This ATM has been prepared to summarize the several sequences of experiment testing as they are presently defined for engineering model 1 & 2 and probe brassboard only.

Many of the tests to be described must be carried out on each component separately since critical test points are lost or shunted when the components are mated (hard wired together).

The test sequence shall be approximately as shown in Figure 1 & 2 and as described herein.

Engineering Model 2 is not intended to be tested by Bendix but left at A.D. Little for further probe testing.

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Engineering Model I
(Reference Figure 1)

I. CONDUCTIVITY (Ring) SENSORS

A. Screening Tests

(1) Test Purpose:

(a) To demonstrate that each RFC Model 137CR-2 will functionally meet all requirements before being connected into the probe cab ling.

(2) Test Equipment:

(a) 137CR-2 Specification Control Drawing

(b) REC Model 913 Bath (Bath - REC Bulletin 9131)

(c) Secondary Standard 162C (Bulletin 1621)

(d) 920 Commutating Bridge

(e) Vibration and Shock Jig

(f) Megohmmeter

(3) Test Required:

(a) Dimensional and Visual Inspection

(b) Initial Calibration

(c) Thermal Cycling

(d) Sinusoidal Vibration

(e) Mechanical Shock

(f) Calibration Check

(g) Repeatability

(h) Insulation Resistance

2. GRADIENT SENSORS

A. Screening Tests

(1) Test Purpose:

(a) To demonstrate that each REC Model 137CR-1 will functionally meet all requirements before being connected into probe cabling.

(2) Test Equipment:

(a) 137CR-1 Specification Control Drawing

(b) Spectrometer

(c) Transfer Standard Model 137CR-3

(d) Bath, REC Model 913

(e) Standard Model 162C (Bulletin 1621)

(f) 920 Commutating Bridge

(g) Vibration and Shock Jig

(3) Test Required:

(a) Dimensional and Visual Inspection

(b) Helium Leak

(c) Initial Calibration

(d) Thermal Cycling

(e) Sinusoidal Vibration

(f) Mechanical Shock

(g) Calibration Check

3. ELECTRONIC BOX SENSOR ACCEPTANCE TESTING

A. Screen Testing

(1) Test Purpose:

(a) To eliminate sensors of inherently deficient construction.

(2) Test Equipment

(a) Refer to paragraph 2.A(2)for test equipment

(3) Test Required:

(a) Calibration at two points in range of -20 to +60°C

(b) Thermal cycling (screen testing) room temperature, to dry ice, 180°F $\pm$ 20°F, dry ice, 180°F $\pm$ 20°F and return to room temperature.

(c) Repeat calibration to check for a change less than 0.1°C.

B. Calibration Testing

(1) Test Purpose:

(a) To eliminate sensors of inherently deficient construction.

(2) Test Equipment:

(a) Same as paragraph 2.A(2) for test equipment.

(3) Test Required:

(a) Calibrate over temperature range -20 to +100°C. Five points required.

(b) Environment of Table I.

(c) Recalibration to demonstrate that bridge shift was less than 0.1°K minus the RMS measurement error.

Table I

Sinusoidal	Freq. Range	Acceleration g Zero to Peak	Deviation
3 axis	10-50 50-100	10 20	25 minutes total time on each of 3 axis at sweep rate of 1 octave per minute
Random Vibration			
3 axis	20-2000	$.028g^2/hg$	25 minutes on each of 3 axis

Steady state acceleration 4g in each of 3 axis 5 minutes running time/axis.

Shock

1. 22 millisecond $\pm$ 10% half sine wave to a level of 32 $\pm$ 2g on each of 3 axis.

2. 11 millisecond $\pm$ 10% half sine wave to a level of 30 $\pm$ 2g on each of 3 axis.

4. SUB-CABLE TEST SPECIFICATION

A. Bare Wire

(1) Test Purpose:

(a) To demonstrate that wire to be used is of the highest quality available.

