no compensation is used, this will be total load current. If compensation is properly adjusted, this will be a net resistive (real) current.

A small black knob on the lower center of the meter cover adjusts the position of the red limit needle on this meter. When the black indicating needle reaches the setting of the red limit needle, a rejection will be indicated.

**CAUTION:** The red limit needle may become ineffective if set beyond the graduated portion of the meter dial.

# SLAUGHTER

The ProTesters

## CONTROLS AND INDICATORS — Cont'd.

### 9. METER MULTIPLIER SWITCHES

When used, Meter Multiplier Switches are mounted adjacent to the meter they affect. In such cases, the true reading will be the actual meter reading multiplied by the setting of its multiplier switch.

Standard Models 103 and 105 do not incorporate meter multiplier switches. Standard Model 103/105 incorporates a leakage meter multiplier switch only.

Units supplied with Option "E" (Dual Range Voltmeter) incorporate a 2-position voltmeter multiplier switch. Series 103 and 105 units supplied with Options "J" or "K" (Multiple Range Leakage Meter) incorporate a 3-position leakage meter multiplier switch.

### 10. ARC DETECTOR

This small speaker is used to detect and signal low energy arcing, too low in intensity to deflect the leakage meter. This speaker is in the high voltage circuit and no attempt should be made to amplify or put auxiliary speakers or "head phones" in place of or in conjunction with this speaker.

### 11. REJECTION INDICATORS

These include a front panel red warning lamp and an internal buzzer, which are activated by the red limit pointer on a leakage meter. When the black indicating needle reaches the setting of the red limit pointer, a rejection will be indicated. As shipped, the unit is arranged so that these rejection signals will lock in, and they can be cleared only by interrupting the power supply to the unit, or by cycling the power switch momentarily to the OFF position. This functional arrangement should not be changed in the field without first checking applicable UL or other approving agency specifications.

### 12. ZERO BALANCE

Used only in higher voltage multi-range units, the zero balance control is used to compensate for miscellaneous internal and external stray capacities.

### CALIBRATION NOTE

Before shipment, all units are calibrated to an accuracy of better than  $\pm 5\%$  of full-scale with equipment fully traceable to the NBS. To maintain original accuracy, checking of calibration and recalibration should be conducted on a periodic basis. To maintain traceability, standards used in checking and recalibration procedures must be traceable to NBS standards.

# SLAUGHTER

The ProTesters

## INITIAL CHECKOUT 103, 105 & 103/105

**CAUTION:** Since any electrical equipment can be hazardous, the initial checkout procedure listed here should be conducted only by qualified personnel familiar with safety rules applying to electrical equipment. It is suggested that before checkout, the Basic Facts booklet supplied with this equipment be reviewed, particularly pages 19 through 22 for safety suggestions.

To check the unit quickly, adjust compensation control to NONE (or "real current") and plug the unit into 115-volt, 60-cycle power. With the test leads removed from their connectors, turn unit ON and raise voltage to approximately 60% of full scale. On AC units and on AC/DC units set for AC operation, a slight residual reading may appear on the leakage meter. This should be no more than 3% of full scale of the meter. On DC, this should be less than 1%. Decrease voltage to zero. Turn unit off.

Set voltmeter and leakage meter range switches (if any) to maximum position. Insert the test leads into their bayonet connectors. Keep these leads separated and AVOID CONTACT with the clips. Turn unit ON and raise voltage to value indicated in chart below. Turn unit OFF, leaving voltage control set. Now, short circuit the test leads and again turn the unit ON. On Series 103, the leakage meter should rise to AC S/C milliampere value indicated within  $\pm 10\%$ . Series 105 units should conform to the listed DC S/C milliampere value. Series 103/105 units should conform to the AC value when operated with the AC/DC switch in the AC position, and to the DC value when operated with the switch in the DC position.

The short-circuit check procedure outlined above can be used only on limited energy (50VA) units. It cannot be used with high-capacity units because milliammeter readings will go "off-scale" on such units. Also, this procedure cannot be used with Option "D" (Zero Start Interlock) units. Instead, short-circuit leads and raise voltage control to obtain the indicated current. Note position of voltage control knob. Turn unit OFF, remove short circuit, and turn ON again, bringing voltage control knob to same position. Voltmeter reading should correspond to the indicated value within  $\pm 10\%$ .

UNIT MAX VOLTAGE RATING	2500	5000	10,000
TEST VOLTAGE SETTING	1000	2000	4000
A.C. S/C MILLIAMPS	3.8	3.7	3.7
D.C. S/C MILLIAMPS	2.4	1.5	1.6

To check reject circuit, hold switch ON and adjust red limit pointer on leakage meter until it contacts the black indicator needle. Buzzer will sound, indicating rejection. High-voltage lamp will go OFF, indicating removal of test voltage.

If the unit does not operate according to the above specifications, remove rear panel or top cover and check for evidences of damage. If the difficulty is not readily apparent, do not attempt further work which might void warranty. Contact factory for instructions.



# SLAUGHTER

The ProTesters

## CONTROLS AND INDICATORS 103 MP, 105 MP & 103/105 MP

Functions of the various controls and indicators are as follows:

1. **MAN-AUTO SWITCH**—This 3 position toggle switch is the mode switch. The center position is idle, while the locking upper position turns the unit on for AUTOMATIC operation. The momentary MANUAL position is used only for manual operation, and must be held on when used in this manner.
2. **PILOT LAMP**—The pilot lamp always indicates when the unit is ON, or is ready for automatic or manual operation. In other words, this lamp will be on, unless the ON/OFF switch is OFF.
3. **START-RESET SWITCH**—This switch is used to control the automatic cycle when the unit is in automatic operation. It is also utilized to reset the unit after a rejection has occurred. The function of this switch is covered in more detail as part of the description of the automatic cycle.
4. **HIGH-VOLTAGE LAMP**—The high-voltage lamp illumination indicates that the test voltage is ON, and contact with test leads or circuits under test can be hazardous.
5. **VOLTMETER**—The voltmeter, mounted on the upper left of the panel, indicates the test voltage at the output terminals of the unit at all times. Note that when a short occurs, this indicator will fall to zero, indicating zero voltage at the output. However, the tester may still be on, producing test voltage which is absorbed by limit resistors within the unit. When this is the case, the high-voltage lamp will remain on. A small black knob on the lower center of the meter cover adjusts the position of the red limit needle on this meter. The position of this needle establishes the testing voltage when the unit is cycled automatically. This red limit needle acts merely as a maximum limit on test voltage when the unit is in manual operation.

**CAUTION:** The red limit needle may become ineffective if set beyond the graduated portion of the dial.

6. **INCREASE-DECREASE**—This switch is used to operate the motor-driven voltage control manually, thereby permitting manual control of the testing voltage. It is used only when the MAN-AUTO switch is in the manual position.
7. **COMPENSATION CONTROL**—This knob is used to adjust the amount of internal compensation applied to balance the capacitive charging current in the device under test. To increase compensation, rotate clockwise. In the extreme counter-clockwise position, no compensation is applied. In units supplied with step-type (tap switch) compensation control, an extreme CW position is provided in which the internal compensation capacitors are removed from the circuit and terminals provided for external compensation capacitors become active. In units featuring continuous compensation, the external terminals are omitted. In units featuring Option "N", compensation is controlled by a real current/total current switch.

Series 105 units are straight DC testers and hence, do not have this compensation control.

# SLAUGHTER

The ProTesters

## CONTROLS AND INDICATORS – Cont'd

8. LEAKAGE METER—This meter, mounted on the upper right of the panel, indicates current drawn by the device under test. If no compensation is used, this will be total load current. If compensation is properly adjusted, this will be a net resistive (real) current.

A small black knob on the lower center of the meter cover adjusts the position of the red limit needle on this meter. When the black indicating needle reaches the setting of the red limit needle, a rejection will be indicated.

**CAUTION:** The red limit needle may become ineffective if set beyond the graduated portion of the meter dial.

9. METER MULTIPLIER SWITCHES—When used, meter multiplier switches are mounted adjacent to the meter they affect. In such cases, the true reading will be the actual meter reading multiplied by the setting of its multiplier switch.

Standard Models 103-MP and 105-MP do not incorporate meter multiplier switches. Standard Model 103/105-MP incorporates a leakage meter multiplier switch only.

Units supplied with Option "E" (Dual Range Voltmeter) incorporate a 2 position voltmeter multiplier switch. Series 103-MP and 105-MP units supplied with Options "J" or "K" (Multiple Range Leakage Meter) incorporate a 3 position leakage meter multiplier switch. Series 103/105-MP units also incorporate a leakage meter multiplier switch as a standard feature.

10. ARC DETECTOR—This small speaker is used to detect and signal low energy arcing, too low in intensity to deflect the leakage meter.
11. REJECTION INDICATORS—These include a front panel red warning lamp and an internal buzzer, which are activated by the red limit pointer on a leakage meter. When the black indicating needle reaches the setting of the red limit pointer, a rejection will be indicated. As shipped, the unit is arranged so that these rejection signals will lock in, and they can be cleared only by cycling the reset switch momentarily or interrupting the power to the unit. This functional arrangement should not be changed in the field without first checking applicable UL or other approving agency specifications.
12. ZERO BALANCE—Used only in higher voltage multi-range units, the zero balance control is used to compensate for miscellaneous internal and external stray capacities.

# SLAUGHTER

The ProTesters

## CONTROLS AND INDICATORS – Cont'd

13. **TIMER**—The adjustable timer is used to preset the time dwell, or period of application of test voltage when the unit is operating in the automatic mode. Dwell time does not start until voltage reaches preset value. Do not set timer to zero as this causes motor to run backwards.

