

I N S T R U C T I O N B O O K

F O R

~~MODEL~~
SERIES

8 9 3 0 - 4 0 0 A

T E R M A L I N E [®] W A T T M E T E R

BIRD

Electronic Corporation

30303 Aurora Road, Cleveland, Ohio 44139-2794

Copyright 1992 by Bird Electronic Corporation

SAFETY PRECAUTIONS

The following are general safety precautions that are not necessarily related to any specific part or procedure and do not necessarily appear elsewhere in this publication.

Keep away from live circuits.

Operating personnel must at all times observe normal safety regulations. Do not attempt to replace parts or disconnect an RF transmission or any other high voltage line while power is applied. When working with high voltage always have someone present who is capable of rendering aid if necessary. Personnel working with or near high voltage should be familiar with modern methods of resuscitation.

Warning: Warning notes call attention to a procedure which, if not correctly performed, could result in personal injury.

Caution: Caution notes call attention to a procedure which, if not correctly performed, could result in damage to the instrument.

The following will appear in the text of this publication and are shown here for emphasis.

```
*****
*                               C A U T I O N                               *
*                               *                                           *
* This equipment is designed for operation in only a *
* horizontal position, with mounting brackets down. *
* Do not operate in any other manner. *
*                               *                                           *
*                               pg 1 *
*****
```

Continued

* W A R N I N G *
* *
* Before placing the unit in operation, remove the *
* shipping plugs at the top of radiator, near front, *
* substitute with the specially shielded breather plugs. *
* Use a 3/4 inch flat wrench for this purpose - do not *
* lose the O-Ring seal. *
* *
* The vent holes must remain open at all times when the *
* unit is in operation or cooling. Failure to do this *
* could result in damage to the equipment and endanger *
* the operator's safety. The use of the vent plug also *
* protects the filler opening against intrusion of *
* foreign material while allowing unobstructed venting *
* of the tank. The shipping plugs (with O-Ring seals) *
* should be put back in place whenever the unit is to be *
* transported. Be sure to check these plugs. *
* pg 3 *

* W A R N I N G *
* *
* Never attempt to disconnect RF equipment from a *
* transmission line while RF power is being applied. *
* Leaking RF energy is a potential health hazard. *
* pg 9, 10 *

* C A U T I O N *
* *
* Without the blowers operating the continuous RF power *
* input is limited to 2500 watts. If the READY light is *
* off, do not exceed this value, regardless of the *
* selector switch position. *
* pg 9 *

* W A R N I N G *
* *
* When using dry cleaning solvents, provide adequate *
* ventilation and observe normal safety precautions. *
* Many dry cleaning agents emit toxic fumes that may be *
* harmful to your health if inhaled. *
* pg 12 *

Continued

* CAUTION *
*
* This unit is factory filled with approximately 6.7 *
* gallons (25.3 liter) of a specially selected *
* dielectric fluid, P/N 5-1070-3. No other coolant *
* should be used. *
* pg 14 *

TABLE OF CONTENTS

	Page
SAFETY PRECAUTIONS	i
INTRODUCTION	
Purpose and Function.....	vi
Performance Characteristics and Capabilities.....	vi
Dimensions and Weight.....	vii
Power and Utility Requirements.....	vii
Environmental Requirements.....	vii
Items Furnished.....	vii
Items Required.....	vii
Tools and Test Equipment.....	vii
SECTION I - INSTALLATION	
Mounting.....	1
Coupling Kits.....	1
RF Connection.....	1
Meter Placement.....	2
Thermoswitch.....	2
SECTION II - THEORY OF OPERATION	
General.....	5
Element Socket.....	5
Coupling Circuit.....	5
Dielectric Coolant and Seal.....	6
Cooling.....	6
SECTION III - OPERATING INSTRUCTIONS	
Use and Function of Controls.....	7
Initial Adjustment and Control Settings.....	7
Start-Up.....	8
Normal Operation.....	8
Operation Under Emergency, Adverse or Abnormal Conditions.....	8
Shutdown.....	9
Emergency Shutdown.....	9
SECTION IV - MAINTENANCE	
Troubleshooting.....	10
Cleaning.....	11
Inspection.....	11
Preventive Maintenance.....	12
Contact Adjustment.....	12

TABLE OF CONTENTS [CONT.]

	Page
Repairs.....	12
Unit Test.....	12
Disassembly.....	13
Reassembly.....	13
Coolant.....	13
 SECTION V - PREPARATION FOR RESHIPMENT	
General.....	14
 SECTION VI - STORAGE	
General.....	15
 SECTION VII - REPLACEMENT PARTS LIST	
General.....	16
 ILLUSTRATIONS	
3 1/8" Flanged Attachment.....	3
3 1/8" Unflanged Attachment.....	3
Thermoswitch Assembly (P/N 8890-017).....	4
Series 8930-400A Outline Drawing.....	18
Shipping Plug.....	19
Shielded Vent Plug Assembly.....	20
 TABLES	
Specifications for Series 8930-400A.....	viii

SERIES 8890-400 TERMALINE® WATTMETERS

INTRODUCTION

PURPOSE AND FUNCTION

The Series 8930-400A TERMALINE® Wattmeters are designed to be low reflection and nonradiating terminating wattmeters for 50 ohm RF coaxial transmission lines. They serve to aid in the tuning and trouble shooting of transmission equipment whose characteristics fall within the performance range of the elements. These performance specifications are described in the next paragraph and summarized on page viii.