(2) Test Equipment:

(a) As required to meet test indicated below (4.A(3)).

(3) Test Required:

(a) Log-in each spool and record

(1) Wire Trade Name

(2) Batch number

(3) Gross

(4) Tare and Net Weights

(5) Resistance per foot.

(b) Visual Inspection

(c) Diameter measurement to within 1/10 mil and record

(1) Rejection limits for wire type and sizes:

#34 6.3 mils ± 2%

#30 10.0 mils ± 2%

#28 12.6 mils ± 2%

(d) Electrical Resistance per foot

(1) One or more samples per spool

(2) Rejection limits for wire type and sizes:

#34 Evanohm, 800 ohms per CMF ± 5%

#30 Manganin, 290 ohms per CMF ± 5% at 20°C

#28 Manganin, 290 ohms per CMF ± 5%

B. Coat Cable and Fabricate into 15 Conductor 33 foot lengths

(1) Purpose:

(a) To coat wire and assemble into sub-cable.

(2) Record Material for Traceability

(a) Bare Wire Lot number

(b) Wire Coating Material Lot Number

(c) Retain Certification that PTFE and Polyimide Insulation Materials lot meet ASTM Specifications.

(3) Record Processing Conditions

(4) In Process Tests

(a) Those tests required to ensure highest quality and reliability in the final cable.

(5) Cut Cable in 33 foot (15 conductors) Lengths

C. Coated Wire Sub-Cable Tests

(1) Test Purpose:

(a) To select for delivery sub-cable that have passed tetsts defined in (3) below.

(2) Test Equipment:

(a) As required to perform tests required in (3) below.

(3) Test Required:

(a) Thermal and Mechanical Bend Survival

(1) High Temperature Expose and Bend

(2) Low Temperature Expose and Bend

(b) Physical Configuration Measurement

(1) Picks per inch of outer (11 conductor) braid. over a 10 inch length and recorded

(2) Pick per inch of inner (4 conductor) braid.

(3) Select for Delivery

(a) Outer braid 2 picks per inch $\pm$ 10%

(b) Inter braid angle 1^{o} to 10^{o} greater than outer braid angle.

(4) Measure diameter to 1/10 mil of all 15 coated wires at one available end of each 33 foot finished sub-cable.

(5) Measured minimum wall of all 15 coated wires at one available end of each 33 foot finished sub cable and record.

(6) Select for delivery sub-cable in which all 15 coated wire diameters, 4 above, and minimum walls, 5 above, fall within Table II range.

TABLE II

	Diameters		
	Min.	Max.	Min.
#34 Evanohm, TFE Coated	16 mils	19 mils	4.1 mils
#30 Manganin, HF Coated	17 mils	20 mils	2.8 mils
#28 Manganin, HF Coated	20 mils	23 mils	2.9 mils

(c) Electrical Integrity: These tests are to be performed and recorded for each conductor in the following conductor groups:

Center four #34 Evanohm
Outer four #34 Evanohm
Outer three #30 Manganin
Outer four #28 Manganin

(1) Electrical Resistance
(2) Insulation Resistance

5. FINAL SENSORS CALIBRATION AND INSPECTION

A. Conductivity Sensors

(1) Test Purpose:

(a) To demonstrate that in the bridge configuration, when connected to the cable, the output will be less than the equivalent of 0.1°K at the ice point. Two-dimensional matrix of calibration points consisting of three (3) differential temperature points, and four (4) absolute temperature points. The matrix will be as defined in Table III below:

TABLE III

Lower Ring Sensor * Temperature (°K)		Upper Ring Sensor** Temperature (°K)	
200	198	200***	202
212.5	210.5	212.5	214.5
237.5	235.5	237.5	239.5
250 250	248	250***	252

*This shall be the ring sensor farthest from the exiting cable of the 137CR.
** This shall be the ring sensor nearest the exiting cable of the 137CR.
*** These points will be taken with the standards in their normal and interchanged positions.