### AUTOMATIC CYCLE

Functions of the various cycle control switches and the operating cycle are as follows:

1. **MAN-AUTO** switch selects mode. Center position is idle. Normal position is **AUTO**.
2. When the **START-RESET** switch is momentarily tripped to **START**, the motor-driven voltage control increases test voltage at a fixed speed until the preset limit (set on the voltmeter) is reached.
3. When the preset voltage has been reached, the motor stops, and test voltage is maintained for whatever period has been set on the timer.
4. When the timing period has elapsed, the motor-driven voltage control reverses, and the test voltage is automatically reduced to zero.
5. If at any time breakdown occurs, or the leakage exceeds the limit, which has been preset on the leakage meter, a reject lamp and buzzer are energized. The high voltage is reduced to zero immediately, and the rejection circuits will remain on until manually reset.
6. Tripping the **START-RESET** switch to **RESET** will return the voltage control to zero immediately, regardless of the conditions existing.
7. When the power switch is in the **MAN** position, voltage control is manual, through the **INCREASE-DECREASE** switch. If a breakdown occurs during manual operation, the **MAN-AUTO** switch must be returned to the center position to reset the signal circuits. If the **MAN-AUTO** switch is set to **AUTO** after a manual test, the voltage control will automatically return to zero.

# SLAUGHTER

The ProTesters

## INITIAL CHECKOUT 103 MP, 105 MP & 103/105 MP

**CAUTION:** Since any electrical equipment can be hazardous, the initial checkout procedure listed here should be conducted only by qualified personnel familiar with safety rules applying to electrical equipment. It is suggested that before checkout, the Basic Facts booklet supplied with this equipment be reviewed, particularly pages 19 through 22 for safety suggestions.

To check the unit quickly, adjust compensation control to NONE (or "real current") and plug the unit into 115 volt, 60-cycle power. With the test leads removed from their connectors, operate AUTO-MAN switch to the MAN position, and use the INCREASE-DECREASE switch to raise voltage to approximately 60% of full scale. On AC units, and on AC/DC units set for AC operation, a slight residual reading may appear on the leakage meter. This should be no more than 3% of the full scale of the meter. On DC, this should be less than 1%. Decrease voltage to zero. Turn unit off.

Set voltmeter and leakage meter range switches (if any) to maximum position. Insert the test leads into their bayonet connectors. Keep these leads separated and AVOID CONTACT with the clips. Turn unit ON and raise voltage to value indicated in chart below. **Carefully** short circuit the test leads. On Series 103-MP, leakage meter should rise to AC S/C milliampere value indicated within  $\pm 10\%$ . Series 103/105-MP units should conform to the AC value when operated with the AC/DC switch in the AC position.

The short-circuit check procedure outlined above can be used only on AC limited energy (50VA) units. It cannot be used with high-capacity units because leakage meter readings will go "off-scale" on such units.

UNIT MAX VOLTAGE RATING	2500	5000	10,000
TEST VOLTAGE SETTING	1000	2000	4000
A.C. S/C MILLIAMPS	3.8	3.7	3.7
D.C. S/C MILLIAMPS	2.4	1.5	1.6

To check reject circuit, operate unit and adjust red limit pointer on leakage meter until it contacts the black indicator needle. Buzzer will sound, indicating rejection. High-voltage lamp will go OFF, indicating removal of test voltage.

# SLAUGHTER

The ProTesters

## INSTALLATION

A prime consideration in the installation of equipment of this type is to insure safety both to the operator and to any casual bystanders. As a general rule, avoid locations with extremes of temperature, humidity, or vibration. Also avoid metal top benches and metal operator stools. The electrical power receptacle which will be utilized to operate this unit should be checked for proper polarity and adequate grounding. It is mandatory this equipment be used with a properly grounded three wire receptacle.

After equipment has been installed, a careful study should be made of the test station to determine what, if any, safeguards are needed. Again, it is suggested that any electrical test station involving voltages in excess of 42.4 volts peak (approximately 30 volts RMS) should be equipped with safeguards. These should operate both for the protection of the operating personnel and for the protection of casual bystander personnel. At the minimum, safeguards should prevent the operating personnel or casual bystanders from coming into contact with the test circuit.

In the event electrical interlocks of any sort are required, either to insure that guards are in position, or to insure that the operator's hands are in a safe location, the installer should refer to the proper schematic drawing and install these interlocks in series with the external interlock terminals provided in the unit.

After the installation has been completed, a review of the installation should be conducted to determine what, if any, hazardous warning signs or labels may be needed. These should, of course, be installed before the test station is placed in service. Two safety warning labels are provided with the equipment. Additional labels are available — see inside front cover.

# SLAUGHTER

The ProTesters

## TECHNICAL NOTES

The following notes may be helpful in specifying use, setup and operation of this unit.

1. DC Leakage is a direct measure of the DC insulation quality. It may be expressed in terms of insulation resistance as follows:

$$\text{DC Insulation Resistance in Megohms} = \frac{\text{DC Test Voltage}}{\text{Microamperes Leakage}}$$

2. AC Leakage readings may be utilized to establish other useful information regarding insulation under test. The AC leakage reading with compensation control properly adjusted is essentially a pure resistive current, which may be used to establish the AC insulation resistance as follows:

$$\text{AC Insulation Resistance in Megohms} = \frac{\text{AC Test Voltage}}{\text{Microamps, Compensated}}$$

Approximate insulation power factor may also be established by taking another reading with compensation set to NONE, then:

$$\text{Approximate Insulation P.F.} = \frac{\text{Microamps with Compensation}}{\text{Microamps with No Compensation}}$$

The approximate inherent capacity of the unit under the test may also be established by determining the compensation capacity required for minimum microammeter reading, then:

$$\text{Inherent Capacity in MFD} = \frac{\text{Compensation Capacity in MFD}}{\text{Compensation Ratio}}$$

3. The step-type compensation control provided on 50VA units will rarely permit the attainment of a true null. Therefore, for high precision tests, the use of an external capacitor decade is recommended. This should be connected to the blue terminals provided and the compensation selector set to EXT. "WARNING" These terminals may have up to 500 volts across them with the selector set to EXT. The external decade is then adjusted in the same manner as described above. Calculations are made in the same manner, using the decade readings as compensation capacity values. Unless the external decade is rated for more than 600 volts, do not use test voltage settings above 1000 volts.

In units fitted with continuous compensation control, the use of the external capacitor decade is not necessary. To determine the inherent capacity of the unit under test, adjust for null, obtain compensation control setting, and refer to calibration curve supplied. In units fitted with Option "N", simply transfer compensation switch to obtain real or total current.

4. Though the voltage wave form applied to the object under test will be as true as the wave form of the line supplying the tester, the wave form of the current in the load will typically be complex, because of the complex impedance characteristics of insulating materials and the relationship of these characteristics to the internal circuits of the tester. For this reason, it will rarely be possible to obtain zero null conditions even with a practically pure capacitive load. In other words, the internal compensation circuits can be expected to compensate or cancel 95% of the capacitive component in the load, but not 100%. This condition becomes especially noticeable in 50VA multi-range units if the user attempts to extend the compensation capabilities of the unit by adding higher values of capacity to the blue external terminals.

# SLAUGHTER

The ProTesters

## TECHNICAL NOTES – Cont'd.

5. When using the tester in GO/NO-GO production inspection service the capacity compensation may be adjusted on the first unit of a given production item and need not be readjusted. The high limit pointer may also be preset to specification. With this setting the buzzer will sound under conditions of excessive leakage and/or complete breakdown. Any arcing, even so low that the leakage meter will not deflect, will cause "static" in the loud speaker.
6. Length and arrangement of test leads is very important on low range AC tests. Leads should be as short as possible and arranged for minimum stray residual meter reading. Excessive residual readings may be due to an improperly grounded or improperly polarized line cord receptacle.  
  
These residual effects, plus basic physical differences in insulation material make absolute correlation between DC and AC tests impossible. AC insulation resistance will generally run considerably below the DC values.
7. Multi-range units incorporate a very sensitive leakage meter. When not in service, it is desirable to set the multiplier switch "OFF". When carrying or shipping the unit, set meter multiplier switch "OFF" and set red limit pointer to zero.
8. These units incorporate internal current limiting circuits to reduce damage on breakdowns and for greater operator safety. Since the short circuit current varies with the voltage setting, care must be taken to see that the high limit leakage meter setting is not above the short-circuit current of the tester. See Setup, Note 6.
9. **WARNING:** For safety reasons and to avoid possible tester damage in case of a complete product breakdown, the product under test should not be grounded nor should it be connected in any way to the AC power lines.

If the product must be grounded, the low side (black receptacle) or metering side must be used. Under no circumstances should the high side be grounded. On units with sensitive leakage ranges, capacitance may be required at the external compensation terminal to cancel internal leakage reading resulting from grounding of the low side. It may also be necessary to readjust the internal residual variable capacitor for a null or cancellation of internal leakage. Under this condition, the internal capacity decade is not usable and an external decade is required.

10. **CAUTION:** When the following connection is made, test leads will be "HOT" at all times that the test switch is in the locking "ON" position.

For some applications, it is necessary that the test switch have a locking ON position. This can be accomplished by connecting the lower switch terminals to the upper terminals. DO NOT cross over from one side of the switch to the other, but jumper top and bottom contacts that are in a vertical line. The upper position of the test switch will then be a locking ON position.