PERFORMANCE CHARACTERISTICS AND CAPABILITIES

With the blower unit running, the Series 8930-400A Wattmeters are able to safely and continuously dissipate up to 10,000 watts of RF power. They will measure and indicate RF power applied within +8 percent of full scale from 54 to 890 MHz, on a meter for direct reading. It is possible to subject these wattmeters to moderately higher power for limited periods of time. The Series 8930-400A may be equipped with a thermoswitch, Bird P/N 8890-017, which would be interlocked with the source of RF energy. In this way, the load will be automatically protected from the consequences of over heating. The intended frequency range is 2 to 1000 MHz within which the loads will reflect very little power back to the source. The actual VSWR, "voltage standing wave ratio", will not exceed 1.15 to 1.00 max from 0 to 400 MHz, 1.2 to 1.00 max 400 to 1 GHz.

The blower unit of the Series 8930-400A operates with a set of three axial fans placed beneath the heat exchanger unit. These fans are controlled by a special thermoswitch inserted through the front face of the unit and into the dielectric medium. Use as a reject load is particularly appropriate as the fans will operate only when the extent of the RF loading is sufficient to increase the dielectric temperature enough to require forced air cooling. Continuous power rating of load without blower running is approximately 2500 watts.

The unique shape of the load housing is designed for maximum heat dissipation. This housing is filled with a specially selected dielectric coolant which carries the electrically produced heat of the load resistor to the walls of the housing by natural convection. Near the top close to the front of the unit, are two vent plugs to relieve the internal pressure resulting from expansion of the heated coolant. The RF input connection is on the lower front face of the unit. The wattmeters are designed for use with 3-1/8 inch rigid lines.

The front and rear blower housing panels are bent outward at 90° on the bottom to form mounting flanges. These flanges act as supports for free standing use or as mounting brackets for fixed installation. There are mounting holes provided in the flange for this purpose.

DIMENSIONS AND WEIGHT

The Series 8930-400A Wattmeters are 33-21/64 inches high x 9-1/2 inches wide and approximately 32-1/8 inches long (847 x 241 x 816 mm) with blower assembly. The length is dependent on the type of connector used on the different models. Exclusive of the connector, the length is approximately 29 inches (737 mm). The net weight is approximately 142 lb, (64.4 kg).

POWER AND UTILITY REQUIREMENTS

The blower assembly must be provided with an external source of power which can be either 115 Vac, 50/60 Hz or 230 Vac, 50/60 Hz. Each of the models of the Series 8930-400A is offered in two versions accordingly. No other utility sources are needed other than the RF input power.

ENVIRONMENTAL REQUIREMENTS

Although Series 8930-400A Wattmeters are ruggedly built and should provide trouble free service a dust and vibration free dry environment is preferred. The wattmeter will function according to its specifications as long as the ambient temperature remains within the range of -10°C to +45°C (14F to 113F), and its access to air is not impeded. It is recommended that a clear space of at least 12 inches (30 cm) be allowed around the load. Since the wattmeter absorbs and dissipates, as heat, all of the RF power it receives, no harmful RF radiation is released into the environment.

ITEMS FURNISHED

Series 8930-400A Wattmeters are prefilled with the proper amount of coolant at the factory. The coolant is sealed within the radiator by a special shipping plug. The shipping plug is to be replaced, before operating the wattmeter, by a vent relief valve which is attached to the wattmeter by a chain. The coupler for connecting the wattmeter to the coaxial transmission line is already mounted on the wattmeter. A meter in a housing with connecting cables the two thermoswitches, control and overtemp and this instruction book are the only additional parts furnished with all Series 8930-400A Wattmeters.

ITEMS REQUIRED

No additional equipment is required except for having an appropriate mating connector on the transmission line to which the wattmeter is to be connected. An ac socket must be provided convenient to the equipment.

TOOLS AND TEST EQUIPMENT

Only simple tools such as screwdrivers and box wrenches are needed for changing connectors, replacing the resistor element, changing the coolant, etc. For checking the resistor, a resistance bridge or ohmmeter with an accuracy of +1 percent, or better, at 50 ohms is suggested. A simple volt-ohm meter will suffice for checking the blower assembly and thermoswitch.

SPECIFICATIONS FOR 8930-400A TERMALINE® WATTMETERS

Impedance	50 ohms
VSWR	1.15-1.0 dc to 890 MHz
Connectors	
Model 8936-415A/420A.....	3-1/8" EIA flanged
Model 8897-415A/420A.....	3-1/8" unflanged (Flush center conductor)
Power Rating	
All models.....	10 kW continuous duty*
Frequency Range	54 to 890 MHz
NOTE - Actual frequency and power ranges are determined by the element used.	
Accuracy	±8% of full scale
Ambient Temperature	-10°C to +40°C (14F to 104F) storage 25°C ±5°C (77F ±9F) operating
Cooling Method	Liquid dielectric and convection currents**
Overall Dimensions	33-21/64"H x 9-1/2"W x 32-1/8"L (847 x 241 x 816 mm)
Length	
Flanged units.....	32-1/8" (816 mm)
Unflanged units.....	31-5/32" (791.4 mm)
Meter	4-11/64"L x 5-9/16"W x 6-1/2"H (106 x 141 x 165 mm)
Weight	142 lb (64 kg)
Meter	5 lb (2.27 kg)

SPECIFICATIONS FOR 8930-400A TERMALINE® WATTMETERS [CONT.]

Finish

Load and Metering Housing.....	Light navy gray baked enamel (MIL-E15090B)
RF Section.....	Bright silver plate

*Power rating with:
Blower running - 10 kW
Blower not running - 2.5 kW

**Assisted by forced draft when blower assembly is running.

SPECIFICATIONS FOR BLOWER ASSEMBLY

Power Supply.....	115 Vac, 50-60 Hz, or 230 Vac, 50-60 Hz (400 Hz units, special)
Supply Current.....	115 V, 2.5A maximum, 230 V, 1.275A maximum
Blower Capacity.....	1020 CFM - Free delivery Approximate 255 W input.

