TROUBLESHOOTING PRELIMINARY

- **To troubleshoot, one must first have a working knowledge of the individual parts and their relation to one another.**

- **Must have adequate hand tools**

- **Must have basic instrumentation:**
  Accurate digital voltmeter with diode test mode for silicon units
  Clamp-on AC – DC ammeter
  Voltage detectors
  Cell phone very useful

- **Observe all safety precautions**

RECTIFIER COMPONENTS

- Cabinet - protects the rectifier components from the elements
- Circuit Breaker - serves as an on - off switch and overload protection
- Transformer - reduces the line voltage to a useable level for the cathodic protection system and isolates the CP system from the incoming power
- Rectifier Stack - used to change A.C. to D.C. (Silicon) or (Selenium)
- Fuses - to protect the more expensive components (like Diodes, ACSS,etc.
- Meters - used to indicate D.C. Voltage and D.C. Current
- Shunts - used to accurately measure circuit current
- Arrestors - protects the rectifier from voltage and lightning surges

TROUBLESHOOTING - BASIC

An adequate inspection and maintenance program will greatly reduce the possibility of rectifier failure. Rectifier failures do occur, however, and the field technician must know how to find and repair troubles quickly to reduce rectifier down time.

MAJOR CAUSES OF RECTIFIER FAILURES

1. NEGLECT
2. AGE
3. LIGHTNING

TROUBLESHOOTING PRECAUTIONS

- **Turn the RECTIFIER and the MAIN DISCONNECT OFF!**
- **Be careful when testing a rectifier which is in operation. Safety first**
- **Consult the rectifier wiring diagram before troubleshooting**
- **Correct polarity must be observed when using DC instruments**
- **Rectifier should be in the OFF position before using an OHMETER**
- **Common sense prevails**

TROUBLESHOOTING PROCEDURES

Most rectifier troubles are simple and do not require extensive detailed troubleshooting procedures. The most common problems are:

- **Faulty meters**
- **Loose terminals**
- **Blown Fuses**
- **Open ground bed leads**
- **Lighting damage**

Universal RECTIFIERS, INC.

TROUBLESHOOTING MORE DIFFICULT PROBLEMS

It is usually better to systematically isolate the rectifier components until the defective part is found.

- **TROUBLESHOOTING IS THE PROCESS OF ELIMINATION!**

Universal RECTIFIERS, INC.

CHECK

The AC voltage across line side of circuit breaker (Points A-A)

• The AC voltage across load side of circuit breaker (Points B-B)

This voltage should be the same as points A-A.

• The input change taps for loose connections (Point C) Adjust for the correct input voltage.

• The transformer secondary tap link bars for the presence of voltage (Points D-E)

Voltage may be measured between any of the secondary taps If the circuit breaker trips, indicating a short circuit, the transformer can be isolated by removing the link bars. If the circuit breaker continues to trip, the transformer is shorted. If the circuit breaker holds, the short is not in the transformer.

• The AC voltage supplied to the rectifier stack (Points F-G) This voltage should be the same as points D-E.

• If the circuit breaker trips, isolate the stack by removing one of the DC leads. (Points H or J)

• If AC voltage is supplied to the stack, check the DC output voltage. (Points H-J) If DC voltage is present but is less than expected, stack may have an open circuit and is half-waving.