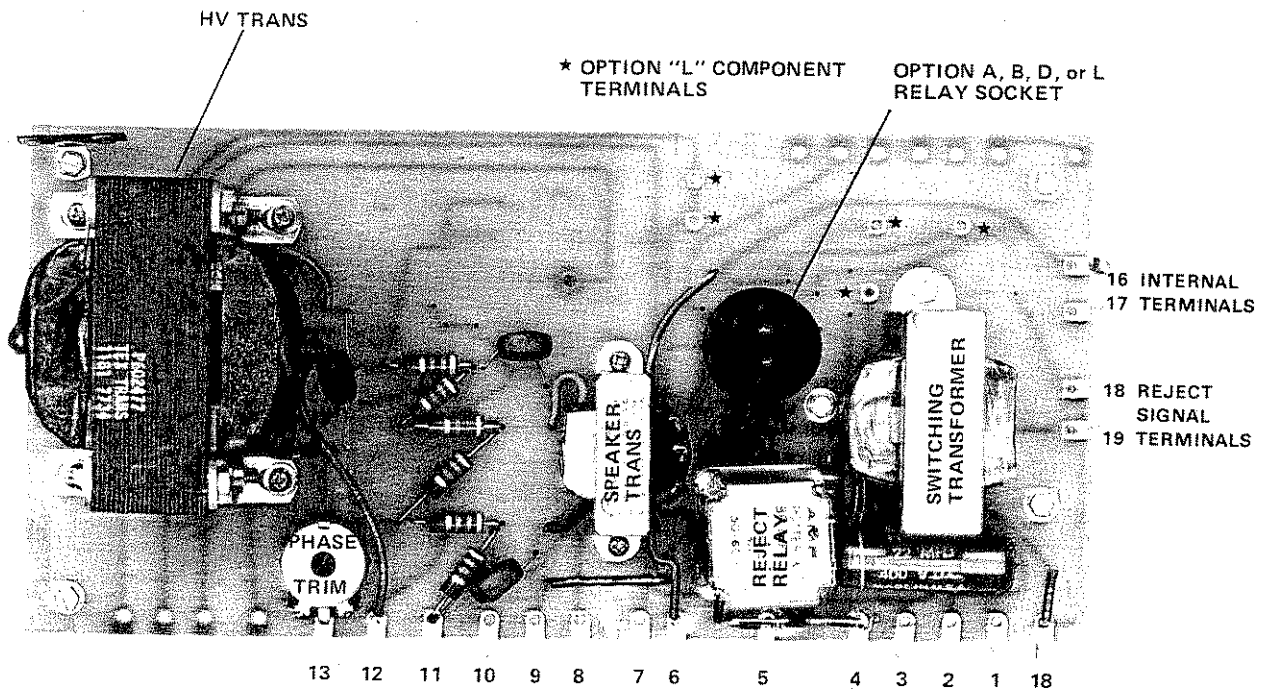
# SLAUGHTER

The ProTesters

## TECHNICAL NOTES — Cont'd.

11. If an external interlock switch is desired as a safety feature, this can be connected in series with the primary line cord. Alternatively, interlock terminals are located inside the tester. These must be strapped if no interlock switch is used. (See photo below)
12. Series 103, 105 and 103/105 units may be used to operate external signals such as lamps, bells, buzzers, counters, etc. These should be connected between terminals No. 18 and 19 on the high-voltage chassis. A reject signal of 115 volts appears between these terminals. (See photo below)
13. As shipped, standard units lock up on rejection, requiring recycling of the power switch, or interruption of power to the unit to reset the reject circuits and cancel the rejection signals. On units equipped with Option "A" or "B" (Automatic Dwell Timing), there is a reset position on the test switch that can be used for this purpose.  

The lock-up feature on units equipped with automatic dwell timing can be disabled by removing the jumper between terminals "C" and "D" on the timer program strip. The lock-up feature on standard units without the dwell timing can be disabled by moving the wire connected to terminal 2 on the high-voltage chassis over to terminal 1 and adding a jumper between terminals 2 and 3. Consult schematics for additional information.
14. For unattended automated test stations, or for testing with prods, automatic reset of the rejection signals may be required. This is provided by Option "L". With this option, automatic reset is provided and the rejection signals are automatically extinguished and high voltage removed from the test leads on part failure. After approximately two seconds the voltage is again applied to the test leads if the power switch has not been released. The unit will cycle between REJECT and ON until the power switch is released or the leakage is reduced below the limit setting.



TYPICAL CHASSIS BOARD ASSEMBLY

INSULATION TESTERS • COIL & WINDING TESTERS • CABLE & HARNESS TESTERS • BATTERY TESTERS



# SLAUGHTER

The ProTesters

## PRODUCTION TEST SETUPS

**CAUTION:** Be sure tester installation is in accordance with instructions. The actual production test setup should then be made only by qualified technical personnel.

Exact setup details will vary with the test procedure utilized. In some procedures test voltage is preset to a fixed value and requires no operator attention. In other procedures gradual application and removal of test voltage is required and voltage cannot be preset. (If high production rates are contemplated, requiring gradual application and/or removal of voltage, our MP series units are recommended).

The same comments apply to capacity compensation. With a consistent production, the capacity compensation may be preset and will require no operator attention. If the product varies or several products are involved, readjustment of the compensation, as part of the test procedure, may be required. Option "N", automatic capacity compensation, is available to eliminate the need of manual readjustment.

The following notes cover typical setup procedure for routine production testing:

1. Using a known good sample of the product to be tested, arrange tester, leads and the product in the mechanical layout to be used, but do not connect leads to the product.
2. Check tester, using procedure under Installation and Checking section.
3. Connect tester to the product to be tested and set capacity compensation to NONE.
4. Turn tester ON and raise voltage to required test value. Total leakage current will appear on the leakage meter. (If meter goes off scale, reduce voltage to get a reading of about 80% full scale). Note this value. Turn tester OFF.
5. Disconnect one test lead only from the product. AVOID CONTACT, but leave it as nearly as possible in the same mechanical layout as will be utilized. Turn tester ON and using the same voltage as in No. 4 above, note residual reading on leakage meter. This residual reading is due to distributed capacities and leakages of the layout and should be kept as low as possible. Generally, if the residual reading is less than 10% of the full reading obtained in No. 4, results will be satisfactory. If this reading is too high, rearrangement of the layout, etc., will be required. (See Technical Note No. 6, Page 21)
6. Reconnect the test lead which was disconnected in No. 5 above. Again, turn the tester ON and adjust test voltage to the same value as used in No. 5. Rotate compensation switch for minimum leakage meter reading. With typical products, this minimum reading will be in the range of .05 to 1.0 milliamperes per 1000 volts, corresponding to an AC insulation resistance in the range of 1 to 20 megohms. If necessary, readjust the test voltage to the actual voltage that will be used in testing. Note the leakage meter reading which can be considered the nominal for the product.

# SLAUGHTER

The ProTesters

## PRODUCTION TEST SETUPS — Cont'd.

Typically, allowable limits will run between 10% and 50% above the nominal established above. However, the limit selected must not be more than 90% of the short circuit capacity of the tester at this particular voltage setting.

To verify, leave voltage control set, turn power off, short circuit tester leads and then turn the unit on. Leakage meter reading will be the actual short circuit capacity of the unit at this particular voltage control setting.

7. After the establishment of test voltage setting, compensation control setting and allowable leakage reading, the unit is ready for production testing. The red limit pointer on the leakage meter should, of course, be set to the allowable limit so that the internal go/no-go rejection circuits will function.

Operation of reject circuits should be checked periodically by short circuiting the test leads and turning the unit on. The leakage needle will rise, hit the red pointer, and register rejection with the reject lamp and buzzer. The Red H.V. lamp will go off, and voltmeter will fall to zero, as soon as rejection signals operate.

8. The procedure for setup on DC testing is exactly as outlined above, except that the compensation control, if any, remains at NONE.
9. After completion of setup, operating personnel should be carefully instructed in the test procedures and properly cautioned regarding any potential hazards involved. Safety training of the operator is an essential part of the production test setup.

## TEST PROCEDURES

**CAUTION:** Test procedures should be carried out only by personnel who have been thoroughly instructed as to the nature of the procedure, the hazards involved, and the necessary safety precautions.

Production Test Procedures, after the setup has been made, are quite simple:

1. Attach test lead clips to terminals to be tested.
2. Depress power switch and raise voltage to specified value. Hold the switch on for the duration of test required.\*

\* **NOTE:** In units supplied with Options A and B (Automatic Dwell Timing), timing of test duration is automatic. The switch should be actuated only momentarily and the unit will then automatically cycle for the duration of test that has been set up on the timer. In units supplied with Option D (Zero Start Interlock), the voltage control **MUST** be **MANUALLY HELD** at the zero or extreme counter-clockwise position for the test switch to be effective in turning the high voltage ON.

3. Leakage will be indicated on the leakage meter. If excessive, the rejection will be indicated by the reject lamp and a buzzer signal which will sound until the ON/OFF switch is recycled.

Minute arcs which are too small to deflect the leakage meter will be indicated by static in the arc detection speaker.

# SLAUGHTER

The ProTesters

## MAINTENANCE AND REPAIR

**CAUTION:** Since any electrical equipment can be hazardous, maintenance and repair procedures should be conducted only by qualified personnel familiar with safety rules applying to electrical equipment. It is suggested that the BASIC FACTS booklet supplied with this equipment be reviewed, particularly pages 19 through 22 for safety suggestions.

Routine maintenance of this unit should include the following:

### 1. FUNCTIONAL CHECK:

Several times daily verify that rejection circuits are functional by shorting test leads across a known load of proper value while the test switch is operated.

### 2. SAFETY INSPECTION:

- A. **DAILY:** On limited energy 50VA-2500V rated units check high voltage isolation by alternately connecting each test lead to a bare metal point on the case and operating the test switch at normal operating voltage. Leakage indication of about 100 microamps is normal. A breakdown indication means an internal failure and the unit should be **removed from service** until repaired.

If the unit is equipped with test prods, check prods for burning or contamination inside barrel by bringing the tip ends together in the **retracted** position while test voltage is kept on. There should be no evidence of arcing or rejection. If there is, prods should be considered unsafe and **removed from service**.

- B. **MONTHLY:** Repeat above test with tester voltage set to full scale.

Check your line receptacle for ground integrity. Check line cord on tester for damage, deterioration, and ground lead integrity. Check test leads for damage or deterioration.

### 3. SERVICE RECOMMENDATIONS:

- A. Clean dust and dirt from interior as required. Use a soft brush or low-pressure dry air.

