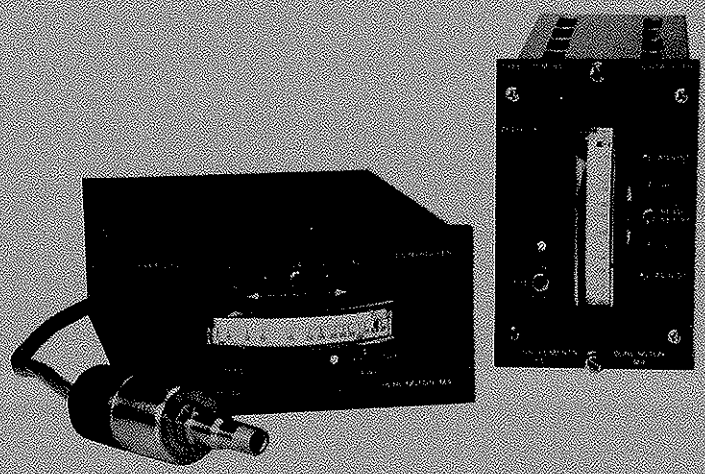
Manual 195-107809-B-2/83

INSTRUCTION MANUAL

THERMAL CONDUCTIVITY VACUUM GAUGE



Type TC-1 & TC-2 Gauge
170M-85 & 285
Controller

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MKS INSTRUMENTS, INC.

WARRANTY

MKS Instruments, Inc. (MKS) warrants that all equipment manufactured by **MKS** shall be free from defects in materials and workmanship for a period of one year from date of shipment. For the period commencing with the date of shipment of the equipment and ending one year later, **MKS** will, at its option, either repair or replace any part which is defective in materials or workmanship without charge to the purchaser. The foregoing shall constitute the sole remedy of the purchaser for any breach by **MKS** of this warranty.

The purchaser, before returning any equipment covered by this warranty, which is asserted to be defective by the purchaser, shall make specific written arrangements with respect to the responsibility for shipping the equipment and handling and other incidental charges, with the **MKS** sales representative or distributor from which the equipment was purchased, or in the case of a direct purchase, from **MKS** home office in Burlington, Massachusetts, USA.

The warranty does not apply to any equipment which has not been used in accordance with the specifications recommended by **MKS** for the proper and normal use of the equipment. **MKS** shall not be liable under any circumstances for consequential or incidental damages in connection with, or arising out of the sale, performance or use of, the equipment covered by this warranty.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES BY **MKS,** EXPRESSED OR IMPLIED, INCLUDING WARRANTIES OF MERCHANTABILITY, WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE AND WARRANTIES AGAINST INFRINGEMENT OF ANY PATENT.

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INSTALLATION AND OPERATING INSTRUCTIONS
For
Thermal Conductivity
(Thermocouple) Vacuum Gauge

Section 1 GENERAL

A Thermal Conductivity Gauge measures, as the name would imply, the thermal conductivity of the gas in which a thermocouple is immersed.

Conductivity and pressure are related and, although non-linear, this leads to the gauge's use as a pressure transducer. In its basic form, The gauge functions in the following manner: A thermocouple is resistively heated using constant power. The hot junction will generate an EMF (voltage output) which is linear with respect to its temperature. Since the thermocouple is fashioned from fine wire, the ambient gas will conduct large quantities of heat away from the junction and thus be the primary influence on its temperature. As the concentration (pressure) of the ambient gas changes, the temperature of the T.C. changes, and hence its voltage output. Readout in the simplest form is a milliammeter whose scale has been printed with graduations which make pressure determination (0 to 2000 microns max.) quite simple. At the outset, it must be understood that a T.C. gauge is gas species sensitive.

DESCRIPTION

MKS Instruments manufactures two T.C. transducers (TC-1 and TC-2) and two readout packages that are identical in function although not in appearance (170M-85 and 285). Either readout may be used with either T.C. transducer.

Section 2 THEORY OF OPERATION

TRANSDUCER

The transducer consists of a Platinel II T.C. pair mounted in a cross configuration. The two dissimilar wires are spot welded at their ends to a 4-pin header. The wires are also spot welded together at the cross, this weld forming the hot junction. The cold junction then becomes the weld at the pins of the header, and this junction stays at ambient temperature. The electronics package (170M-85 or 285) supplies a constant square wave current through one of the two wires thus raising its temperature and the junction temperature.

Since the wire is very fine and the transducer's body massive, the heat generated in the wire does not raise the transducer temperature significantly. At vacuum, the temperature difference between hot and cold junction will be maximum (gas removed from the hot junction) and this situation then corresponds to zero pressure. As pressure rises, the temperature difference will decrease. At atmospheric pressure, the temperature difference will be about 5% of the maximum. The temperature difference is however not a constant, but varies with ambient. This means that the transducer is somewhat sensitive to ambient in a non-linear fashion.

A negative temperature coefficient device very closely compensates for the transducer's sensitivity to room ambient by varying input power to the hot junction.

Two types of transducers are available. The Type TC-1 is for general purpose use in non-corrosive environments up to a maximum temperaure of 100°C. It may be mounted to the system using its 1/8 MNPT fitting or in a 1/2" o-ring compression fitting.

