

OPERATIONS MANUAL
FOG DETECTION SYSTEM

MOD. VR-13

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INTRODUCTION

PURPOSE

The Model VR-18 fog detection system was developed by Oregon State University for the U. S. Coast Guard so that several 13th Coast Guard District stations can detect fog at their harbor entrance at night or when observation tower is unmanned.

TYPE

An infrared thermometer remotely senses water temperature at the harbor entrance. This temperature is displayed on a meter at the station communications panel. If the entrance is obscured by fog, air temperature will be sensed and displayed. The displayed temperature is compared to existing air and water temperature readings from independent sensors to infer the presence or absence of fog. The system requires 110v, 60 hz, single phase power at 1 amp to the sensor unit and 1/4 amp to the display unit.

APPLICATION

The sensor unit should be mounted close to the harbor entrance (within 1 mile) and as high above the water as possible (100-150 feet). A Coast Guard observation tower with a good overview of the entrance is recommended. The display unit should be located at the communicator's panel.

THEORY OF OPERATION

The presence or absence of fog is inferred by remotely sensing surface temperature changes at the harbor entrance. The Barnes Instatherm radiometer operates on the principle that energy is emitted by all objects in proportion to their temperature. The Instatherm collects this energy using a fixed focus optical system and a sensitive thermal detector. The signal is amplified and displayed as a temperature.

The Instatherm is installed in a temperature-stabilized water-tight fiberglass equipment enclosure mounted on the Coast Guard observation tower. Its optical axis is aimed at the water near the harbor entrance - generally the jaws of a two-jetty system and about one mile from the tower. A metal sector reticle just outside the enclosure rotates at 1 rpm, so that the radiometer alternately looks at the reticle and the water. In the absence of fog, the output signal of the radiometer will be proportional to either the reticle (air) or water temperature depending on the reticle position. The signal is transmitted by landline to the communicator's position in the operations room of the Coast Guard station. The communicator already has readouts for air and water temperature on his panel from independent sensors previously installed.

Without fog, the air/water temperature difference seen by the radiometer and the independent sensors will be approximately equal. With fog, the independent sensors still measure air and

water temperatures, but the radiometer output varies only slightly from the air temperature value as the reticle rotates, because fog and light drizzle droplets fill much of the aperture of the radiometer and radiate at air temperature.

The system enables the watchstander at the communications panel to be warned of fog occurrence and to take whatever operational steps are indicated by the information.

EQUIPMENT

SENSOR UNIT

The sensor unit is housed in a 16 by 14 inch fiberglass instrument enclosure with stainless steel hinges and latches and a neoprene gasket. MS connectors are used for the input and output connections. Outside screw holes are sealed with silicone grease.

The Instatherm radiometer remotely senses the heat given off by a distant body. Its field of view is 2.8° or about 100 yards wide at a distance of one mile; its temperature range is -10 to 60°C (14 to 140°F) with a sensitivity of $\pm 0.2^\circ\text{C}$ (0.5°F) in the 6.5 to 20 micron band of wavelengths. Recorder output is 0-1v at 10,000 Ω impedance. The Instatherm radiometer is mounted in the center of a stainless steel panel with the reticle drive motor and shaft above. Space between the panel and enclosure has been filled with a short PVC pipe and sealant, to reduce enclosure internal heat loss. The motor shaft has been extended to provide about $3/4$ inch clearance between enclosure and the sector reticle.

The power supply circuit board uses both a positive and negative voltage regulator chip to convert $\pm 15\text{v}$ to $\pm 9\text{v}$. Clips are used to connect to existing 9v battery clips in the Instatherm battery pocket. A thermostat activates a 25 watt power resistor to provide a stabilized temperature in the enclosure. An on/off switch controls motor, power resistor and power supply.

The aluminum reticle, 1/16" thick and about 7 1/2" in diameter, is large enough to cover the entire viewing port. The outer 2" of the reticle has been painted flat black only on the side facing the enclosure, to reduce reflections of external radiation into the Instatherm optics.