# SLAUGHTER

The ProTesters

## MAINTENANCE AND REPAIR — Cont'd.

- B. Inspect voltage control contacts every 3 to 12 months depending on severity of service. Replace as necessary.
- C. Check calibration of meters every 6 to 12 months. Check against standard meters of at least 1% accuracy.
- D. Replace pilot and breakdown lamps as necessary.

Some units are self-protecting and have no fuse. Others are protected by a fuse. If the fuse blows, it should be replaced by one of the same style and rating. If the fuse blows and the replacement also immediately blows, something is wrong with the tester and it must be repaired before proceeding. If the replacement holds, the original fuse failure was probably due to an extreme line voltage surge or normal aging of the fuse. Replacement fuses are available from any radio supply house.

Repair of these testers in the field is not recommended. Testers sent in for repair will normally be repaired and returned within 72 hours. However, if field servicing must be done, follow the procedures suggested in the following paragraphs. Most replacement parts are available from radio supply houses. If replacement parts are to be ordered from the factory, be sure to include a reasonable description of the unit, and the parts required.

If in-plant servicing must be done, the diagrams should first be carefully studied. The area of trouble should then be localized between the control circuits and the high-voltage transformer primary lead wire at the variable transformer.

If an AC voltmeter is then connected to the output terminals of the variable transformer, a voltage of 0 to 130 volts should appear if the unit is ON and the voltage control is rotated clockwise.

To check the rejection circuit, momentarily short circuit the two upper terminals on the rear of the limit style leakage meter. When these terminals are shorted, the unit should register rejection.

Troubles in the control circuitry will generally be due to defective plug-in relays, switch contacts or limit circuit diodes. Diodes should show at least two megohms reverse resistance and less than 650 ohms forward resistance when checked on typical multi-testers.

**WARNING:** Use great care in working on this section, as the voltages are lethal and capacitors can hold a charge even when the unit is "OFF".

If the control circuitry checks O.K., the trouble must be in the high-voltage circuits and can generally be traced to open limiting resistors, shorted filtering capacitors or a defective high-voltage transformer.

Trouble-shooting of metering circuits is covered in the section on Calibration.

# SLAUGHTER

The ProTesters

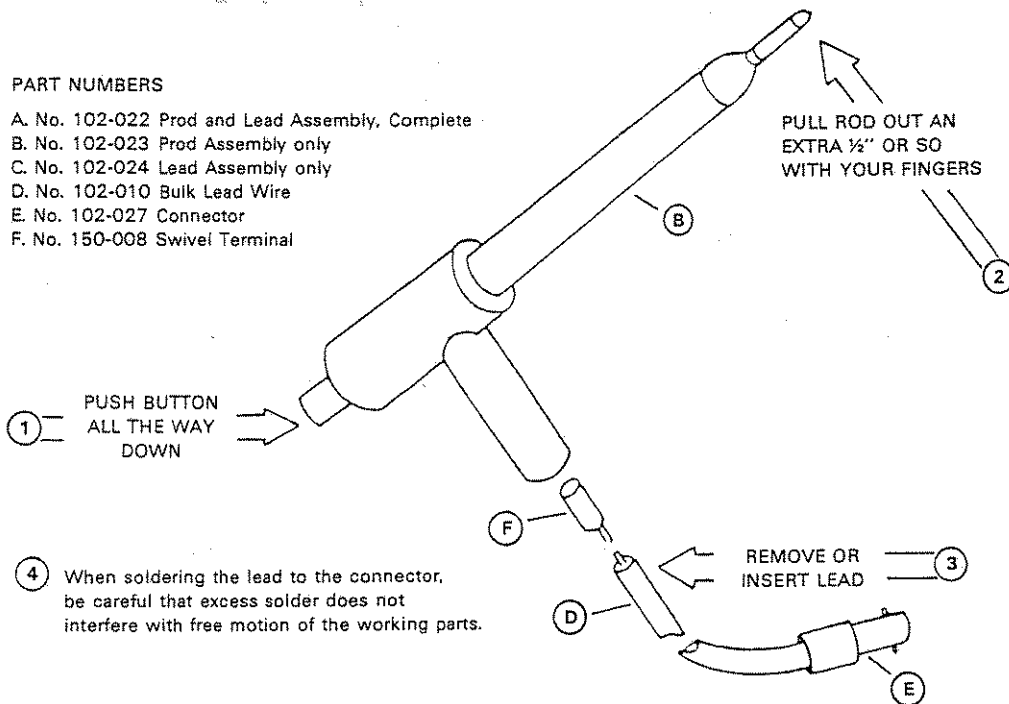
## TEST PRODS

Prods and leads should be inspected periodically for damage or wear which might result in an unsafe condition. In particular, inspect the lower portion of the prod barrel for evidence of burning. If this is detected, replace, and check operating technique.

Test for possible tracking or contamination inside barrel by setting tester to full rated voltage, and bringing the tip ends of the barrels together in the **retracted** position. There should be no evidence of any arcing or rejection when this test is made. If there is, the prods should be considered unsafe and taken out of service.

It is characteristic of the construction of these parts that the prod and lead assembly may show an intermittent open condition when checked with an ordinary multimeter. This is normal and no reason for concern. To verify, hold a gentle pull on the cable where it enters the handle and work the button a few times. This should clear up the apparent discontinuity. If it does not, the trouble is probably in the core of the cable, near the handle.

Test prods are permanently assembled, and no attempt should be made to dismantle them in any way. To do so will void warranty, and might create a dangerous situation. To replace test leads, follow instructions below:



Replacement prods with leads, prods only, leads only, etc., are available from factory stock. See service and repair parts list.







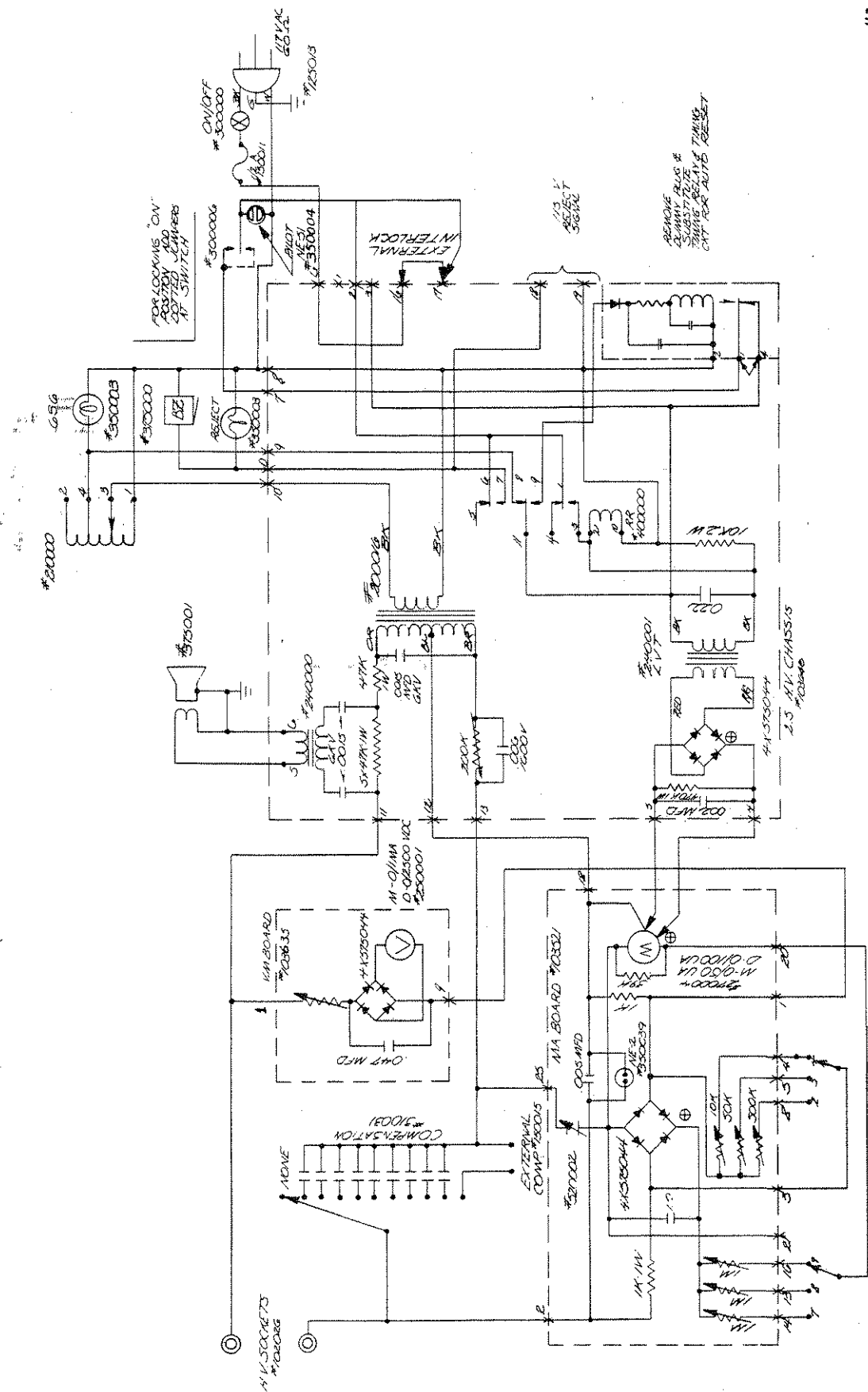


#103502

SLAUGHTER  
Company

THIS PRINT IS SUPPLIED FOR REFERENCE ONLY, AND IS NOT TO BE USED FOR ANY OTHER PURPOSES. IT IS NOT TO BE COPIED OR REPRODUCED IN ANY MANNER WITHOUT OUR EXPRESS WRITTEN PERMISSION.