B. Gradient Sensor

(1) Test Purpose:

(a) To demonstrate that in the bridge configuration, when connected to the probe cable, the output will be less than the equivalent of 0.1°K at the ice point. The bridge shall undergo a two-dimensional matrix of calibration points consisting of nine (9) differential temperature points and five (5) absolute temperature points (except calibration temperatures below 195°K will not be performed). The matrix will be as defined in Table IV below.

TABLE IV

Lower Gradient Sensor* Temperature (°K)				Upper Gradient Sensor ** Temperature (°K)				
200			198	199	200***	201	210	220
212.5		202.5	210.5	211.5	212.5	213.5	223.5	232.5
225	205	215	223	224	225***	226	235	245
237.5	217.5	227.5	235.5	236.5	237.5	238.5	247.5	257.5
250	230	240	248	249	250***	251	260	270

*This shall be the gradient sensor farthest from the exiting cable of the 137CR.
** This shall be the gradient sensor nearest the exiting cable of the 137 CR.
*** These points will be taken with the standards in their normal and interchanged positions.

(2) Test Equipment:

(a) Same as paragraph 2.A(2)

(3) Test Required:

(a) E_o/E_{in} (Ratio of bridge output to input)

(b) R_{in} (Input impedance of bridge)

(c) ΔT (Differential temperature between upper and lower sensor)

(d) T (absolute temperature of lower ring sensor)

6. PROBE FUNCTIONAL TEST (without electronics)

A. Temperature Gradient Test

(1) Test Purpose:

(a) To demonstrate that probe bridges function and are capable of measuring absolute temperature, and temperature gradients.

(2) Test Equipment:

(a) Temperature gradient apparatus, and

(b) Associate subsystem and instrumentation are to be used for the gradient measurements.

(3) Test Required:

(a) Two Tests are to be Performed

(1)

Nominal Probe Temperature (^{o}K)	Nominal Temperature Gradient (^{o}K over 50 CM)
225	2
225	20

B. Thermal Conductivity (Ring) Sensor Test

(1) Test Purpose:

(a) To demonstrate the probe functional capability operation to measure thermal conductivity in Mode 2 & Mode 3.

(2) Test Equipment:

(a) Thermal conductivity apparatus No. 1 containing glass beads and gaseous nitrogen filled void space.

(3) Test Required:

(a) Two tests are to be performed in Mode 2 (0.001 w heater power) and two tests in Mode 3 (0.500 w heater power).

Htr. No.	Probe Half Element	Mode
1	Upper	2
3	Lower	3
2	Upper	2
4	Lower	3

7. ELECTRONICS FUNCTIONAL/ACCEPTANCE TEST

A. Functional Test

(1) Test Purpose:

(a) To demonstrate the electronics output information is what's requested by input commands.

(2) Test Equipment:

(a) Test Set

(3) Test Required:

(a) I.D. Bits information

(b) Heater Sequencing

(c) Measurement Sequencing

(d) Proper Initialization

B. Electrical Interface

( ) est Purpose:

(a) To demonstrate electronics functional capability with a simulated central station.

(2) Test Equipment:

(a) Test Set

(b) Other associated electronic test equipment such as oscilloscopes, etc.

(3) Test Required:

(a) Digital Data t_r & t_f

(b) "1" and "0" levels

(c) Digital Line Noise Level (Peak-to-peak)

(d) Analog Line Noise Level (Peak-to-peak)

(e) Command Line Rejection of 100 usec pulse

(f) Timing and Control Line Rejection of 50 usec pulses

(g) Power Line for;

(1) Noise and ripple due to electronics;

(2) Rate of Change for I_{max}; and

(3) I_{max}.

(h) Digital Lines Steady State I;

(i) Ground to Ground Isolation;

(j) Primary Power Polarity Reversal Test

C. Probe Heater I (using probe simulator)

(1) Test Purpose:

(a) To demonstrate that the probe heater current supply performance meets the specification in Mode 2 and 3.