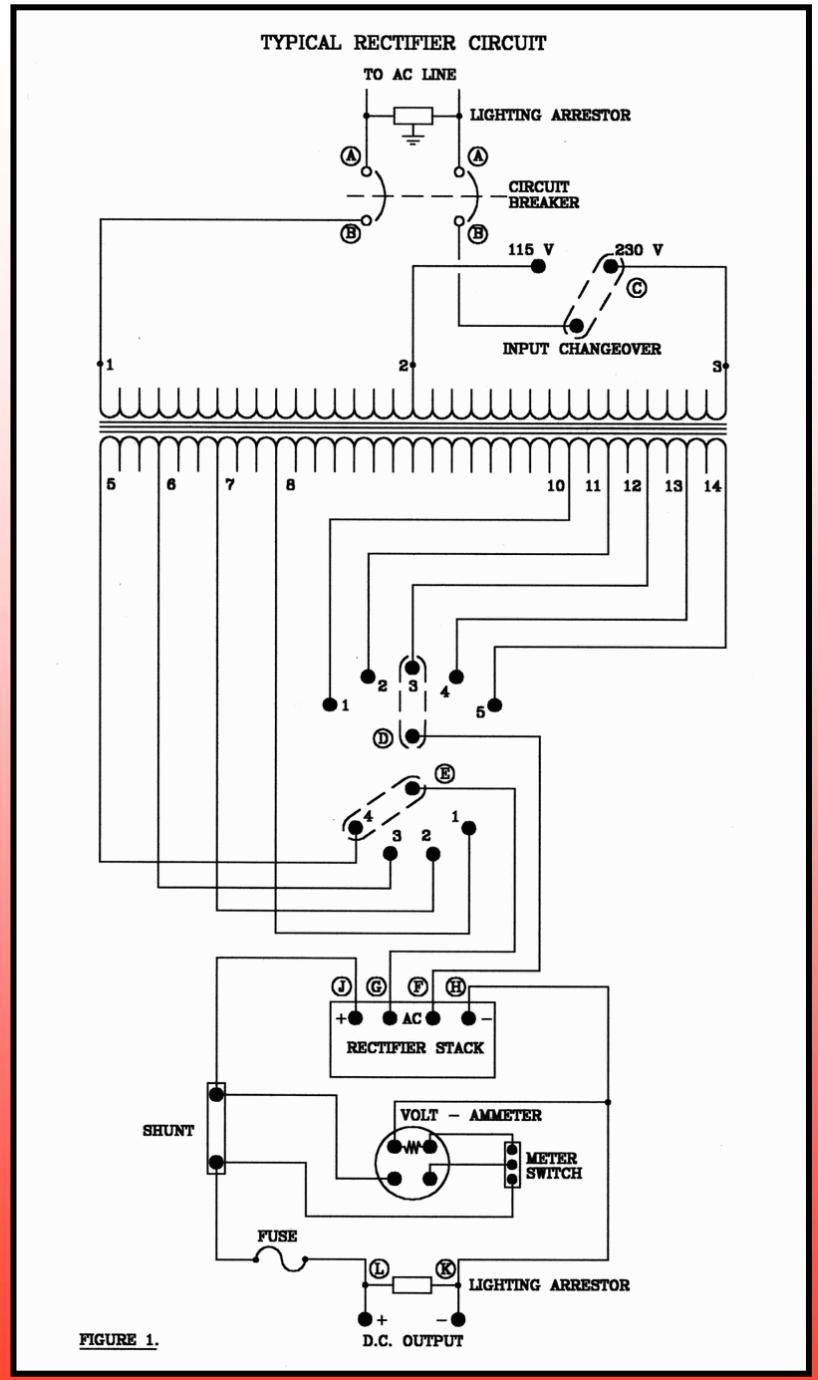


FIGURE 1.

Universal RECTIFIERS, INC.

CHECK

- If the circuit breaker does not trip when a DC lead on the stack is removed, but does when it is connected, a short circuit is probably is the external ground-bed or structure leads.
- If DC voltage is present at the stack Points J-H, but not at the rectifier output. Check for loose connections or open leads between Points J-K or H-L.
- **<u>If DC voltage is present at the rectifier output terminals, but no current is flowing, there is an open in one of the external DC Leads</u>**.
- Meters may cause the rectifier to appear defective. Check meter with portable meters known to be accurate.
- Meter switches may be checked with an ohmmeter.
- If it is suspected that the choke is defective, it may be effectively taken from the circuit by placing a heavy jumper lead across the choke leads.
- Capacitors in an interference filter are individually fused. If fuse is blown, replace with a new fuse and turn the on again.
- Lighting arrestors in rectifier may be isolated by removing them from the circuit.