TITLE		SCHEMATIC	
MODEL 103-2.5 U		SCALE M	
DATE 4/29/78	DWG. BY S	ISSUE 23	DEPT
REF. NO.	DWG. NO.	103502	



TYPICAL SERIES 103-2.5 INCLUDING OPTIONS 'H', 'J' & 'L'

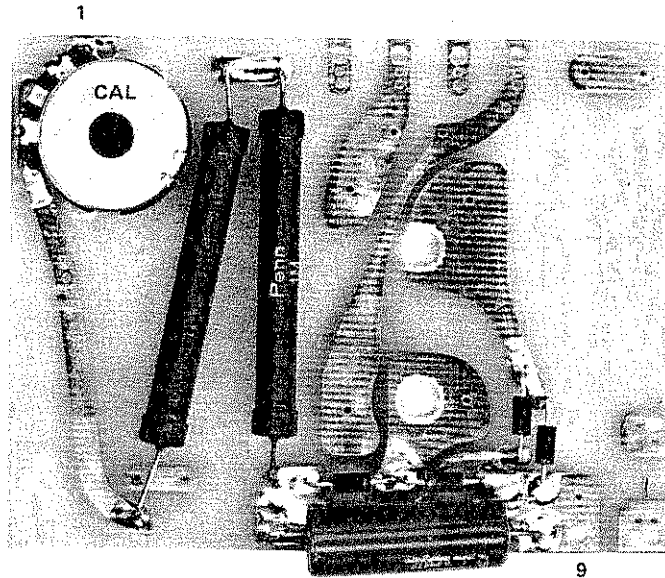
MULTIPLIER SWITCH #310003



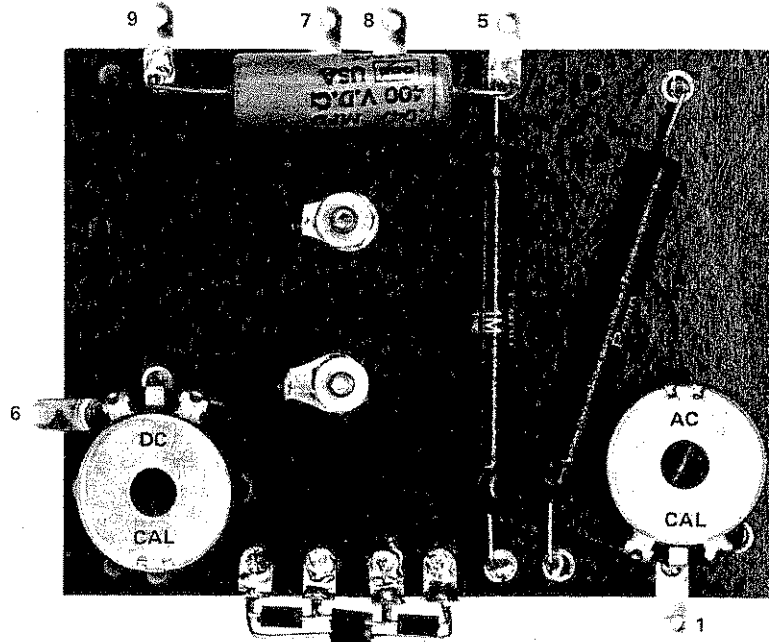


# SLAUGHTER

The ProTesters



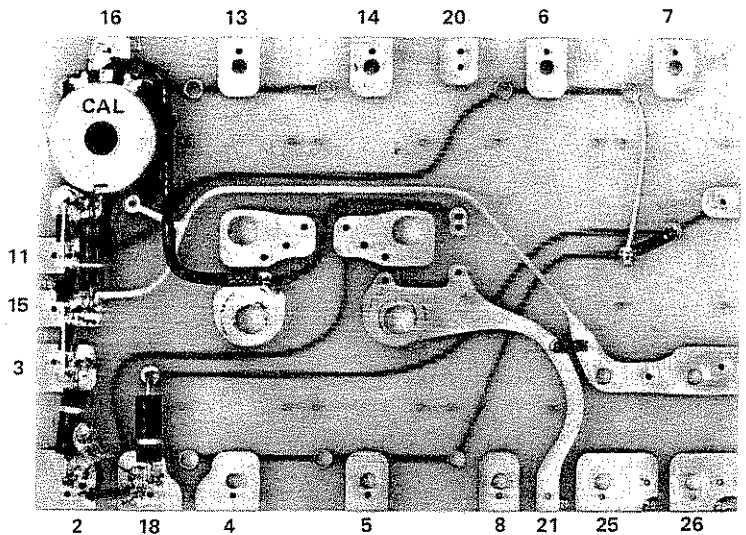
**TYPICAL SINGLE RANGE AC VOLTMETER BOARD**  
(DC Similar Except Diodes Omitted)



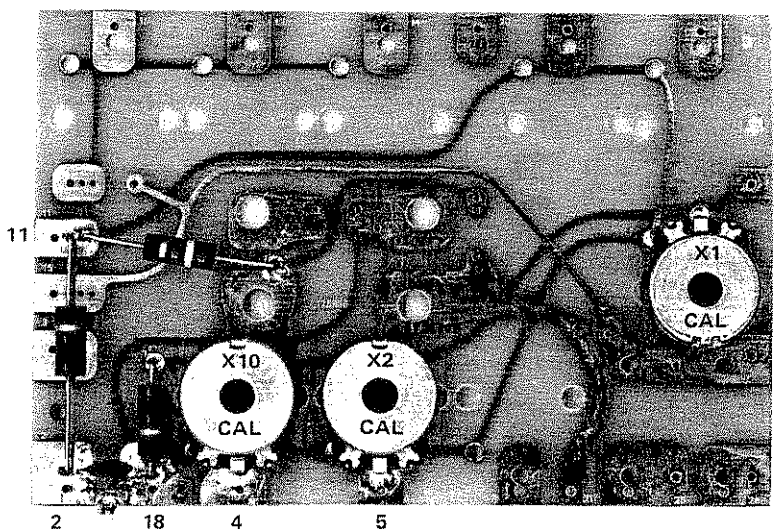
**TYPICAL SINGLE RANGE AC/DC VOLTMETER BOARD**