DISPLAY UNIT

The display unit consists of a cabinet, meter and circuit board. A 4 1/2 inch meter with scale markings of 30-70°F is used. A BNC female connector is provided on the back panel for the input signal. A ± 15 v power supply and operational amplifier with associated circuitry amplify the incoming signal. A potentiometer, labeled AIR TEMP SET on the front panel, is used to adjust the meter to ambient air temperature as indicated by the independent air temperature meter.

INSTALLATION

SENSOR UNIT

The sensor enclosure should be mounted on a Coast Guard tower overlooking the channel entrance. The enclosure can be securely mounted to an existing railing by using aluminum channel bars, hose clamps and bolts.

Coat aluminum MS connectors with silicone grease to retard corrosion. Connect neoprene covered AC power cord and shielded signal cable (coax) to connectors provided. Check a telephone cable pair from tower to operations room for continuity. Strap the output signal cable to this pair. Plug in AC power cord, turn ON. Check operation of motor and power supply. Set the thermostat to about 75°F. Secure power cord and signal cable to tower to prevent wind damage.

Stop the reticle motor when radiometer field of view to water is clear. Sight through the viewer with reticle removed and aim for a body of water near the harbor entrance. Avoid jetties, beaches and large outcroppings in the line of sight. A few hundred yards to one side of a jetty is adequate.

DISPLAY UNIT

Mount display unit with meter on communications panel. Connect coax cable to INPUT BNC connector but do not connect to telephone terminal block yet.

CALIBRATION

SENSOR UNIT

Turn ON unit and make sure reticle is turning. Check operation of power supply by turning radiometer function switch to Batt 1 and Batt 2. Needle should read in upper black portion of scale. If not, use a voltmeter and adjust 5K pots on power supply circuit board to give +9v and -9v output. Pull Instatherm calibration shutter OUT to cover optics and turn function switch to CAL. Read and remember temperature indicated on radiometer. Turn function switch to TEMPERATURE position. Adjust temperature control knob to right of function switch to indicate same temperature value as when on CAL position. Push shutter all the way back IN.

The temperature of the reticle (air) and water should now be indicated alternately on the radiometer. Close enclosure cover and latch. The next day, after enclosure temperature has stabilized, re-check calibration of Instatherm and adjust if necessary.

DISPLAY UNIT

The gain pot on the circuit board has been set to indicate the correct range of temperatures by laboratory test prior to field installation. The air temperature set pot on the front panel does not affect gain.

Check output of sensor unit at telephone block for $\sim +0.3v$. Connect center conductor of coax leading to display unit to

positive side and coax shield to negative side. Turn unit ON. Set meter to ambient air temperature. Gain should be re-checked after field installation as the reticle turns, using values derived from independent sensors for air and water temperature. Adjust gain pot for correct readings, if necessary. Replace cover.

OPERATION

The presence of fog can be inferred by a small difference between left and right swings on the radiometer with a much larger difference between the independent air temperature and water temperature values. Note that the independent water temperature reading is influenced by the tidal stage in the bay; at ebb or low tide, the indicated water temperature meter may be closer to the bay temperature than the nearshore ocean temperature.

MAINTENANCE

SCHEMATICS

Figure 1 is a schematic of the sensor unit, while Figure 2 shows the location of the various components. Figure 3 shows the front of the sensor unit, Figure 4 is a schematic of the display unit pictured in Figure 5.

PARTS LIST

Table 1 is a list of replaceable parts for both the sensor and display units.