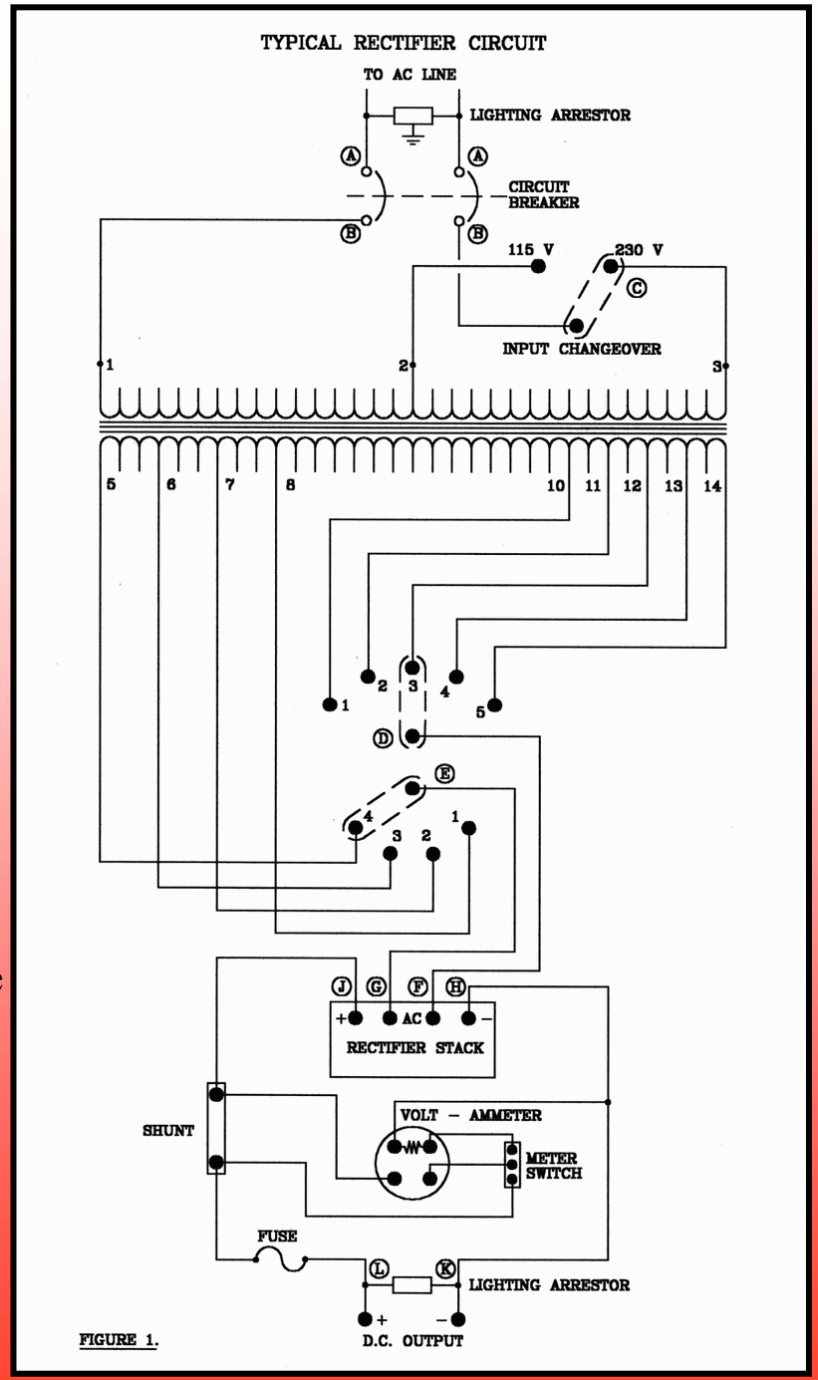


FIGURE 1.

TROUBLESHOOTING TIPS

Many rectifier problems are relatively obvious to the experienced technicians upon physical examination. The obvious should never be overlooked! Loose connections, signs of arcing, strange odors, etc., indicate troubles, which do not require elaborate test procedure to uncover.

Universal RECTIFIERS, INC.

SOME HELPFUL TROUBLESHOOTING TIPS TO FOLLOW

1. No output voltage or current present.

    A. Breaker Tripped (or Fuse Blown)
        1. Steady overload, reduce output slightly.
        2. Short circuit in some component.
    B. No AC Line Voltage
    C. Open Circuit
        1. Check all connections
        2. Check all diodes in silicon stacks
    D. Defective meters or meter switches Paragraph 11, Troubleshooting Procedure section of your guide.

Universal RECTIFIERS, INC.

SOME HELPFUL TROUBLESHOOTING TIPS TO FOLLOW

E. Defective Transformer, good primary input, but no secondary output.

1. Secondary probably open.
2. Check DC resistance of windings with an ohmmeter.
   (a.) Secondary should have less than 1Ω resistance.
   (b.) Primary should have 1-10Ω resistance
   (c.) An open circuit is possible if resistance is extremely high.

F. Circuit Breaker (or thermal overload protectors).

If contacts do not close, repair or replace breaker.

Universal RECTIFIERS, INC.

SOME HELPFUL TROUBLESHOOTING TIPS TO FOLLOW

2. If maximum DC output voltage at rated DC current is half output.
    A. Check for proper AC input voltage.
    B. Check stacks for plates open circuit, this would make unit operate as a half-wave rectifier.
    C. Badly aged stacks.
    D. For 3Ø rectifiers, in addition to the above 1Ø rectifiers.
        (1.) Open circuit if, one AC line is considerably less than the other two.
        (2.) One of three stacks are more aged than the other two.
    E. Low line voltage.