# SLAUGHTER

The ProTesters



TYPICAL SINGLE RANGE AC LEAKAGE METER BOARD



TYPICAL 3 RANGE DC LEAKAGE METER BOARD

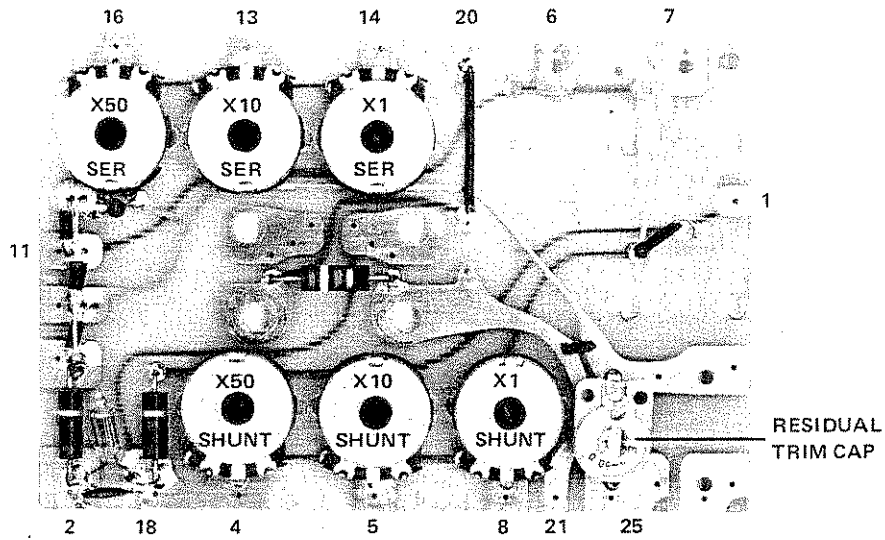
---

INSULATION TESTERS • COIL & WINDING TESTERS • CABLE & HARNESS TESTERS • BATTERY TESTERS

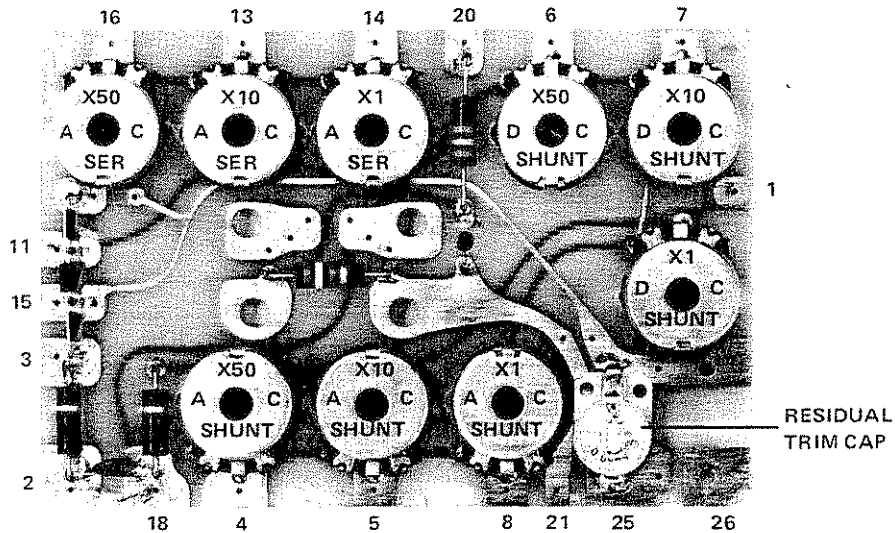
---

# SLAUGHTER

The ProTesters

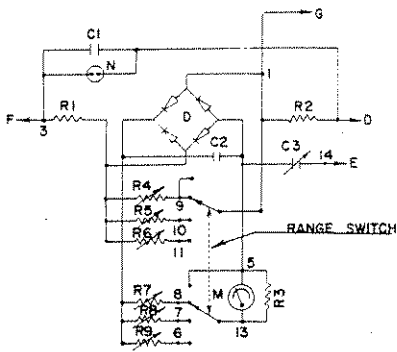


TYPICAL 3 RANGE AC LEAKAGE METER BOARD

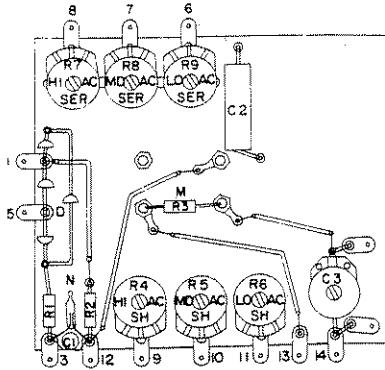


TYPICAL 3 RANGE AC/DC LEAKAGE METER BOARD

INSULATION TESTERS • COIL & WINDING TESTERS • CABLE & HARNESS TESTERS • BATTERY TESTERS



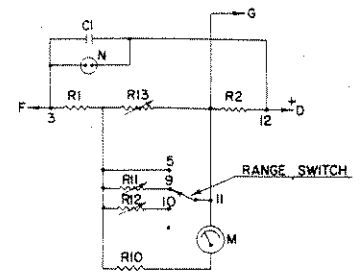
SCHEMATIC



TYPICAL METER BOARD

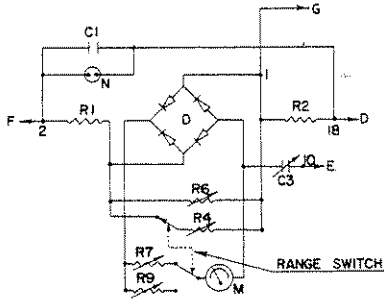
TRIPLE RANGE AC LEAKAGE METERS

103521

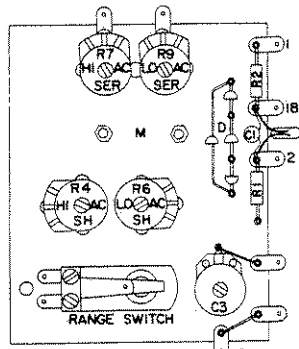


SCHEMATIC

TRIPLE RANGE DC



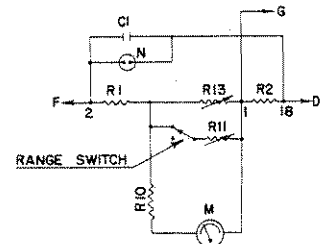
SCHEMATIC



TYPICAL METER BOARD

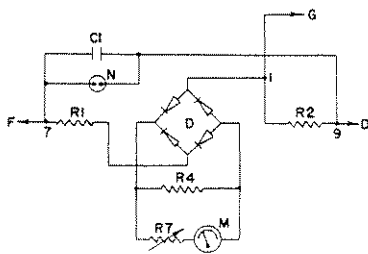
DUAL RANGE AC LEAKAGE METER

122005

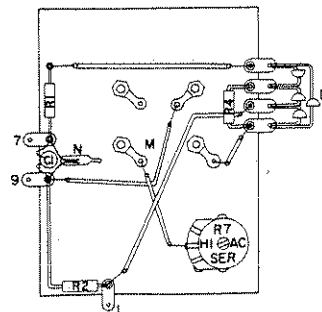


SCHEMATIC

DUAL RANGE DC



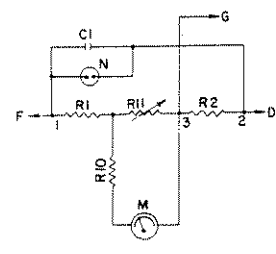
SCHEMATIC



TYPICAL METER BOARD

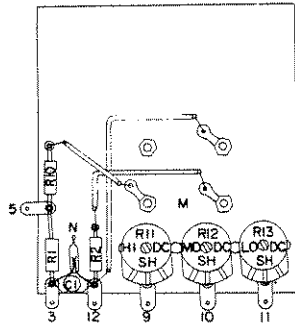
SINGLE RANGE AC LEAKAGE METER

103049



SCHEMATIC

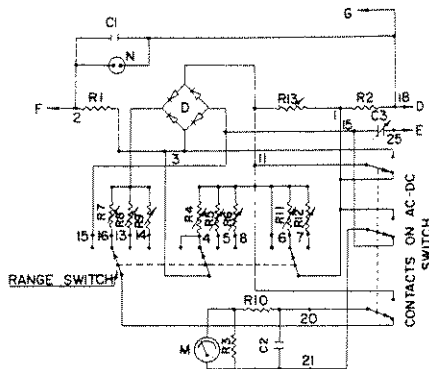
SINGLE RANGE DC



TYPICAL METER BOARD

LEAKAGE METERS

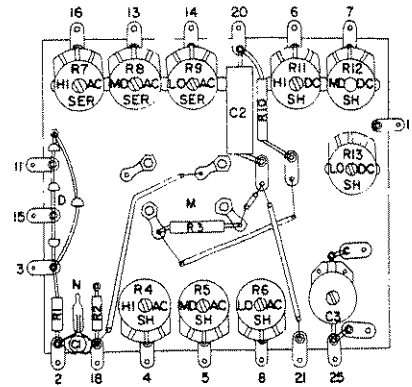
103851



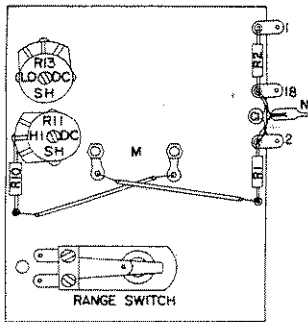
SCHEMATIC

TRIPLE RANGE AC-DC LEAKAGE METERS

103518



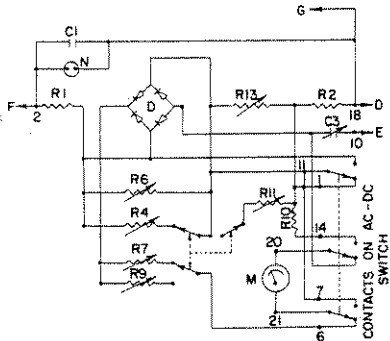
TYPICAL METER BOARD



TYPICAL METER BOARD

LEAKAGE METERS

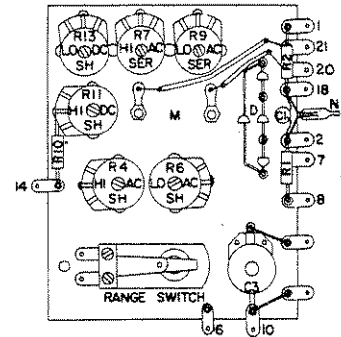
122044



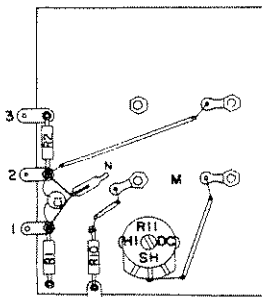
SCHEMATIC

DUAL RANGE AC-DC LEAKAGE METERS

122024



TYPICAL METER BOARD



TYPICAL METER BOARD

LEAKAGE METERS

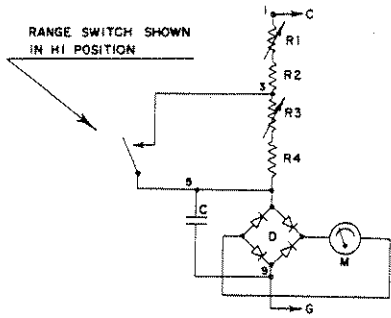
103859

NOTES:

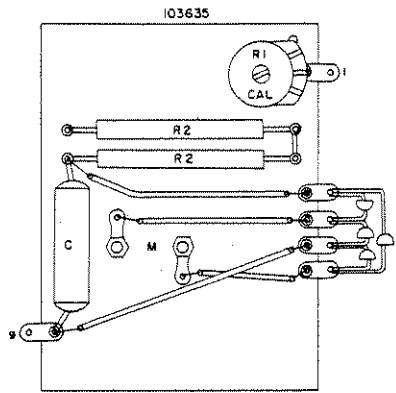
1. BOARDS SHOWN ARE TYPICAL - DETAILS VARY WITH RATING AND MODEL.
2. ALL DIODES ARE \*575026.
3. METER MOVEMENTS ARE 0/20-0/50-0/1000 MICROAMP.
4. FOR INTERCONNECTIONS, SEE BASIC TESTER SCHEMATICS.
5. ALL RANGE SWITCHES SHOWN IN HIGH POSITION.
6. ALL AC-DC SWITCH CONTACTS SHOWN IN AC POSITION.