SECTION I - INSTALLATION

1-1. MOUNTING

```
*****  
*                               C A U T I O N                               *  
*                               *                                           *  
* This equipment is designed for operation in only a *  
* horizontal position, with mounting brackets down. *  
* Do not operate in any other manner. *  
*****
```

1-2. The Series 8930-400 TERMALINE® Wattmeters are equipped for either fixed installations or portable use. There are mounting brackets on the front and rear faces of the unit. The load may stand free or be attached to a bench, etc., by means of four suitable fasteners. Four 3/8 inch (9.5 mm) mounting slots, to be used with appropriate screw sets up to 3/8 inch diameter, are arranged in a 7 inch x 27-23/32 inch rectangle (178 x 704 mm). The wattmeter is installed in a 3-1/8 inch 50 ohm coaxial line where desired and the insertion coupling is feasible. Be sure that all exposed electrical surfaces, both on the metal contacts and insulators, are thoroughly clean and free of moisture before making the installation.

1-3. COUPLING KITS

1-4. The RF section is a length of matching 3-1/8 inch coaxial transmission line. For Models 8936-415A and 8936-420A the RF connector section have bolted flanges that are of the swivel type. It is inserted into the existing transmission line using a coupling kit, P/N 4600-020.

1-5. For Models 8937-415A and 8937-420A the RF connector section is unflanged. It is inserted into the transmission line using an unpressurized straight coupling kit, P/N 5-726.

1-6. RF CONNECTION

1-7. For the models with flanged RF connectors, Models 8936-415A and 8936-420A wattmeters, the center conductor anchor bullets, P/N 4600-021, mate with the center conductor of the 3-1/8 inch 50 ohm coaxial transmission line. This line should be fitted with 3-1/8 inch EIA bolt-type flanges, see figure 1-1. It is permissible for the mating flanges of the stationary line to be of the rigid type because the connector section has a swivel type flange. Before fitting bolts to the coupling flanges, make sure that the center conductor anchor bullets have been positioned with insulators properly seated in the counterbores. Use six suitable screw and nut assemblies for attachment, 3/8-16 x 1-1/2 nut and screw assemblies are recommended. Tighten evenly all around to get a firm and uniform contact on the periphery of the outer conductor of both flanges.

1-8. For the models with unflanged connectors, Models 8937-415A and 8937-420A Wattmeters, the connector bullets mate with the center conductor of the 3-1/8 inch 50 ohm coaxial transmission line. Insert the bullet in the center conductor of the wattmeter's connector and push firmly in until it bottoms. Slide the outer conductor sleeves over the transmission line first and then insert the connector into the transmission line, see figure 1-2. Both ends of the bullet should be firmly seated in the center conductor with the connector of the wattmeter butted snugly against the transmission line. Then slide the outer sleeve over the junctures of the connector and the transmission line and tighten the clamping band screws to complete the installation.

1-9. METER PLACEMENT

1-10. A standard ten foot (3 meter) cable is supplied with each wattmeter and is equipped with a dc connector plug on one end and lugs on the other. Alternate lengths are available on request. Connect the dc cable plug to the jack on the measuring element socket. Make certain that the connection is tight and clean to ensure accurate readings, see Section IV - Maintenance. The meter may be placed anywhere within the reach of the dc cable, but avoid locations that are dusty or subject to temperature extremes.

1-11. THERMOSWITCH

1-12. The wattmeters is provided with an interlock thermoswitch assembly, P/N 8890-017. Installed in the back of the radiator, it will prevent possible damage occurring from accidental transmitted power overload or equipment malfunction. Being normally closed, the thermoswitch opens at a maximum safe coolant temperature. Connected in series with the transmitters interlock, it cuts off transmitter power if the coolant temperature exceed this value. The assembly consists of a thermoswitch body, P/N 8890-015 with a coupling jack, P/N 2450-018 attached.

```
*****
*                                     W A R N I N G                                     *
*                                                                                       *
* Before placing the unit into operation, remove the                               *
* shipping plug at the top of radiator, near front,                               *
* substitute with the specially shielded breather plugs.                          *
* Use a 3/4 inch flat wrench for this purpose - do not                            *
* lose the O-Ring seal.                                                            *
*                                                                                       *
* This vent holes must remain open at all times when the                          *
* unit is in operation or cooling. Failure to do this                              *
* could result in damage to the equipment and endanger                            *
* the operator's safety. The use of the vent plugs also                          *
* protects the filler opening against intrusion of                                *
* foreign material while allowing unobstructed venting                            *
* of the tank. The shipping plugs (with O-Ring seals)                             *
* should be put back in place whenever the unit is to be                         *
* transported. Be sure to check these plugs.                                       *
*****
```