SOME HELPFUL TROUBLESHOOTING TIPS TO FOLLOW

3. Variable Transformer Control

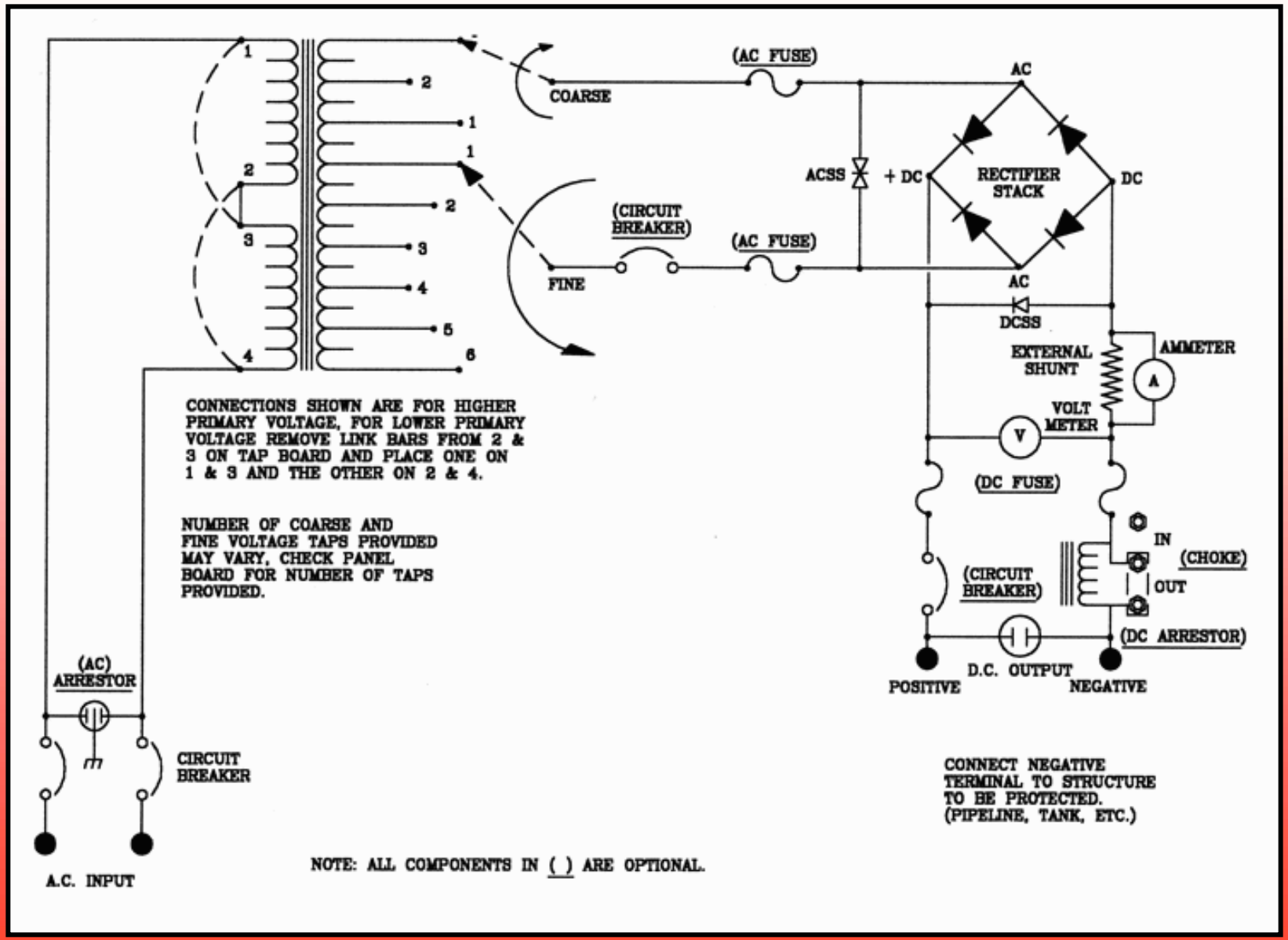
Some rectifiers may be equipped with a variable transformer in lieu of the standard tap and link bar arrangement. The variable transformer will provide step-less, infinite control of the output of the rectifier.