<b>SLAUGHTER</b> Company	
<small>THIS PRINT IS SUPPLIED FOR REFERENCE ONLY, AND IS NOT TO BE USED FOR ANY OTHER PURPOSES. IT IS NOT TO BE COPIED OR REPRODUCED IN ANY MANNER WITHOUT OUR EXPRESS WRITTEN PERMISSION.</small>	
TITLE	ISSUE NO. x
CURRENT METERING CIRCUITS	NO.
	103211

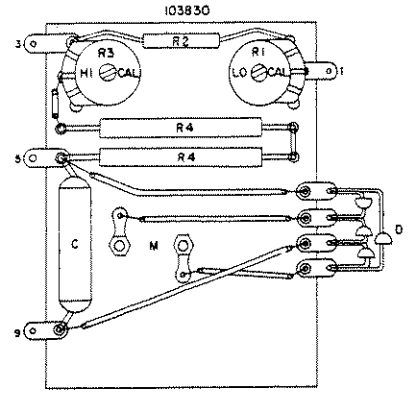




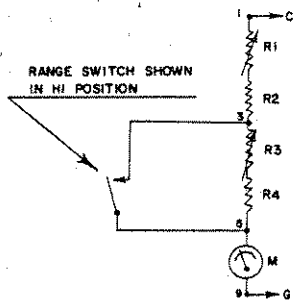
AC VOLTAGE METERING CIRCUIT



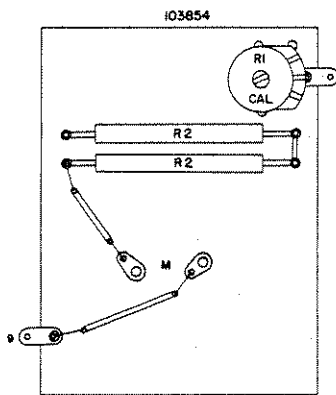
SINGLE RANGE AC  
VOLTMETER BOARD



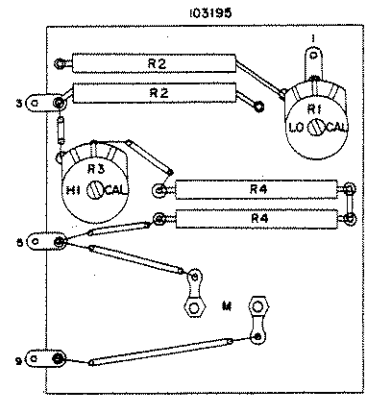
DUAL RANGE AC  
VOLTMETER BOARD



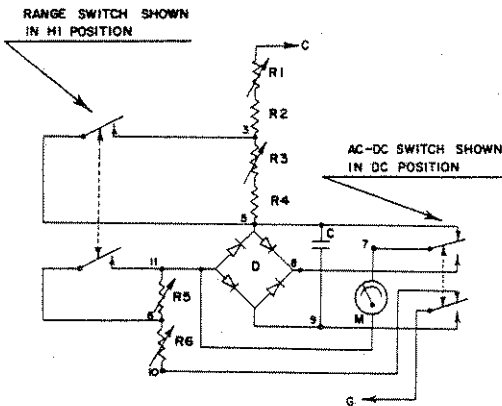
DC VOLTAGE METERING CIRCUIT



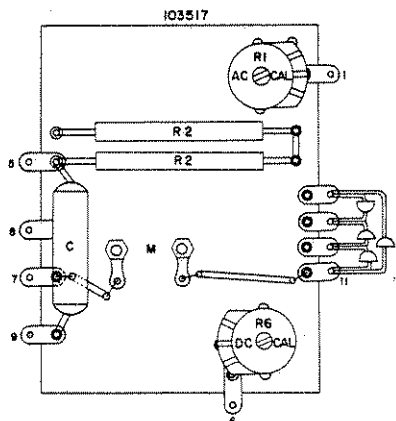
SINGLE RANGE DC  
VOLTMETER BOARD



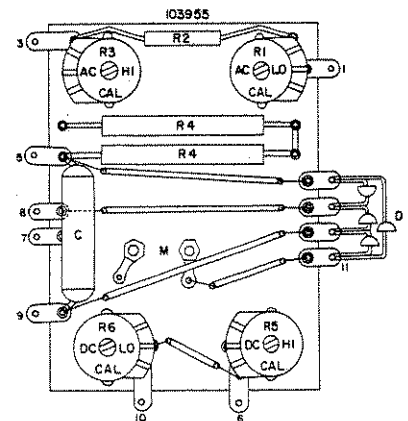
DUAL RANGE DC  
VOLTMETER BOARD



AC-DC VOLTAGE METERING CIRCUIT



SINGLE RANGE AC-DC  
VOLTMETER BOARD



DUAL RANGE AC-DC  
VOLTMETER BOARD

**NOTES:**

- 1 BOARDS ARE TYPICAL - DETAILS VARY WITH RATING AND MODEL.
- 2 ALL DIODES ARE \*575026.
- 3 MOST METER MOVEMENTS ARE 1 MA.
- 4 FOR INTERCONNECTIONS, SEE BASIC TESTER SCHEMATICS.

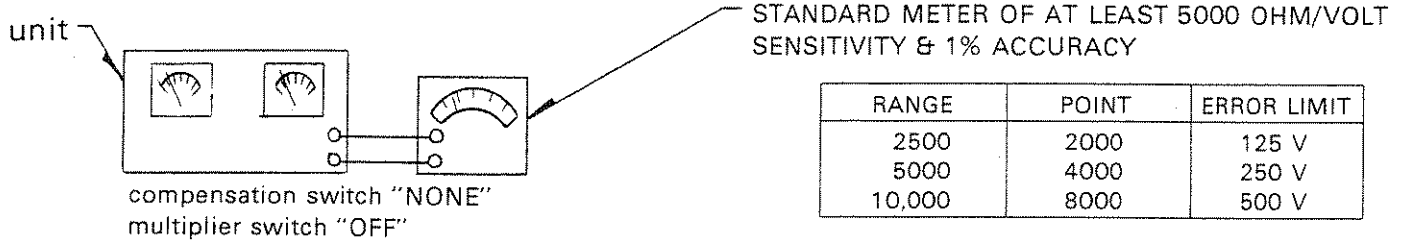
<b>SLAUGHTER</b> <i>Company</i>	
<small>THIS PRINT IS SUPPLIED FOR REFERENCE ONLY, AND IS NOT TO BE USED FOR ANY OTHER PURPOSES. IT IS NOT TO BE COPIED OR REPRODUCED IN ANY MANNER WITHOUT OUR EXPRESS WRITTEN PERMISSION.</small>	
TITLE VOLTAGE METERING CIRCUITS	ISSUE NO. X NO. 103210

# SLAUGHTER

The ProTesters

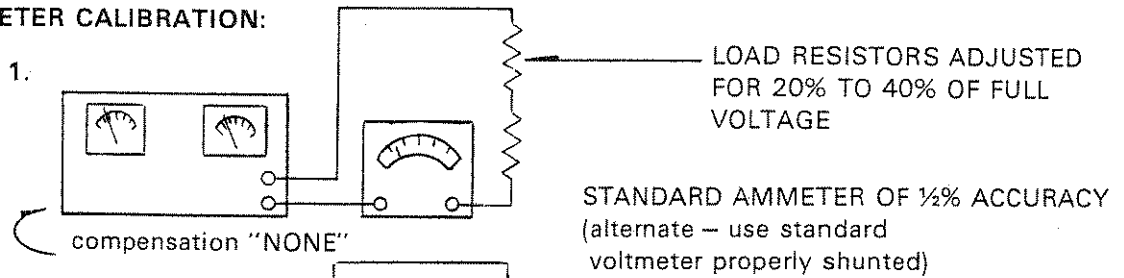
## CONDENSED CALIBRATION INSTRUCTIONS SERIES 103-105-103/105

### A. VOLTMETER CALIBRATION:

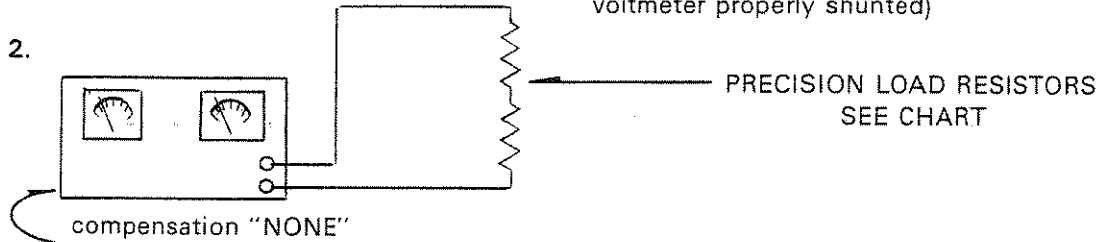


### B. CURRENT METER CALIBRATION:

#### METHOD 1.



#### METHOD 2.



RANGE	VOLTS	LOAD RESISTORS		CURRENT	ERROR LIMIT
		OHMS	WATTS		
0/100 UA AC	1000	50M	2	20 UA	5 UA
	1000	20M	2	50 UA	5 UA
	800	10M	2	80 UA	5 UA
0/1000 UA AC	2000	10M	2	200 UA	50 UA
	1000	2M	2	500 UA	50 UA
	1600	2M	2	800 UA	50 UA
0/5 MA AC	1000	1M	2	1 MA	.25 MA
	900	300K	5	3 MA	.25 MA
	800	200K	10	4 MA	.25 MA
0/100 UA DC	1200	20M	2	60 UA	5 UA
0/1000 UA DC	1200	2M	2	600 UA	50 UA
0/5 MA DC	900	300K	5	3 MA	.25 MA
0/25 UA DC	1000	50M	2	20 UA	1.25 UA
0/50 UA DC	2000	50M	2	40 UA	2.5 UA
0/250 UA DC	2000	10M	2	200 UA	12.5 UA

INSULATION TESTERS • COIL & WINDING TESTERS • CABLE & HARNESS TESTERS • BATTERY TESTERS

# SLAUGHTER

The ProTesters

## CALIBRATION PROCEDURES

These are precision units and have been carefully calibrated at the factory. Do not attempt recalibration unless suitable standards are available. AC current metering circuits incorporate adjustments for linearity as well as range. Careless adjustment can result in a calibration that is accurate only over a limited range and, therefore, useless.

When operating above half-scale, on all ranges, internal heating may occur in the protective limiting resistors. Operating periods should be limited to 15 seconds maximum with about 1 minute cooling period allowed between cycles.

### A. CHECKING CALIBRATION

#### 1. VOLTMETER

Voltmeter calibration should be checked first. For this purpose, use a quality voltmeter of at least 1% accuracy and at least 5000 ohms per volt-sensitivity. Electrostatic type meters are recommended. When checking voltmeter calibration, compensation switch should be set to NONE and leakage meter range switch should be set to OFF. Check calibration at four or five points on the scale. At no place should the error exceed 5% of the full-scale rating of the voltmeter. Refer to condensed instructions supplied with this manual for hook-up and additional notes.