(2) Test Equipment

(a) Test Set

(b) Probe Simulator Unit

(3) Test Required:

(a) Measurement of Heater I in Modes 2 and 3.

(1) Measured value compared with Gulton's measured value chart.

(b) Measurement of heater regulation over a period of time.

(c) Check to ensure heater I is not applied during Mode 1 operation

(d) Check of Heater I rise time (t_r)

D. Excitation Power Supply (EPS)

(1) Test Purpose:

(a) To demonstrate electronics EPS functional capability.

(2) Test Equipment:

(a) Test Set

(3) Test Required:

(a) Pulse Amplitude and Width

(b) EPS stability between 1st and 2nd samples

(c) Special measurement of pulse amplitude for reference bridge excitation.

E. Power Profile

(1) Test Purpose:

(a) To demonstrate electronics power supply functional capability.

(2) Test Equipment:

(a) Test set, and associated equipment

(3) Test Required:

(a) Average power in all modes during lunar day operation.

(b) Peak power in Mode 1 during lunar days

(c) Peak power in all modes during lunar day

(d) Peak power in Modes 1 and 2 during lunar night.

F. Analog Housing Keeping Signals

(1) Test Purpose:

(a) To demonstrate electronics repeatability

(2) Test Equipment:

(a) Test set

(b) Gulton's Calibration Curves.

(3) Test Required:

(a) Measure analog signals and check to calibration curves.

G. Accuracy Check of All Channels

(1) Test Purpose:

(a) To demonstrate electronics repeatability.

(2) Test Equipment:

(a) Test set

(b) Gulton's Bridge Simulator (for bridge channels) and precision voltage source (for thermocouple channels)

(3) Test Required:

(a) Spot check measurements to compare to Gulton's calibration curves.

H. Mechanical Interface

(1) Test Purpose:

(a) To physically demonstrate that electronic unit meets specifications.

(2) Test Equipment

(a) Scales, etc.

(3) Test Required:

(a) Weight

(b) Dimensional

(c) Proper connector pin assignment of cable

(d) Thermal Plate Hole Sizes.

I. Special Test

(1) Test Purpose:

(a) To demonstrate that electronics will function properly with a 20% decrease in prime power and will not change mode of operation.

(2) Test Equipment:

(a) Test Set

(3) Test Required:

(a) Varying prime power input up to a 20% decrease.

8. FUNCTIONAL TEST (Probes & Electronics Integrated)

A. Temperature Gradient Tests

(1) Test Purpose:

(a) To demonstrate probe-electronics functional capability for measuring absolute and gradient temperatures within the operating range.

(2) Test Equipment:

(a) Temperature gradient apparatus, and

(b) Electronic test set

(3) Test Required:

(a) Same as 6.A(3)

B. Thermal Conductivity Tests

(1) Test Purpose:

(a) To demonstrate probe-electronics functional capability for measuring thermal conductivity in both Modes 2 & 3.

(2) Test Equipment:

(a) Thermal conductivity apparatus No. 1 containing beads and gaseous nitrogen filled void space, and

(b) Electronic test set.

(3) Test Required:

(a) Same as 6B.(3)

C. Back-up Functional Test: This test is to be used only if the Engineering Model 1 electronics will not function properly in the vacuum chamber.

(1) Test Purpose:

(a) To demonstrate that electronics will produce meaningful signals when connected with the probe.

(2) Test Equipment

(a) Refrigerated cold box capable of producing and maintaining temperature below 250°K, and

(b) Electronic test set

(3) Test Condition:

(a) Probe is to be placed into the refrigerated cold box.

(b) Probe cable is to be fed through the cold box wall to the electronics.

(c) Electronics to be at ambient temperature.

(4) Test Required:

(a) One test is to be performed in which all heaters are activated and measurements are made with all bridges.