TROUBLESHOOTING THE VARIABLE TRANSFORMER

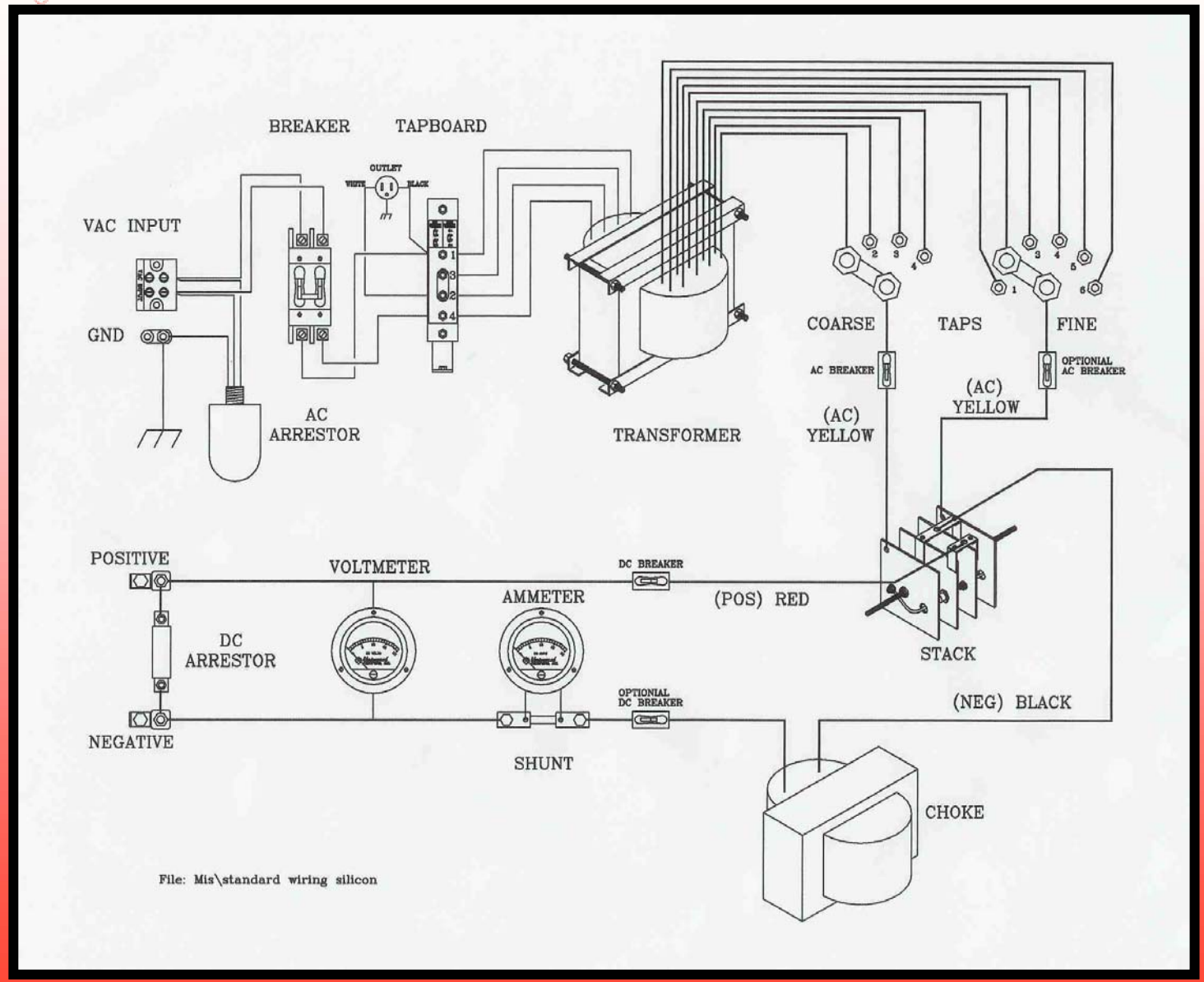
Troubleshooting the variable transformer will be the same as the procedure for the main transformer.

A. AC input voltage should be checked across terminals one and four.
B. Output AC voltage can be checked across terminals one and three. (Control knob should be at maximum rotation.
C. Output voltage should be the same as Input voltage.
D. If no AC voltage is present on the output terminals of the variable transformer, check for open winding, dirty or worn wiper brush.