FIGURE 1-1. 8936-415A/420A, 3-1/8 INCH FLANGED ATTACHMENT

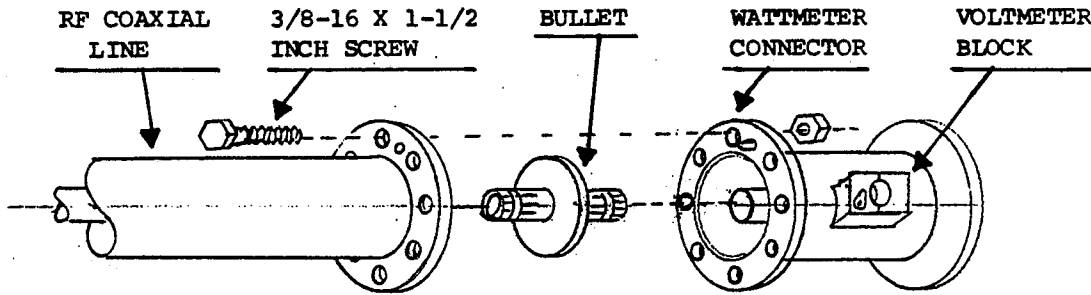
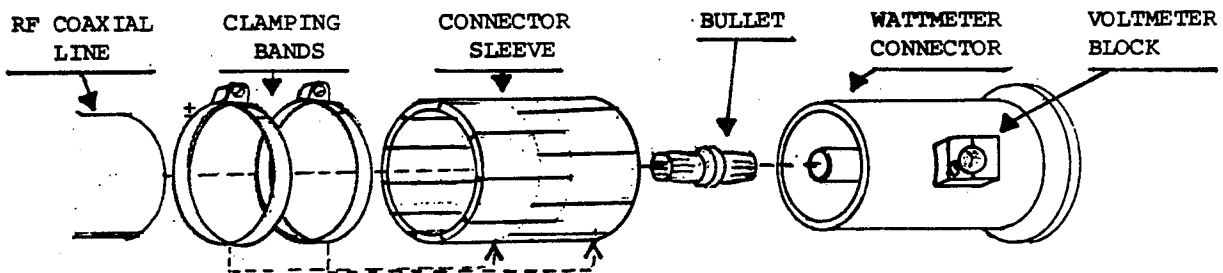


FIGURE 1-2. 8937-415A/420A, 3-1/8 INCH UNFLANGED ATTACHMENT



1-13. If a thermosthich is to be replaced or field installed, proceed as follows:

- a. Replace the vent plugs with the shipping plugs first. Then stand the unit on its front end with the connector down. In this position there is no danger of the coolant pouring out through the rear socket plug hole.
- b. Using a 9/16 inch Allen wrench, remove the socket plug from the center of the back panel.
- c. Replace the plug with the thermosthich. Use an acceptable pipe sealing compound sparingly on the external threads only of the thermosthich. Do not contaminate the coolant with pipe sealing compound. Observe closely for coolant leaks upon completion.

1-14. Connect the thermosthich as follows: (See reference photo figure 1-3).

- a. Unscrew the larger knurled ring-nut (A) at the lower end of the coupling jack assembly. Pull it off from the thermosthich jack (B). Unscrew the small knurled cover fitting (C) from the base plug (D) of the connector to release the base.
- b. Thread the interlock wires through the clamp (E) with the washers (F) inside and with its threaded fitting in place. Service the interlock wire with short tips, use spaghetti sleeves over the wire ends if needed. Then securely solder the interlock leads to the lugs (G) of the connector base. Note - Be sure that the larger captive clamping nut (A) is in place over the base plug (D) with the knurled end outward towards face.
- c. Screw on the cover ring (C) first, then fasten the cable clamp (E) in place, and tighten the two yoke screws (H) on the cable. Push the plug back on to the thermosthich, and tighten the captive knurled connecting ring. Do not attempt to operate the equipment without the interlock attached.

FIGURE 1-3. THERMOSTHICH ASSEMBLY

SECTION II - THEORY OF OPERATION

2-1. GENERAL

2-2. The Series 8930-400A equipment consists essentially of a film-on ceramic resistor immersed in a dielectric coolant. The resistor, which is individually selected for its accuracy is enclosed in an exponentially tapered housing, providing a reduction in surge impedance directly proportional to the distance along the resistor. When the resistor unit is immersed in dielectric liquid, the characteristic impedance will be 50 ohms at the connector end and graduate down from there to zero ohms at the rear, where the resistor joins the housing to form the return conductor of the coaxial circuit. This produces a uniform, practically reflectionless line termination over the stated frequencies of the wattmeter.

2-3. ELEMENT SOCKET

2-4. An accurately positioned socket for inserting a radio frequency coupling device, called a THRULINE[®] Plug-In Element, is mounted on the outer conductor of the input connector. The socket is precision bored to hold the rotatable element in its calibrated position, with a spring-loaded clasp to keep the element firmly seated. The machined step on the top face of the socket engages a stop-pin on the element. Rotary movement of the element is thereby restricted to 180° and is stopped on the axial center line.

2-5. The measuring socket has a hole bored through the wall through which an insulated phosphor bronze contact finger projects. The plug-in element has terminals on diametrically opposite sides of its body, so that pick-up can be made from either side. A small silvered button tip can contact the element only in the precise forward and reflected measuring position (against the end stops). A specially designed jack mounted on the side of the socket mates with the plug on the dc cable furnished with the read-out meter. The dc jack assembly has a built-in filter capacitor shunted across the meter circuit. This more fully protects meter readings against the adverse effects of any stray RF energy generated in the plug-in element.

2-6. COUPLING CIRCUIT

2-7. The coupling circuit which samples the travelling waves is in the plug-in element. Energy will be produced in the coupling circuit of the element by both mutual inductance and capacitance from the travelling RF waves of the line section. Of course, the inductive currents will flow according to the direction of the travelling waves producing them.

2-8. The capacitive portion of these currents are naturally independent of the direction of the travelling waves. Therefore, it is apparent that the inductive portion of the current produced from the waves of one direction will add in phase to the capacitive portion of the current, and those of the opposite direction will subtract in phase. Of course, the additive direction is the forward or arrow direction of the element.