9. BxA TESTS

A. "Receiving Inspection" Type Tests

(1) Test Purpose:

(a) To demonstrate that no damage has occurred to the experiment due to shipment.

(2) Test Equipment:

(a) Test Set

(b) Simulator

(c) Cold Box

(3) Test Required:

(a) Same as paragraph 7B, C, E, F, H, and I.

B. Engineering Model Tests

(1) Test Purpose:

(a) To investigate sources of electrical incompatibilities between experiment and "Central Station."

(2) Test Equipment:

(a) DSSTS - Data Subsystem Test Set

(b) ETS - Experiment Test Set

(c) STS - System Test Set

(3) Test Required:

(a) Category 2 (TC-2) individual experiments integration.

(1) The purpose of this test is to ascertain that the electrical characteristics of the experiment output signals are correct, and that no interactions occur between the various lines within the same experiment, and the experiment and Central Station. The DSST and ETS will be used during this test.

(b) Category #3 (TC-3) experiment interactions

(1) The purpose of this test is to investigate the potential interaction and interference between the experiments. The DSSTS and ETS will be used during this test.

(c) Category #4 (TC-4) data verification and subsystem interactions.

(1) The purpose of this test is to ascertain that the experiment data is correct, and that no interactions within the system produce an error in the data. The STS will be used during this test.