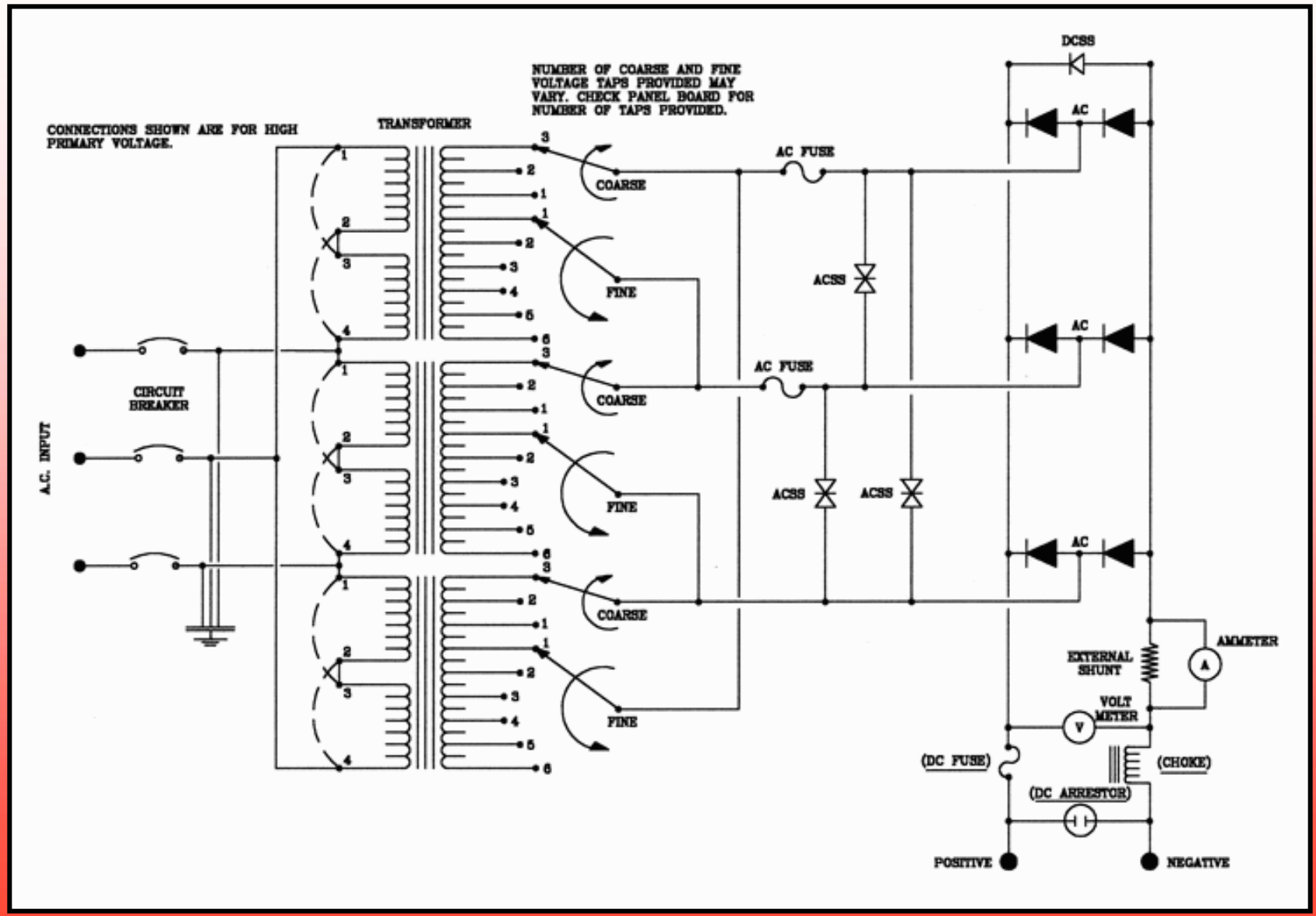
TYPICAL SINGLE PHASE RECTIFIER



Universal
RECTIFIERS, INC.