#### 2. CURRENT METER

**CAUTION:** Length and arrangement of leads is very important on low ranges. Leads should be as short as possible and arranged for minimum stray residual meter reading. For minimum residual, be sure unit is operated from a 3-prong, properly grounded receptacle.

There are two methods of checking leakage meter calibration. First, and best, is to use a precision standard ammeter of a suitable range. When using this method, connect the meter in series with the lower output jack, as close to the tester as possible. Load resistors should then be connected between the meter and the upper jack as shown on the condensed instruction chart, so the unit will operate at between 20% and 40% of full rated voltage during the calibration.

A leakage meter calibration checking unit, AMSC/042, is available from the Slaughter Company. Refer to condensed Calibration Instructions for calibration hook-ups and values. If a suitable ammeter is not available, it is possible to shunt a precision voltmeter. Consult your regular instrument handbook for information on this.

The second method, which is more commonly used in the more sensitive AC ranges, consists of building up a known load on the unit with precision resistors and then applying a known voltage, using the calibrated internal voltmeter as a standard. Since voltage is known and load resistance is known, actual current can be calculated and compared with the actual leakage meter reading. Suggested load values given in the condensed chart in this section apply to limited energy 50 volt-ampere units. For high capacity units, the standard ammeter method of calibration is preferable.

# SLAUGHTER

The ProTesters

## B. TROUBLE-SHOOTING METER CIRCUITS

If the calibration checks considerably off, some defect may exist which should be repaired before attempting recalibration. Consult the following notes for suggestions.

1. If the meter is consistently low on all ranges and appears heavily damped on all ranges, a defective meter movement is indicated.
2. If the meter is about 50% low on all AC ranges but damping is satisfactory, even slightly under damped, a defective meter rectifier diode is indicated.
3. If linearity is poor on all AC ranges, a leaky meter rectifier diode is indicated.
4. If at least one range is good on both calibration and linearity, this is a positive indication that meter movement is O.K. This also means that the meter rectifier is probably O.K., particularly, if the good range is the most sensitive AC range.
5. If the meter will not read at all, either an open meter coil or a shorted rectifier bridge is indicated.
6. Early AC units incorporate a meter rectifier assembly, usually inside the meter case. In such units, the entire meter should be replaced if the internal rectifier is defective. Current production utilizes an external meter bridge made up of four silicon diodes, which can be replaced. To check diodes, disconnect and measure forward VS reverse resistance with a multimeter. Forward resistance should be less than 650 Ohms and reverse resistance should be above two megohms. If any one diode is defective, all four in the bridge must be replaced.
7. If all ranges are good except the linearity at the low end of the most sensitive scale, re-check the test setup to be sure that stray capacities are not causing an excessive residual reading that is giving false results.
8. Some meters utilize an external damping resistor. This is factory matched to the meter and should not be changed. If a new meter is being installed, it may be necessary to change this resistor for optimum damping. The damping resistor should allow a needle over-shoot on the most sensitive range of at least 1% and not more than 3% when checked at about 80% scale reading. Recalibration will be required if this resistor is changed.
9. An internal breakdown between the locking coil and the metering coil of contact meters will result in an excessive residual meter reading even when the test leads are removed from their jacks. To check, disconnect all wiring from meter studs and check with a multimeter. Resistance between all lower studs and all upper studs should be infinite.

# SLAUGHTER

The ProTesters

## TROUBLE SHOOTING METER CIRCUITS – Cont'd.

10. The small trimmer capacitor marked RESIDUAL ADJUSTMENT is utilized to compensate for internal wiring capacity variations. It is adjusted during manufacture of the unit and should not need readjustment thereafter. If this adjustment should be disturbed accidentally, it should be readjusted for minimum residual leakage meter reading with test leads removed and with unit set to its most sensitive range at 80% of maximum voltage.

### C. RECALIBRATION PROCEDURES

When recalibrating a unit, be sure to recalibrate the voltmeter first; then proceed to the leakage meter, recalibrating the most sensitive scale first and proceeding to the less sensitive scales until the job is complete.

The voltmeter should be recalibrated at between 60% and 80% of full scale as convenient. The trimmers marked CAL should be adjusted as necessary. (Early units do not have trimmers and adjustment is made by substituting precision deposited carbon resistors as necessary).

On multiple range voltmeters, recalibrate lowest range first, proceeding on to the highest range. On AC-DC units, recalibrate AC scales before the DC.

AC leakage meters are recalibrated at two points; approximately 80% of full scale and 20% of full scale. There are two adjustments for each range; a shunt trimmer which adjusts the basic calibration and a series trimmer which adjusts linearity. However, these adjustments are inter-acting and it is, therefore, necessary to readjust one after the other in gradually smaller steps until the best results are obtained. Generally speaking, the best procedure is to adjust the shunt first at the 20% point and then the series at the 80% point. Then return to the shunt at the 20% point and back to the series at the 80% point; repeating as necessary until the job is done.

DC leakage meters incorporate only one adjustment, a shunt trimmer, for each range. It is generally recalibrated at between 60% and 80% of full scale.

After recalibration, seal all adjustments with glyptal or similar material.

# SLAUGHTER

The ProTesters

PARTS AND SERVICES LISTED HERE ARE ONLY THOSE MOST COMMONLY REQUESTED. REPLACEMENT PARTS FOR ALL OF OUR EQUIPMENT ARE AVAILABLE GENERALLY FROM FACTORY STOCK. FOR PARTS NOT LISTED CONTACT FACTORY GIVING DESCRIPTION OF ITEM PLUS MODEL AND SERIAL NUMBERS OF UNIT INVOLVED. THESE NUMBERS ARE LOCATED ON THE FRONT PANEL OR ON THE UNDERSIDE OF THE CABINET.

## REPAIR PARTS LIST

PART NO.	DESCRIPTION	PART NO.	DESCRIPTION
102022	PR. PRODS & LEADS	310031	SWITCH, COMPENSATION
102024	PR. LEADS ONLY	320001	KNOB, G.P.
102025	PR. 8 FT. CLIP LEADS	330009	SWITCH, MICRO SAFETY
102026	PR. HV SOCKETS	330013	SWITCH, MICRO (D OPTION)
125013	LINE CORD	350003	LAMP 656 SCREW BASE
150011	FUSE, 1/2A SLO BLO	350004	LAMP NE-51 BAYONET
150027	FUSE, 3/4A SLO BLO	350039	BULB NE-2 PROTECTOR
150047	FUSE, 1 A SLO BLO	375000	BUZZER
150048	FUSE, 1 1/2A SLO BLO	375001	SPEAKER, 4"
150050	FUSE, 5A SLO BLO	375004	SPKR, 1 1/2"
150068	ADAPTER PLUG, 8 PIN	400000	RELAY, 11 P, KRP 14AG x 120V
175056	FLEX COUPLING	400001	TIMER, 3 MIN (OPTION B)
200007	TRANSFORMER, 5KV x 50VA	400021	TIMER, 6 SEC (OPTION A)
200018	TRANSFORMER, 10KV x 50VA	425077	RELAY VACUUM, HV
200022	TRANSFORMER, 5KV x 500VA	460002	RESISTOR, 250K x 1W x 1%
200024	TRANSFORMER, 2.5KV x 500VA	460004	RESISTOR, 1 MEG x 2W x 1%
200029	TRANSFORMER, 10KV x 500VA	500009	CAPACITOR, .047 x 400V x 10%
210000	TRANS. VOLTAGE CONTROL 50VA	500039	CAPACITOR, .22 x 400V x 10%
210009	TRANS. VOLTAGE CONTROL 500VA	500044	CAPACITOR, .10 x 3KV
220013	TRANS. COMPENSATION	500068	CAPACITOR, TANT, 1.0 x 20%
230000	CHOKE (N OPTION)	510000	CAPACITOR, .0015 x 6KV x 20%
240000	TRANSFORMER, SPEAKER	510001	CAPACITOR, .005 x 1KV
240001	TRANSFORMER, SWITCHING	510003	CAPACITOR, .002 x 1KV
240024	TRANS. 24V CONTROL	530000	CAPACITOR, MP, 1.0 x 200V
250001	VOLTMETER, 0/2500VAC	540000	CAPACITOR, ELECT, 20 x 250V
250010	DIAL COVER, ALL VOLTMETERS	540036	CAPACITOR, ELECT, 150 x 50V
250030	VOLTMETER, 0/5KV AC	540055	CAPACITOR, ELECT, 100 x 50V
250034	VOLTMETER, 0/5KV DC	575026	DIODE, 1000 PIV x 1A
250049	VOLTMETER, 0/2500VDC	575066	DIODE, 10KV x 25MA
250051	VOLTMETER, 0/5KV	575067	DIODE, 25KV x 25MA
270004	LIMIT METER 0/100 MICROAMPS	575073	INT. CIR. AMPLIFIER LM301AH
270005	LIMIT METER 0/25 MICROAMPS	575092	MULTIPLIER #4452
270011	DIAL COVER, ALL HIGH LIMIT MTRS.	575110	IN2976 ZENER DIODE
270019	LIMIT METER, 0/5 MILLIAMPS	575143	IC REGULATOR LM 320K-15
300000	SWITCH, POWER	575144	IC REGULATOR LM 340K-15
300003	SWITCH, START	575147	TRANSZORB, 1.5KE-18A
300006	SWITCH, TEST	575148	TRANSZORB, 1.5KE-13CA
200016	TRANSFORMER, H.V.	425000	RELAY, 8P, KCP11 2500 OHM
250002	VOLTMETER, 0/2500 VAC/DC	425001	RELAY, 11P, KCP14 2500 OHM
310002	SWITCH, AC/DC TRANSFER	425007	RELAY, 11P, KCP14 5000 OHM
310003	SWITCH, MULTIPLIER	575096	DIODE, 5 KV x 25 MA
400005	RELAY, 8 P, KRP11AG x 120 V	575044	DIODE, J4 400 VOLT
400029	TIMER, 3 MIN		