2-9. DIELECTRIC COOLANT AND SEAL

2-10. The dielectric coolant, a low volatility, high flash point synthetic oil, is chosen for its desirable thermal characteristics and dielectric properties, to which the diameters of the resistor housing are matched. A synthetic rubber O-Ring around the outside of the resistor housing mount furnishes a seal for the radiator opening. A beveled flange retains the O-Ring which is pressed against the radiator face by the action of drawing up on the radial V-band clamp around the flange.

2-11. COOLING

2-12. When input power is applied, the resistor generates heat which is absorbed by the surrounding dielectric coolant. By convection, the heated oil flows through holes in the coaxial shell to the walls of the radiator tank. The radiator is carefully designed of heat-sink sections on a unique vertical rhombic form and is fabricated into a single unit construction. This provides a very high efficiency in transferring heat from the dielectric coolant into the surrounding air.

SECTION III - OPERATING INSTRUCTIONS

3-1. USE AND FUNCTION OF CONTROLS

3-2. There are no operating controls required for Series 8930-400A TERMALINE® Wattmeters, only the manual/automatic switch. Measurements are made by the insertion and operation of the plug-in elements previously mentioned. The elements will have a power range that corresponds with one of the scales on the meter face, and the major markings are the power values for that element. Elements are also marked for frequency range. The transmitter power and frequency must be within the limitations of the element used.

3-3. The arrow on the plug-in element indicates the sensitive direction; i.e., the direction of power flow which the meter will read. Forward and reflected are directional terms used in reference to the THRULINE® Element, and mean respectively the sensitive and null directions of the element. Rotate the element 180° to reverse the sensitive direction. Forward and reflected also are directional terms used in reference to the source-load circuit.

3-4. INITIAL ADJUSTMENTS AND CONTROL SETTINGS

3-5. The wattmeter is ready for connection as received from the factory, but it may be useful to check the 50 ohm input resistance of the load before attachment, see Section IV, Maintenance. Be sure the vent plug is installed, (See figure 7-2 and 7-3).

3-6. Wipe all conductors and insulator surfaces on the transmission line face with a clean soft cloth and check the RF input connector. Use a self-drying, nonresidue forming contact cleaner on the inaccessible portions of the connector, if necessary.

3-7. Attach the respective wattmeter models to the RF line as follows. Use the connector kits as listed:

1. Model 8936-415A/420A - 3-1/8 inch EIA flanged, 50 ohms. Coupling Kit, P/N 4600-020 - 3-1/8 inch EIA which includes: (6) 3/8-16 x 1-1/2 screw and nut sets, O-Ring, and anchor bullet center conductor.
2. Model 8937-415A/420A - 3-1/8 inch unflanged 50 ohms flush center conductor. Coupling Kit, P/N 5-726 which includes: outer sleeve with two clamping bands and the coupling bullet center conductor. Make sure all connections are properly tightened. Avoid unnecessary use of adapters and elbows as much as possible. After the wattmeter has been properly installed on the transmission line attach the dc connector cable from the element socket to the meter.

3-8. **START-UP**

3-9. Proceed according to the instructions pertaining to the specific transmitting equipment. Due to the difference in VSWR between the dummy load and the transmitter's antenna, readjustment of the transmitter may be required when returning to the original antenna.

```
*****  
*                               W A R N I N G                               *  
*                                                                                   *  
* Never attempt to disconnect the equipment from the                       *  
* transmission line while RF power is being applied.                         *  
* Leaking RF energy is a potential health hazard.                            *  
*****
```

3-10. **NORMAL OPERATION**

3-11. Since there are no operating controls or adjustments, these wattmeters do not require hands-on attention. They should function faultlessly converting RF energy into heat for indefinite periods providing their power capacity is not exceeded.

3-12. Before taking readings be sure that the meter pointer has been properly zeroed under zero power conditions. Direct power readings are made from the wattmeter dial.

3-13. Insert the appropriate element in the socket of the line section and rotate the element so that the arrow on its nameplate is pointed away from the RF source for forward power and towards the source for reflected power. Turn on the RF source and read the power level from the appropriate meter scale.

3-14. **OPERATION UNDER EMERGENCY, ADVERSE OR ABNORMAL CONDITIONS**

```
*****  
*                               C A U T I O N                               *  
*                                                                                   *  
* Without the blowers operating the continuous RF power                       *  
* input is limited to 2500 watts. If the READY light is                       *  
* off, do not exceed this value, regardless of the                           *  
* selector switch position.                                                  *  
*****
```

3-15. The elements for the THRULINE® Wattmeter can withstand at least a 20 percent, of full scale, overload. The meter pointer will be deflected off scale, during overload conditions, but generally no damage to the meter movement will occur. This, however, is not a very propitious condition and should be avoided. This usage will, nevertheless, give an indication of the magnitude of power flow.

3-16. Series 8930-400A Wattmeters are not intended or recommended for outdoor use where they may be unprotected and exposed to the element. They may be subjected to moderate overloads for limited periods without over heating. However, this should be done cautiously and it is strongly

recommended that if such use is contemplated, the interlock thermoswitch should be properly connected. When interlocked with the power line of the source of RF energy, the thermoswitch becomes a fail safe device to guard the load against the dangers of overheating.

3-17. SHUTDOWN

3-18. Because these wattmeters are passive devices and the cooling fans operate automatically, there is no way to turn them off. The RF source must be shut off instead. The blower fans will turn off automatically as the wattmeter cools.

3-19. EMERGENCY SHUTDOWN

```
*****  
*                               W A R N I N G                               *  
*                                                                                   *  
* Never attempt to disconnect the equipment from the                       *  
* transmission line while RF power is being applied.                         *  
* Leaking RF energy is a potential health hazard.                           *  
*****
```

3-20. In case of an overload, it is possible to rotate the element to the midpoint between the forward and reflected positions and thereby electrically decouple the element from the center conductor and shut the meter movement. For safety's sake do not attempt to remove the element while RF power is still flowing through the line section.