TYPICAL THREE PHASE RECTIFIER



TROUBLESHOOTING CHART

RECTIFIER BREAKER DOES NOT TRIP NO D.C. OUTPUT

CHECKPOINT	SYMPTOM	CAUSE	REMEDY
A	NO AC VOLTAGE	NO AC SERVICE BLOWN FUSE OR TRIPPED BREAKER IN DISCONNECT BREAKER TRIPS OR BLOWS FUSE REPEATEDLY	RESTORE POWER RESET CIRCUIT BREAKER OR REPLACE FUSE CHECK AC LIGHTNING ARRESTOR
B	NO VOLTAGE	DEFECTIVE CIRCUIT BREAKER	REPLACE
C	NO VOLTAGE (SECONDARY)	LOOSE PRIMARY CONNECTIONS LOOSE SECONDARY TAP LINK BARS OR CONNECTIONS OPEN PRIMARY OR SECONDARY WINDINGS IN TRANSFORMER	CHECK AND TIGHTEN CHECK AND TIGHTEN CHECK FOR CONTINUITY IN WINDINGS. IF OPEN, REPLACE TRANSFORMER
D	NO VOLTAGE	BLOWN FUSE OR TRIPPED SECONDARY CIRCUIT BREAKER	SEE PROBLEM #3, PAGE 3 *INSTALL TEST BREAKER IN PLACE OF FUSE FOR TROUBLESHOOTING

CHECKPOINT	SYMPTOM	CAUSE	REMEDY
E	AMMETER DOES NOT READ	DEFECTIVE AMMETER	REPLACE AMMETER IF MILLIVOLT READING IS OK ON SHUNT
E	NO MILLIVOLT READING ON SHUNT	OPEN GROUNDBED OR STRUCTURE LEAD	CHECK FOR CONTINUITY
F	NO VOLTAGE (D.C.)	DEFECTIVE BRIDGE (OPEN CIRCUIT) LOOSE CONNECTIONS ON BRIDGE OR AT CONTROL PANEL DEFECTIVE VOLTMETER	ISOLATE AND CHECK. REPLACE CHECK AND TIGHTEN REPLACE

RECTIFIER BREAKER TRIPS

PROBLEM	SYMPTOM	CAUSE	REMEDY
1	BREAKER TRIPS AFTER LONG PERIODS OF USE	OUPUT TOO HIGH DEFECTIVE BREAKER BREAKER RATING TOO LOW FOR INPUT VOLTAGE	LOWER OUTPUT REPLACE REPLACE WITH CORRECT RATING FOR INPUT VOLTAGE (SEE RECTIFIER NAMEPLATE FOR LINE CURRENT VS. LINE VOLTAGE)

PROBLEM	SYMPTOM	CAUSE	REMEDY
2	BREAKER TRIPS IMMEDIATELY	DEFECTIVE TRANSFORMER	ISOLATE (REMOVE TAP CHANGE BARS) IF BREAKER STILL TRIPS, REPLACE TRANSFORMER
		DEFECTIVE SELENIUM STACK	ISOLATE, CHECK AND REPLACE IF FAILED
3	SECONDAY FUSE BLOWS OR CIRCUIT BREAKER TRIPS	OUTPUT TOO HIGH	LOWER OUTPUT
		SHORTED DIODE OR MODULAR BRIDGE	ISOLATE, CHECK AND REPLACE
		DEFECTIVE DC ARRESTOR OR SUPRESSOR	ISOLATE, CHECK AND REPLACE
		SHORT CIRCUIT 1N DC CABLES OR OUPUT CIRCUIT	ISOLATE, CHECK AND REPAIR