FIG. 1
FOG DETECTION MODEL VR-IB SENSOR UNIT SCHEMATIC

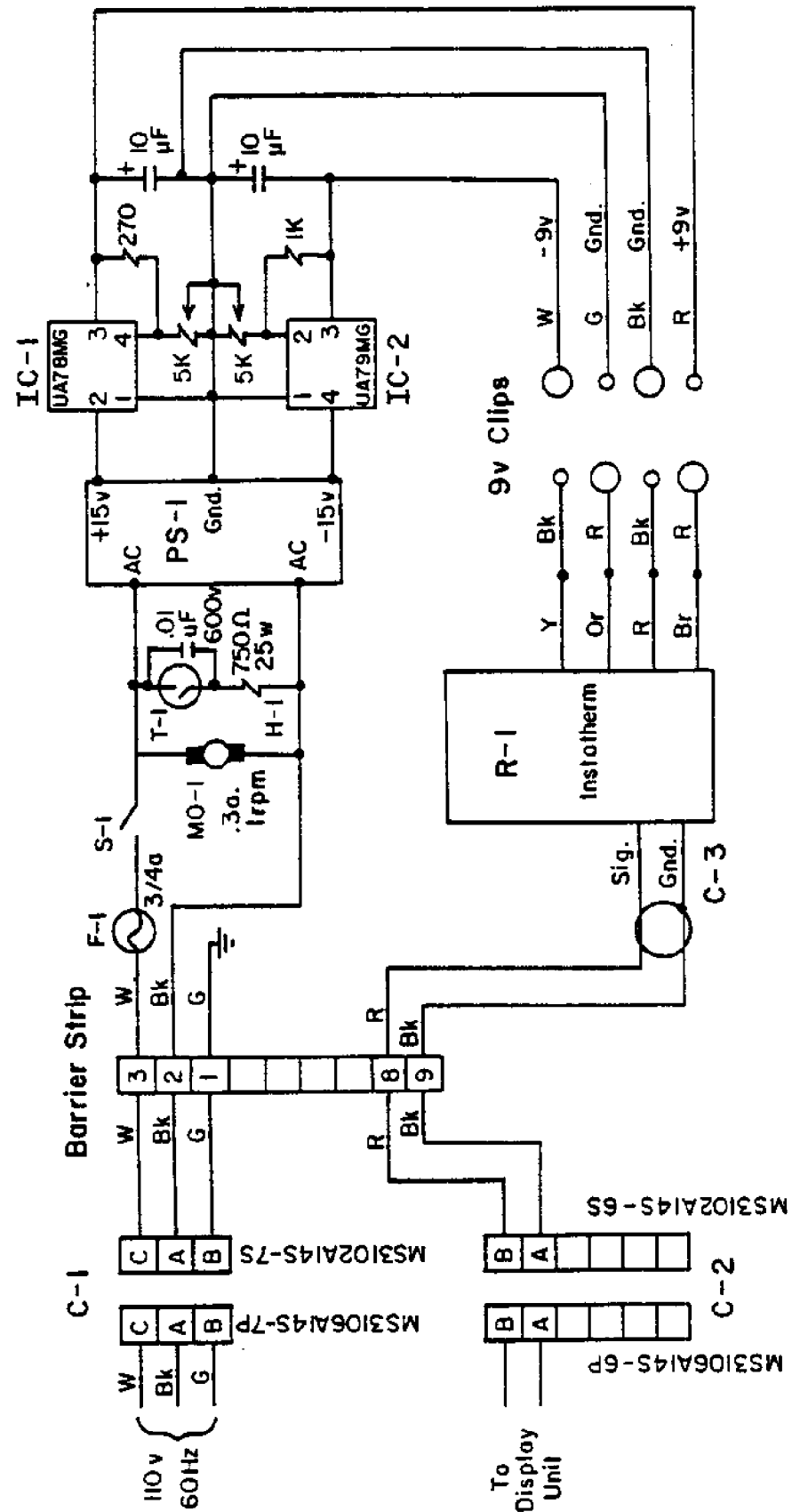


FIGURE 2
Sensor Unit Components, Model VR-1B
Fog Detection System

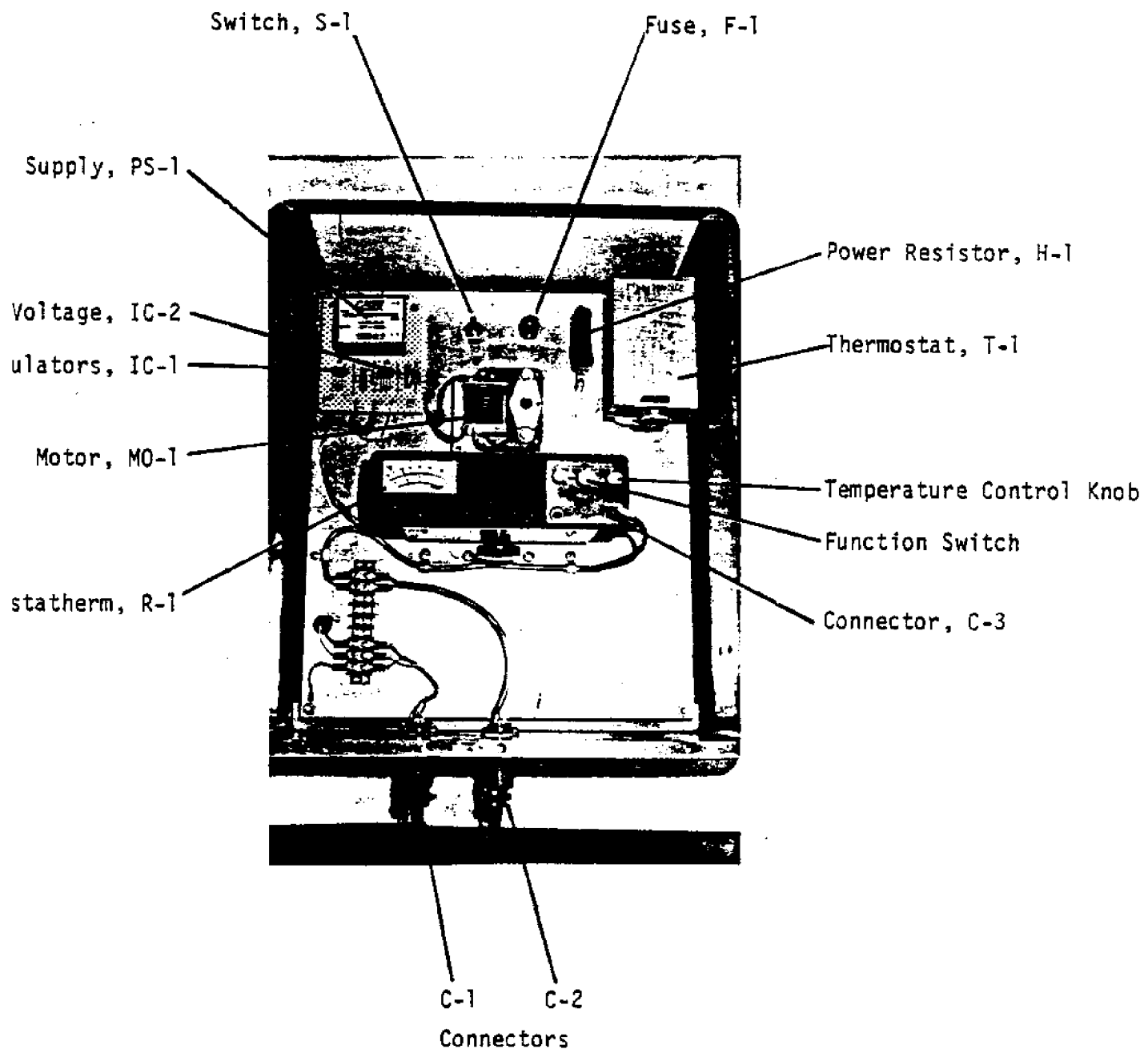


FIGURE 3
Front of Sensor Unit, Model VR-1B
Fog Detection System

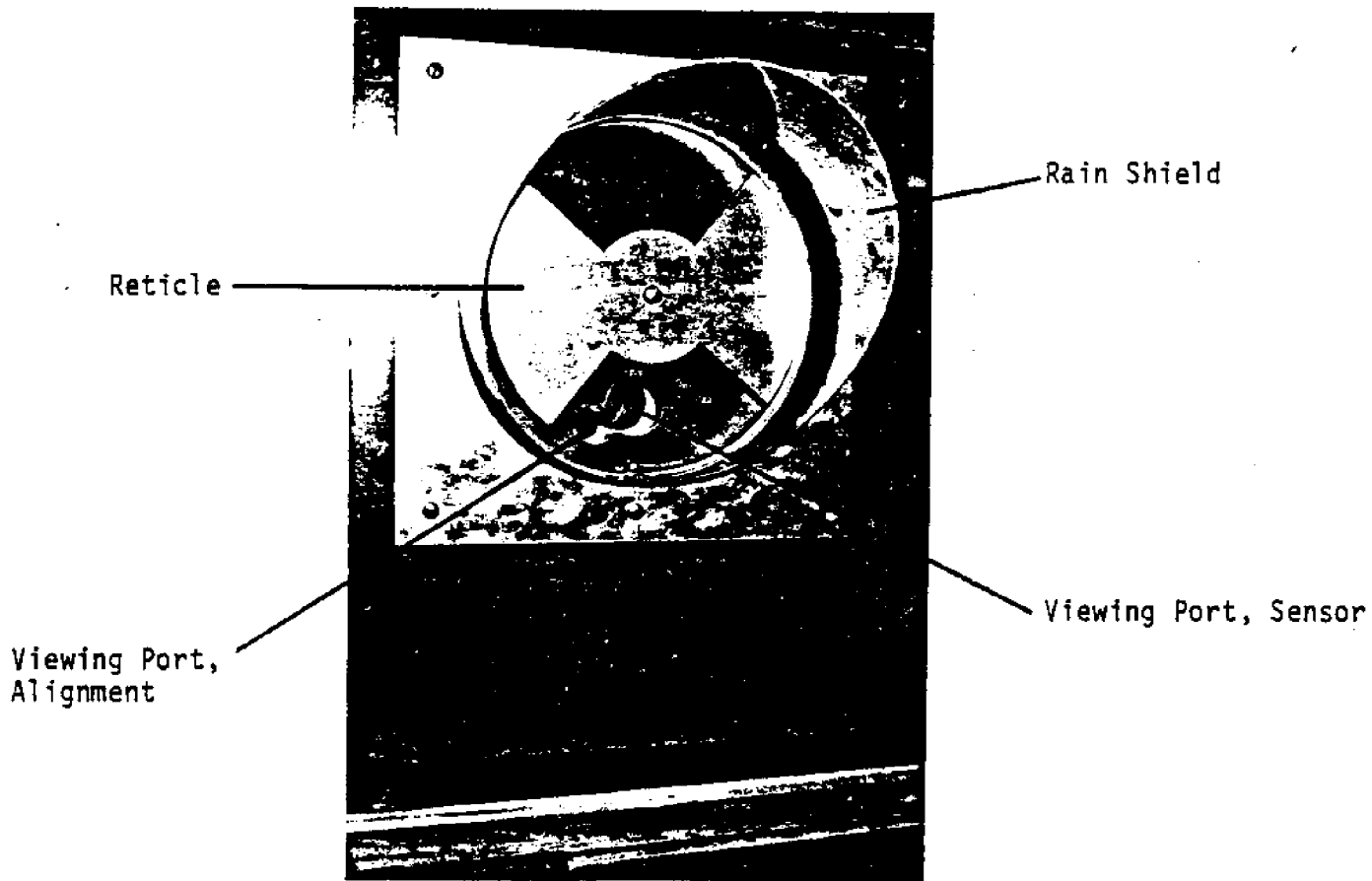