FLOW CHART
ENGINEERING MODEL No. 1

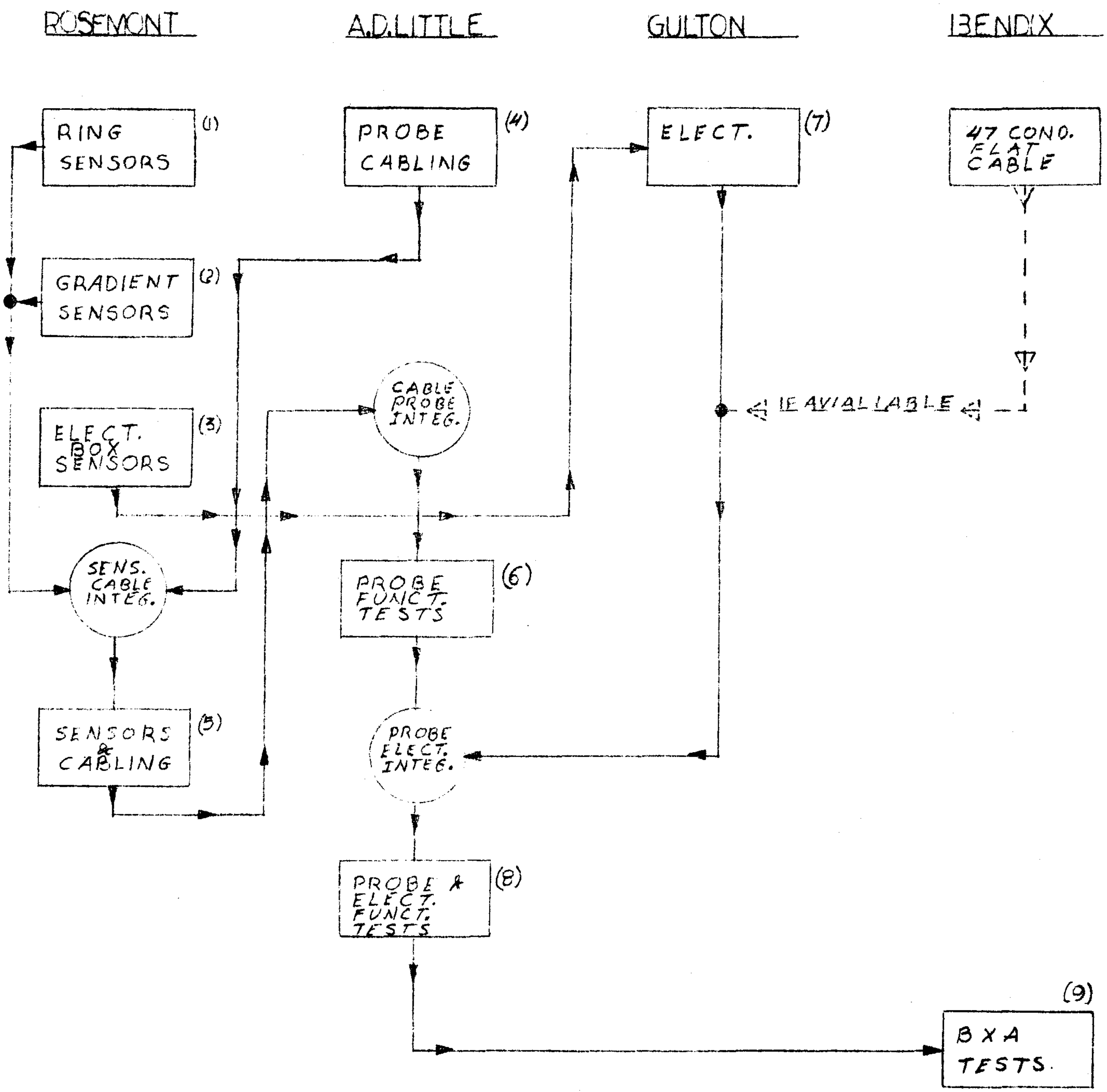

FIGURE No. 1

Engineering Model 2
and Brassboard Probe (reference Fig. 2)

1. Conductivity (ring) Sensors - Same as 1 of EM 1.

2. Gradient Sensors - Same as 2 of EM 1.

3. Electronic Box Sensor - Same as 3 of EM 1.

4. Sub-Cable - Same as 4 of EM 1.

5. Final Sensors Calibration and Inspection - Same as 5 of EM 1.

6. Probe Function Test (without electronics)

A. Gradient Test

(1) Test Purpose

a. To demonstrate and measure operational characteristics of the probe and to obtain probe factor R $\approx$ (ΔT) probe/(ΔT) gradient tube for each half probe element.

(2) Test Equipment

a. Temperature gradient apparatus, and
b. associated sub-system and instrumentation are to be used for the gradient measurement.

(3) Test Required

a. Bridge offset at two temperatures: 200 and 250°K with a gradient level < 0.1°K with a DC temperature and sensor power resulting in a temperature change of the bridge less than 0.002°K/hr.

b. Probe characteristic at these temperatures: 200°K and 250°K with a gradient level approximately equal to 2°K in a positive and negative gradient direction* at a DC (steady state) temperature and sensor power resulting in a temperature change of the bridge of less than 0.002°K/hr. The other temperature level approximately equal to 20°K in a positive and negative gradient direction* at a DC temperature and sensor power resulting in a temperature change of the bridge of less than 0.002°K/hr.

* Positive Gradient $\approx$ Bottom of lower half probe warmer than top of upper half probe. Negative gradient is reverse of these conditions.

(c) Probe reproducibility at two temperatures: One temperature level approximately equal to 200°K with a gradient level approximately equal to 2°K in a positive gradient direction at a DC temperature and sensor power resulting in a temperature change of the bridge of less than 0.002°K/hr; and the other temperature level approximately equal to 225°K with a gradient level approximately equal to 20°K in a positive gradient direction at a DC temperature and sensor power resulting in a temperature change of the bridge of less than 0.002°K/hr.

B. Thermal Conductivity Test

(1) Test Prupose:

(a) To demonstrate probe thermal conductivity measurement method.

(2) Test Equipment:

(a) Thermal conductivity apparatus No. 1 containing glass beads and gaseous nitrogen filled void space.