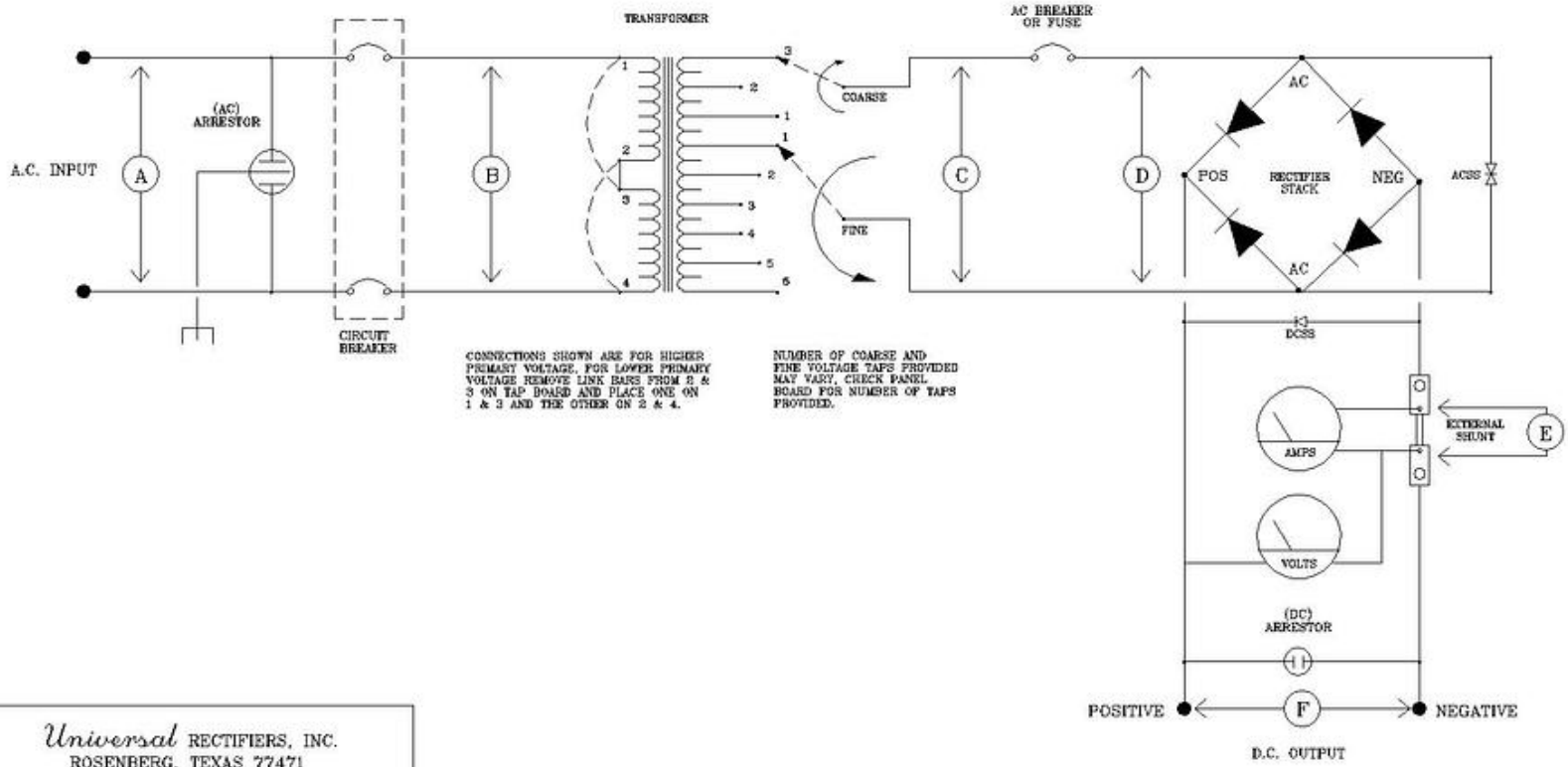
Universal RECTIFIERS, INC.

JOB AID CHECKPOINT READINGS FOR VARIOUS DC OUTPUTS

TYPICAL, NOMINAL VOLTAGE READINGS FOR JOB AID CHECKPOINTS. READINGS ARE APPROXIMATE FOR THE NORMAL DC OUTPUT (NOT FULL RECTIFIER RATING) WHEN THE UNIT IS "ON" AND OPERATING.

NORMAL OUTPUT VOLTS DC	SHUNT READING MILLIVOLTS TIMES SHUNT FACTOR WILL EQUAL AMPS DC	TRANSFORMER SECONDARY AC VOLTS	RECTIFIER STACK INPUT. AC VOLTS		
F	E	D	C	B	A
15 VDC	VARIABLE	20 VAC	20 VAC	LINE VOLTAGE	LINE VOLTAGE
20 VDC	VARIABLE	25 VAC	25 VAC		
25 VDC	VARIABLE	31 VAC	31 VAC		
30 VDC	VARIABLE	37 VAC	37 VAC		
35 VDC	VARIABLE	43 VAC	43 VAC		
40 VDC	VARIABLE	50 VAC	50 VAC		
45 VDC	VARIABLE	56 VAC	56 VAC		
50 VDC	VARIABLE	62 VAC	62 VAC		
60 VDC	VARIABLE	75 VAC	75 VAC		
70 VDC	VARIABLE	87 VAC	87 VAC		
80 VDC	VARIABLE	100 VAC	100 VAC		
90 VDC	VARIABLE	112VAC	112 VAC		
100 VDC	VARIABLE	125 VAC	125 VAC		

Universal RECTIFIERS, INC.



Universal RECTIFIERS, INC. ROSENBERG, TEXAS 77471	
DATE: 12-12-00	APPROVED BY:
SCALE:	DRAWN BY: MIKE LLAMAS
SINGLE PHASE TEST POINTS	FILE: 1500 NO. TEST POINTS