FIG. 4
FOG DETECTION MODEL VR-IB DISPLAY UNIT SCHEMATIC

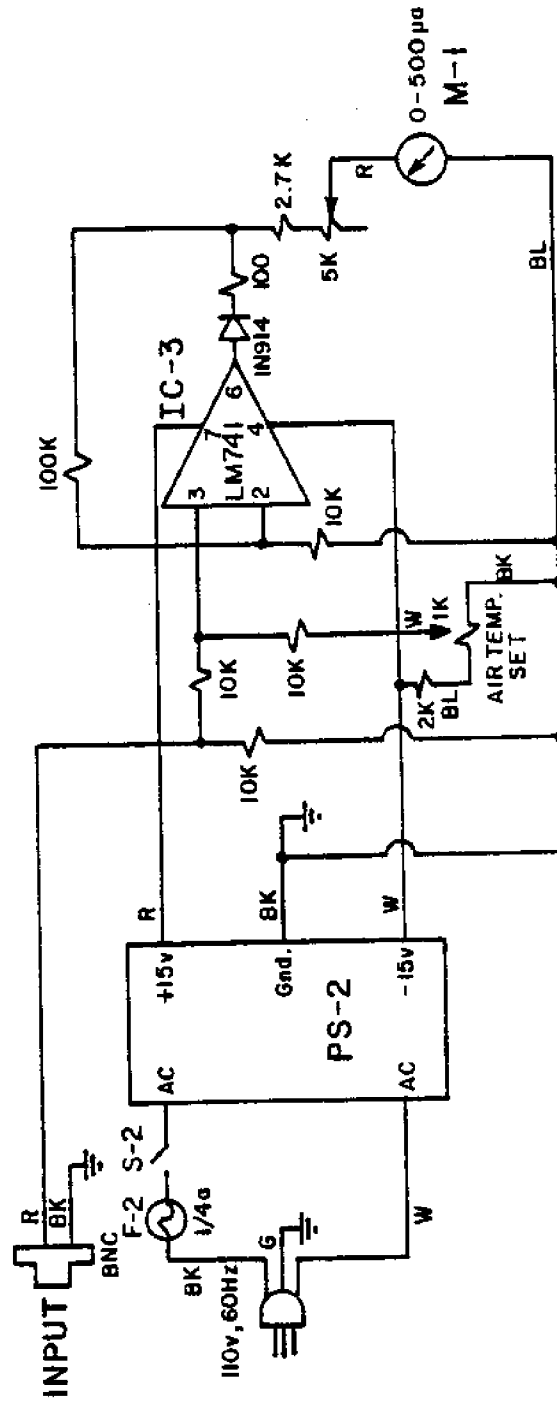
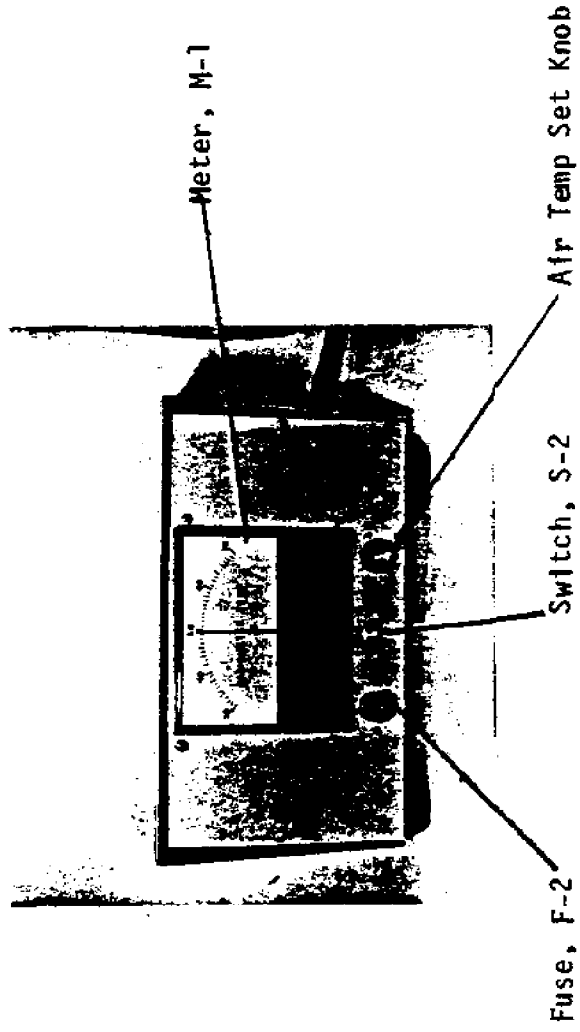


FIGURE 5
Display Unit, Model VR-1B Fog Detection System



Fuse, F-2

Switch, S-2

Meter, M-1

Afr Temp Set Knob

TABLE 1

VR-1B Replaceable Parts

SENSOR UNIT

<u>Item</u>	<u>Description</u>	<u>Manufacturer</u>
R-1	Instatherm, Mod. 14-220-1, 2.8 degree field of view, -10 to 60°C	Barnes Engineering
MO-1	Motor, 1 rpm, 3M095	Dayton
T-1	Thermostat, single pole, 22a, M7	Mears
PS-1	Power supply, $\pm 15v$, 50ma, Mod. 22-40	Calex
F-1	Fuse, 3/4 A	Littelfuse
IC-1	Voltage Regulator, +5 to +30v UA78MGUIC	Fairchild
IC-2	Voltage Regulator, -30 to -2.2v UA79MGUIC	Fairchild
C-1	Connector, 3 pin, MS3102A14S-7S	Amphenol
C-2	Connector, 6 pin, MS3102A14S-6S	Amphenol
H-1	Power resistor, 750 Ω , 25w, #0375	Ohmite
C-3	Connector, miniature, 1/8"	Amphenol