SECTION IV - MAINTENANCE

4-1. TROUBLESHOOTING

4-2. As a brief guide to the operator in isolating occasional difficulties that may occur in the use of the wattmeter, the following summary is included. The remedies for some are reference to the text in this section or are self-evident.

PROBLEM	POSSIBLE CAUSE	REMEDY
No meter indication	No RF power	Check RF source.
	Arrow on plug-in element pointed in wrong direction	Re-position element.
	No pick-up from dc contact finger	Adjust, (see para 4-13, Contact Adjustment).
	Open or short circuit in dc meter cable	Replace defective cable (RG-58/U).
Intermittent or inconsistent meter readings	Meter burned out or damaged	Return wattmeter and elements to the factory for meter replacement and recalibration.
	Faulty transmission line	Inspect line.
	Faulty load	Check load.
	Dirty dc contact on elements	Clean, (see para 4-3, Cleaning).
Excessive reflected power (as indicated by wattmeter)	Sticky or defective meter	Return wattmeter and elements to the factory for meter replacement and recalibration.
	Resistor element damaged	Test resistor for resistance value (see para 4-17, Unit Test).
	Insufficient dielectric fluid	Check coolant level and add coolant if necessary (see para 4-23, Coolant).

TROUBLESHOOTING [CONT.]

PROBLEM	POSSIBLE CAUSE	REMEDY
Leaking dielectric fluid	Worn or defective O-Ring seal	Replace O-Ring.
	Loose clamping band	Tighten clamping band.

4-3. CLEANING

```

*****
*                               W A R N I N G                               *
*                               *                                           *
* When using dry cleaning solvents, provide adequate                       *
* ventilation and observe normal safety precautions.                       *
* Many dry cleaning agents emit toxic fumes that may be                 *
* harmful to your health if inhaled.                                       *
*****

```

4-4. The outside surface of the instrument should be wiped free of dust and dirt when necessary. Excessive collection of dust and lint on the cooling fins will interfere with the efficient dissipation of heat. Clean the RF input connector with a self-drying, nonresidue forming contact cleaner. Take special care to clean the metallic contact surface and the exposed faces of the teflon insulator.

4-5. It is particularly important to keep the mating surfaces of the socket and plug-in element clean. This applies not only to the bore of the socket and circumference of the element body, but most particularly to the bottom rim of the element body and the seat at the base of the socket in the line section. Also check the ends of the insulated dc contacts on the element. They should be clean and smooth. These parts can be carefully cleaned with a soft cloth and contact cleaner as mentioned. There must be a good contact between the base of the plug-in element and its socket to assure stable operation.

4-6. INSPECTION

4-7. Inspect the line from time to time for cleanliness and proper adjustment, (see paras 4-3, Cleaning and 4-9, Preventive Maintenance). Make sure all connections are clean and tight. disconnect the meter lead and check the zero setting without power, adjust if necessary.

4-8. Periodically inspect the clamping band around the connector and also around the thermoswitch, if the load is so equipped, for signs of possible coolant leakage, (see para 4-12, Preventive Maintenance) for proper action. Check the connector assembly for tightness. Inspect the cooling fins for accumulation of dust and lint and the painted metal parts for signs of corrosion.

4-9. PREVENTIVE MAINTENANCE

4-10. With the simple construction and generally self-contained nature of the wattmeter, there is only a moderate amount of maintenance required. One of the major precautions is in handling: Use reasonable care and do not drop the equipment or especially the plug-in elements.

4-11. The main factor in maintenance is care and cleanliness. The element socket should be kept plugged as much as possible to prevent the intrusion of dust. If a plug-in element is to be used for this purpose, use the highest power element available. The element should be positioned so that the arrow is pointing midway between the forward and reflected measuring positions. This will not only protect the meter but will also avoid exposing the element diode to dangerous potentials if the RF line section should be energized.

4-12. If there are signs of coolant leakage around the clamping band try tightening it. If the leakage persists, it is likely that the O-Ring seal is damaged or deteriorated. Replace it, (see para 4-20, Disassembly). Wipe the cooling fins clean of accumulated dust and lint in order to preserve their efficiency in transferring heat to the environment. If signs of corrosion appear on the painted metal surfaces, sand the patches clean of rust and then reseal them with touch-up paint.

4-13. CONTACT ADJUSTMENT

4-14. In cleaning the socket bore, the operator should be careful not to disturb the spring finger of the dc contact. It is important that the operating position of this part be properly maintained. If the spring finger of the dc contact requires adjustment, it may be done manually if carried out with care. The tip must be positioned far enough out to maintain good contact with the element, but not so far as to interfere with easy entry of the element body. The dc jack, with attached spring finger, may be detached for service by removing the two 4-40 fillister head machine screws which fasten it to the side of the RF line section. Then lift off the jack assembly carefully to avoid losing the small teflon insulating bead that straddles the base of the phosphor bronze spring and nests in the counterbore on the side of the RF body. When replacing the assembly, be sure that the bead is again properly inserted.

4-15. REPAIRS

4-16. As indicated in para 4-13, Disassembly, the resistor element is not subject to field repair and must be replaced if it is found to be defective. Similarly if the RF connector in the Series 8930-400A is damaged it must be replaced.