(3) Test Required:

(a) Four tests for method on heater No. 1: One, a low media (5×10^{-5} watts/cm°K) to measure probe to tube resistance Rad T_2(T_2=225°K) in mode 2 (0.001watt htr power); two, a med media (6×10^{-4} to 2×10^{-3} watts/cm°K) to measure probe to tube resistance Rad, T_2 in mod. 2; Three is the same as two except in mode 3 (0.500 watts htr. power); and four is the same as three except for a high media (4-6 x 10^{-3} watts/cm°K)

(b) Two cont act resistance test: One on heater No. 1 in a med media to measure probe to tube resistance Rad, T_1 (T_1= 200°K) in mod 2; the other test is probe to tube resistance Rad, T_3 (T_3= 250°K).

(c) Six position type tests to investigate the effects of the heater location on the results measured: Three tests are performed in the high media on heaters 2, 3, and 4 for probe to tube resistance Rad, T_2 in mode 3; and three tests are performed in the me d media on heaters 2, 3, and 4 for probe to tube resistance Rad, T_2 in mode 1.

6* Brassboard Probe Functional Test (without electronics)

A. Temperature gradient test

(1) Test Purpose

(a) To subject the probe to the induced environment specified in AL380200; and to demonstrate and measure operational characteristics of the probe before and after induced environment as specified in AL 380200, and to obtain probe factor R= (Δ T) probe/(ΔT) gradient tube for each half probe element.

(2) Test Equipment

(a) Same as 6.A.(a) page24 .

(3) Test Required:

(a) Same as 6.A.(3) page 24 plus induced environment as specified in A.D. Little's specification 380200.

7. Electronics Functional/Acceptance Tests

A. Functional Test

(1) Test Purpose:

(a) To subject the electronics to the induced environment specified in AL380100; and to demonstrate the electronics output information is what's requested by the input commands before and after induced environment as specified in AL380100.

(2) Test Equipment:

(a) Test Set

(3) Test Required:

(a) Before induced environment Same as 7.A. (3) page 24.

(b) After induced environment same as 7.A.(3) page 12 thru 7.I.(3) page 16

8. Characterization Test (Probes and Electronics Integrated)

(A) Temperature gradient tests

(1) Test Purpose:

(a) To demonstrate and measure operational characteristics of the probe-electronics, and to obtain probe factor R= (ΔT) probe / (ΔT) gradient tube.

(2) Test Equipment:

(a) Temperature gradient apparatus, and
(b) electronic test set.

(3) Test Required:

(a) Transient characteristics: A temperature level approximately 200-250°K with a gradient level approximately equal to 1-5°K in a positive gradient direction with an AC temperature and a sensor power P_3 (bridge power level produce with the electronics) and a second test temperature level approximately 200-250°K with a gradient equal to 1-5°K in a positive and negative gradient direction with an AC temperature, and a sensor power P_3 (bridge power level produce with the electronics)

(b) Five electronic box test: Two at a temperature level approximately 200°K with approximately a 2°K gradient level, with one test being a positive gradient direction and the other a negative gradient direction, using a AC temperature and a sensor power P_3, two at a temperature level approximately 250°K with approximately a 2°K gradient level with one test being a negative gradient direction and the other a positive gradient direction, using a DC temperature and a sensor power P_3; and one test at a temperature level approximately 225°K with approximately a 20°K gradient level with a positive gradient direction and a DC temperature and a sensor power P_3.

(B) Thermal Conductivity Tests:

(1) Test Purpose:

(a) To demonstrate probe-electronics thermal conductivity characteristics.

(2) Test Equipment:

(a) Thermal conductivity apparatus No. 1 containing glass beads and gaseous nitrogen filled void space, and

(b) electronic test set.

(3) Test Required:

(a) Tests on heaters 1 and 4 in a med media to measure probe to tube resistance Rad, T_2 in mode 2(0.001 watt htr. power) and tests on heaters 2 and 3 in a med media to measure probe to tube resistance Rad, T_2 in mode 3(0.500 watt htr. power).