DISPLAY UNIT

M-1	Meter, 0-500ua	API, LEF Corp
D-1	Dial, meter 40 divisions	API
PS-2	Power supply, $\pm 15v$, 50ma	Calex Mfg.
F-2	Fuse, 1/4 A	Littelfuse
IC-3	Op Amp, LM741	Texas Instruments

ROUTINE SERVICING SCHEDULE

Periodically check the sensor unit for:

- calibration of Instatherm
- line of sight of Instatherm enclosure
- accumulation of moisture in enclosure
(if so increase thermostat temperature)

Carefully clean the transparent plastic window covering the Instatherm optics every month with a Q-tip and cotton moistened in clean water. Immediately wipe dry with another cotton ball. This cleaning can be done by turning unit OFF when viewing port is clear and carefully reaching window from front of enclosure. CAUTION: PRESS LIGHTLY ON WINDOW, IT IS EASILY PUNCTURED. Salt spray can build up a layer on the film causing serious calibration errors.

Table 2 is a trouble-shooting guide for the system.

TABLE 2

Trouble-shooting Guide

<u>Symptom</u>	<u>Probable Cause</u>	<u>Remedy</u>
Meter needle stays on 30°F (extreme left)	110v AC power OFF	Check plug or station circuit breaker
	Power switch OFF	Turn ON
	Bad fuse	Replace
	Bad power supply	Replace/resolder connections
	Wrong polarity	Reverse leads on telephone terminal
	Bad BNC INPUT connector	Resolder
	Open cable pair, sensor unit to display unit	Repair
Meter needle stays on 70° or greater (extreme right)	Sensor unit bad	Repair
	AIR TEMP SET out of adjustment	Turn
	Gain pot wrong	Adjust
	Instatherm calibration incorrect	Recalibrate
Meter needle between 30-70° but cannot get air temp pot to T _A	Air/fog temperature 70°F	None
	Instatherm calibration incorrect	Recalibrate Instatherm in sensor unit
Can set T _A on right swing but left swing value not close to actual water temperature	Gain pot incorrect	Adjust
	IC-3 bad	Replace, LM741 chip
	Dirty sensor window	Clean carefully
	Independent water or air temperature sensors bad	Check independent sensor systems

TABLE 2, continued

<u>Symptom</u>	<u>Probable Cause</u>	<u>Remedy</u>
No movement of needle on display unit	Air/water temperature same	None
	Air/fog temperature same	None
	Bad BNC INPUT connector	Resolder
	Open cable pair, sensor unit to display unit	Repair
	Sensor unit bad	Repair
Erratic movement of needle	Loose connection on circuit board(s)	Resolder
	Bad cable pair and connections	Repair
	Sensor unit bad	Check unit
Sensor unit reticle does not turn	110v AC power OFF	Turn ON
	- Power switch OFF	Turn ON
	Bad fuse	Replace
	Reticle loose on shaft	Tighten screw
	Bad motor	Replace
	Shaft loose	Tighten set screw
Reticle turns but no indication on Instatherm meter	Instatherm function switch turned to OFF	Turn to CAL or TEMP
	Bad power supply	Check BATT 1 and BATT 2 indications, adjust to $\pm 9v$
	Open connections on circuit board	Resolder
	Loose connection on 9v clip	Reconnect

TABLE 2, continued

<u>Symptom</u>	<u>Probable Cause</u>	<u>Remedy</u>
Reticle turns but erratic or false indications on Instatherm meter	Unstable power supply	Check BATT 1 and BATT 2 indications, adjust to $\pm 9v$
	Loose connection on circuit board	Resolder
	Water on window	Carefully clean window
	Window broken	Contact OSU for repair
	Sensor pointed at beach	Realign sensor unit

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