4-17. UNIT TEST

4-18. Accurate dc measurement of the input resistance will provide a good check of the condition of the load resistor. For this measurement, a resistance bridge or ohmmeter with an accuracy of 1 percent or better at 50 ohms should be used. Use low resistance leads, preferably a short piece of 50 ohm cable with clips which can attach to the input connector of the

wattmeter. When the resistor is checked at room temperature, the measured resistance should be within a range of 49 to 52.5 ohms. If the value materially exceeds this allowance, the load resistor may need replacement.

4-19. DISASSEMBLY

4-20. To change the load resistor assembly, place the unit on its back end, connector up, and loosen the 10-32 x 1-1/2 inch screw on the clamping band. When lifting the radiator front, be careful to keep its top side always face up. The vent hole at the radiator top is so placed that, when the equipment is up-ended in this manner, the coolant level will be just below the vent hold and will not spill out. Remove the clamping band, and lift the load resistor assembly out of the tank, allow coolant to drip back into the tank. This unit is not subject to further disassembly by field maintenance, and a defective unit should be returned to the factory, along with the meter and elements, for repair, replacement, and recalibration. Before replacing the RF assembly, be sure that the O-Ring seal is in good condition. It should be free of surface cracks and twists and be positioned evenly all around the beveled flange of the resistor housing. If not, replace it.

4-21. REASSEMBLY

4-22. To reassembly the load after replacing the resistor or the coolant reverse the procedure, (see para 4-20, Disassembly).

4-23. COOLANT

4-24. The level of the dielectric coolant should remain constant in the unit even after prolonged usage under normal operating conditions. Inspect occasionally around the lower portion of the clamping band, for possible coolant leakage. Tighten the clamping screw if required. Under very unusual conditions it might become necessary to replace the resistor housing seal O-Ring (see para 4-19, Disassembly).

```
*****  
*                               C A U T I O N                               *  
*                               *                                           *  
* This unit is factory filled with approximately 6.7 *  
* gallons (25.3 liter) of a specially selected dielectric *  
* fluid, P/N 5-1070-3. No other coolant should be used. *  
*****
```

4-25. Check the coolant level by placing the load on end with the input connector up. As above, remove the load resistor assembly. When the unit is at ambient room temperature, the coolant level should be 4-3/4 inch (120 mm) below the top surface of the load resistor assembly mounting ring.

4-26. When the coolant oil is heated, thermal expansion will cause an increase in the internal pressure. The vent plug installed on the topside of the radiator tank is provided to relieve this pressure while protecting the opening from possible entry of dirt or other contamination.

SECTION V - PREPARATION FOR RESHIPMENT

5-1. GENERAL

5-2. If the occasion arises for the shipment of a Series 8930-400A Wattmeter, the following steps should be taken:

a. Remove the vent plugs and substitute with the special shipping plugs, see Section I - Installation. The vent plugs and shipping plugs are attached to each other by a short length of bead chain. Wrap the vent plugs with padding and tape it to the side of the load for protection. With the shipping plug installed, it is not necessary to empty out the coolant.

b. After disconnecting the wattmeter from the transmission line wrap the connector with padding for its protection.

c. The elements may be left in the sockets of the line section with their arrows turned midway between the measuring positions. Two additional elements can be placed in the storage sockets in the sides of the meter housing. Any additional elements should be well padded and wrapped before being placed in the shipping container.

d. Pad and wrap the dc connector plugs and then coil the cables tightly. For convenience tape them on the back of the meter housing.

e. Cover the meter face with padding to protect the glass window, then wrap the housing and place it in the same container as the wattmeter.

f. Because of the size and weight of the wattmeter it is recommended that the wattmeter be packed and braced in a sturdy wooden crate for shipment.

SECTION VI - STORAGE

6-1. GENERAL

6-2. If it should become necessary to store the wattmeter for any length of time no special preparation is necessary. The vent plug is designed to normally remain closed and therefore no coolant should evaporate during even lengthy storage. The connector, see Section V - Preparation for Reshipment, should be wrapped and sealed to prevent dirt from entering. It is also suggested that the load housing be covered to prevent the accumulation of dust on the cooling fins. The storage environment should be clean, dry and as dust-free as possible and the ambient temperature should be kept preferably within the -10°C to $+40^{\circ}\text{C}$ ($+14^{\circ}\text{F}$ to $+104^{\circ}\text{F}$) working range of the instrument.