FLOW CHART
ENGINEERING MODEL No. 2 & BRASSBOARD PROBES

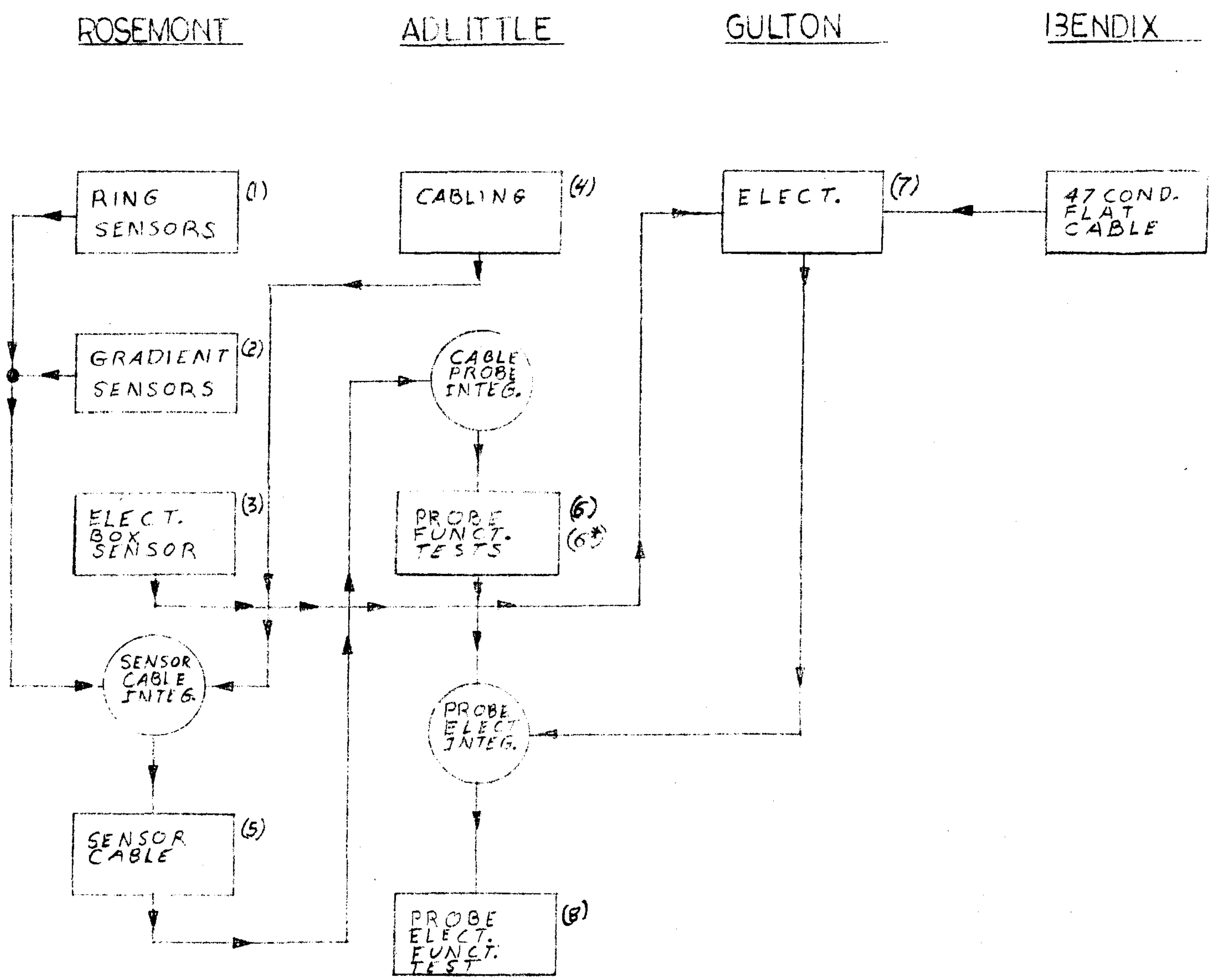

FIGURE No. 2