SECTION VII - REPLACEMENT PARTS LIST

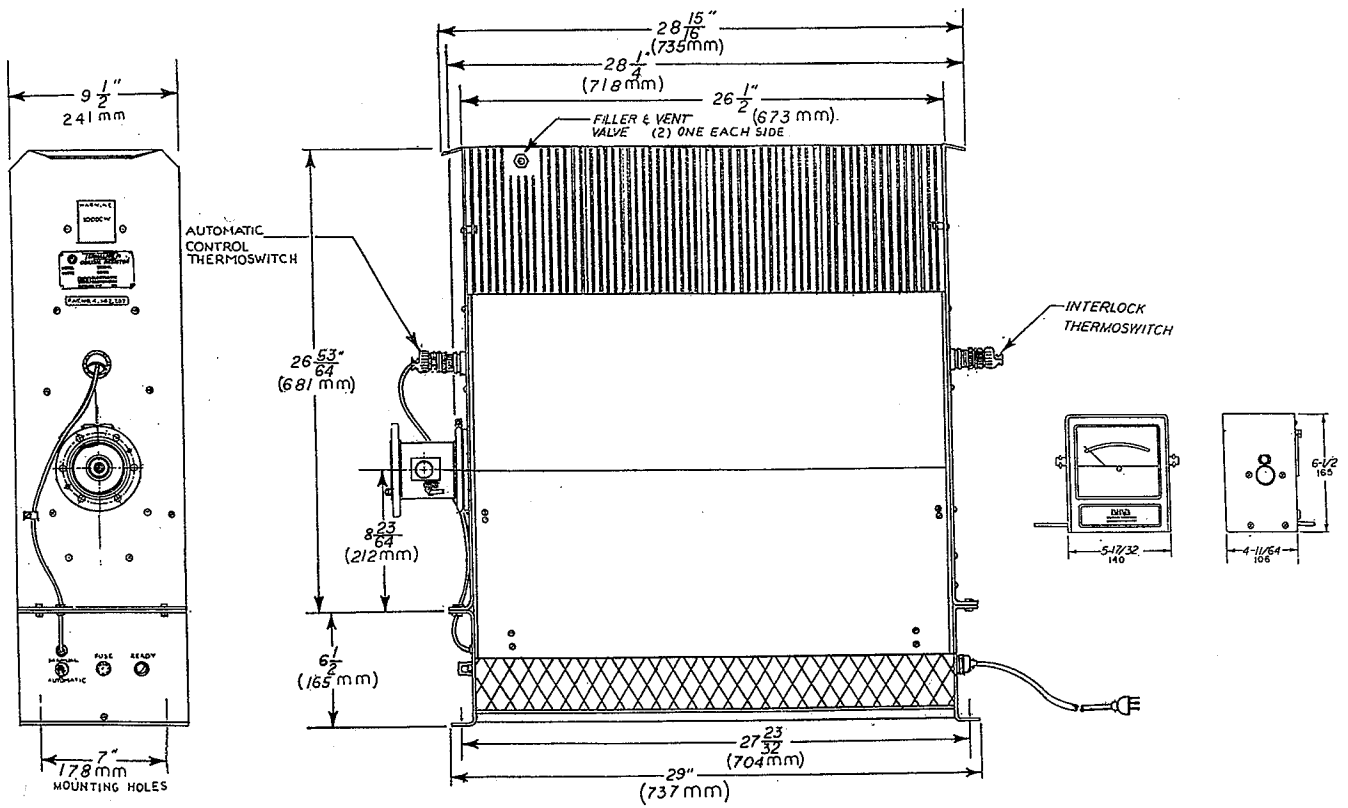
7-1. GENERAL

ITEM	QUANTITY	DESCRIPTION	PART NUMBER
1	1	RF section assembly	
	1	Series 8936-415A/420A	8936-417
	1	Series 8937-415A/420A	8937-417
2	1	O-Ring, resistor housing seal (Also included with item 1)	5-230
3	1	Clamping band assembly (2430-043 & Screw)	2430-055
4	1	O-Ring, breather seal	5-504
5	1	Vent plug assembly	2450-094
6	1	O-Ring, shipping plug	5-504
7	1	Plug, shipping	2450-049
8	1	Thermoswitch assembly, overtemp (includes 9 & 10)*	8890-017
9	1	Body, thermoswitch (goes with item 8)	8890-015
10	1	Jack, thermoswitch (goes with item 8 and 17)	2450-018
11		Dielectric liquid, 6.7 gallons (25.3 liter)	5-1070-3
12	1	Radiator, assembly	8921-002
13	1	DC connector assembly	4230-010
14	1	DC connector plug	7500-076
15	1	Meter assembly	2150-230
16	1	Meter housing assembly	6810-241
17	1	Thermoswitch assembly, control fan (includes items 10 & 18)	8892-333
18	1	Body, thermoswitch (use with item 17)	8892-334
19	1	Blower assembly	
		115 V model	8931-101-1
		220 V model	8931-101-2

REPLACEMENT PARTS LIST [CONT.]

ITEM	QUANTITY	DESCRIPTION	PART NUMBER
20		Side panel assembly	8931-103
21		Blower base grill guard	8931-106
22		Baffle edge "U" strip 20-5/8"L	5-300-2
23	8	10-32 x 3/8" Phillips truss head machine screw panel grille	Standard
24	4	10-32 x 1/4" Phillips truss head machine screw radiator end to panel bracket	Standard
25	3	Blower fan 115 V - 50/60 Hz, 85 W (340 CFM) 2.2A 230 V - 50/60 Hz, 85 W (340 CFM) 1.1	5-740-1 5-740-2
26	1	Fan serviced Front position 115 V/220 V Middle position 115 V/220 V Rear position 115 V/220 V	8931-127-1/-2 8931-128-1/-2 8931-129-1/-2
27	1	Resistor dropping 115 V 230 V	8931-113-1 5-097-8
28	1	Midget socket base	5-748
29	1	Fuse holder	5-547
30	1	Fuse (3AG,5A)	5-342-5
31	1	READY light, indicator	5-860
32	1	Terminal strip - 7 post	5-048-7
33	1	Toggle switch - SPST	5-1069
34	16	10-32 x 7/8 truss head machine screw with nut & washer	Standard
35	1	AC line supply cable 115 V 230 V	8950-023-1 8950-023-1

FIGURE 7-1. SERIES 8930-400AS OUTLINE DRAWING



MODEL 8936-425A ILLUSTRATED

FIGURE 7-2. SHIPPING PLUG - Remove and replace with vent plug when load is in operation

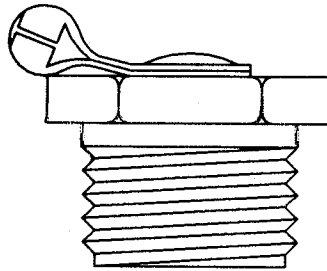


FIGURE 7-3. SHIELDED VENT PLUG ASSEMBLY - Must be installed in place of shipping plug when load is put in operation.