The Type TC-2 is for use in corrosive environments at bakeout temperatures up to 200°C. Operating temperatures should be kept in the 10-50°C range. Since it is built as part of a Conflat® flange, it is to be mounted as would a conflat flange on a 1 3/8" diameter opening mating flange (2 3/4" OD x 1 3/8" ID).

CONTROLLER

The MKS Type 170M-85 and 285 are identical with the exception of package and will be described as though they were one unit. Within the module are two separate circuits – the power supply/readout and the setpoint circuits.

POWER SUPPLY AND READOUT (Refer to Drawing D106852)

The power supply/readout circuit which operates at 39 VDC is derived from reactively dropping 110-120 VAC across D1 and C2 (for zero power dissipation) and rectified by CR1. Current flowing through CR15 lights the "ON" LED (which is protected by CR16-19). CR2 and C16 provide a smoothed, preregulated 39 VDC to U1 whose output is adjusted to provide a precisely regulated 33 VDC. T1, Q1, and Q2 form a saturating switching regulator operating at 30 KHz. The 5-turn upper secondary forms the power supply for resistance heating the thermocouple, and R2 allows for precise setting (of pressure zero). The 24-turn paired lower secondary together with CR3-6, forms the ±15 VDC power suply for the thermocouple amplifier U2. The output of the thermocouple transducer is a signal of approximately 10 MV at full scale (zero pressure). To amplify this signal to a usable 1 volt output level, U2 is selected to be very stable (LM308A). This amplifier drives both the front panel meter and the output pins at the rear panel.

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SETPOINTS (Refer to Drawing D106852)

110-220 VAC power is reduced to 12 VDC by T2, CR14-18, and U6. This 12 VDC is used to supply all the ICs on this board as well as the pecise voltage (CR11) used as reference for the two setpoint comparators (U3B and U7B). U3A and U7A provide buffering so that the voltage appearing at the wipers of R14 and R27 (front panel setpoint pots) will be unloaded. When the setpoint switch S4 is in the middle position, the amplified T.C. signal appears at both setpoint comparators (U3B and U7B) where it is compared with each setpoint, and depending upon the setting K1 and/or K2 will be energized/de-energized. R17 and R30 provide positive feedback for positive (jitter-free) switching. U4A, B, C and D provide for external latch capability, I.E., connecting the latch line to D ground will cause the relay to remain activated once it has been trippd even though the pressure has risen above the setpoint. Breaking the latch line will unlatch the relay. Both relays are DPDT with all contacts brought out to the rear panel connector, (R10 and CR13 are LED) which indicate the relay's state. When S4 (Setpoint Read Switch) is pressed in either direction, the setpoint level is indicated on the meter, and thus by turning the correct pot (R14 or R27) the setpoint level may be adjusted. Note that to facilitate adjustment, the switch is depressed toward the setpoint pot that is to be adjusted.

Section 3 INSTALLATION

The Type TC-1 transducer may be attached to the vacuum system by either screwing it into a mating 1/8 FNPT fitting or sliding it into a 1/2 o-ring fitting such as a Cajon Ultra Torr. It is recommended that the inlet port be oriented downward as dirt will fall away from the thermocouple element. The Type TC-2 transducer is mounted to the vacuum system on a mating conflat flange (2 3/4" OD with a 1 3/8" diameter clearance opening necessary). The readout unit may be mounted in any convenient place within reach of the interconnecting cable (10 feet). Make certain the two rear panel 110-220 VAC switches are in the proper position before power is applied. External setpoint functions (pump activation, alarms) may be wired through the relay contacts which are brought out at the rear panel. *DO NOT OVERLOAD THESE CONTACTS.* The relays will be energized when the pressure is below the setpoints.

SETPOINT RELAY CONNECTIONS

This instrument is equipped with two adjustable setpoints. The relays provided are DPDT, 110 VAC, 1 amp, and are energized as pressure drops. The connections are provided via a pair of rear panel 9-pin connectors whose pin out is as follows:

J — Common #1

K — N.C. #1

D — N.O. #1

A — D GND

H — Common #2

F — N.C. #2

E — N.O. #2

B — LATCH

Section 4 OPERATING PROCEDURE

With power OFF, set the meter pointer to the OFF position using the screw adjust in the face of the meter. Check to make certain the 110-220 VAC power switches on the rear panel are in the right position for the line voltage used. Turn ON the instrument and pump down the vacuum system below the range of the gauge (less than 1 micron). If the transducer shipped with the readout is used, the pressure indicated should be zero. If not, adjust it to zero using the front panel screw. Note that there is a thermal time delay between the adjustment and the new meter position so that the screw should be turned in small steps. To adjust the setpoint, simply depress the front panel switch toward the one to be set. The meter will read the actual trip point and it may be set using the front panel screw to any desired point within the operating range of the gauge. The instrument is now ready for operation.

Section 5 TROUBLESHOOTING

The simplicity of this instrument reduces field troubleshooting to three basic areas.

1. Check the resistances between pins 1 & 5 and 3 & 7 of the transducers. They should be 1.5 ohms and 1.3 ohms ±.1 ohm respectively.

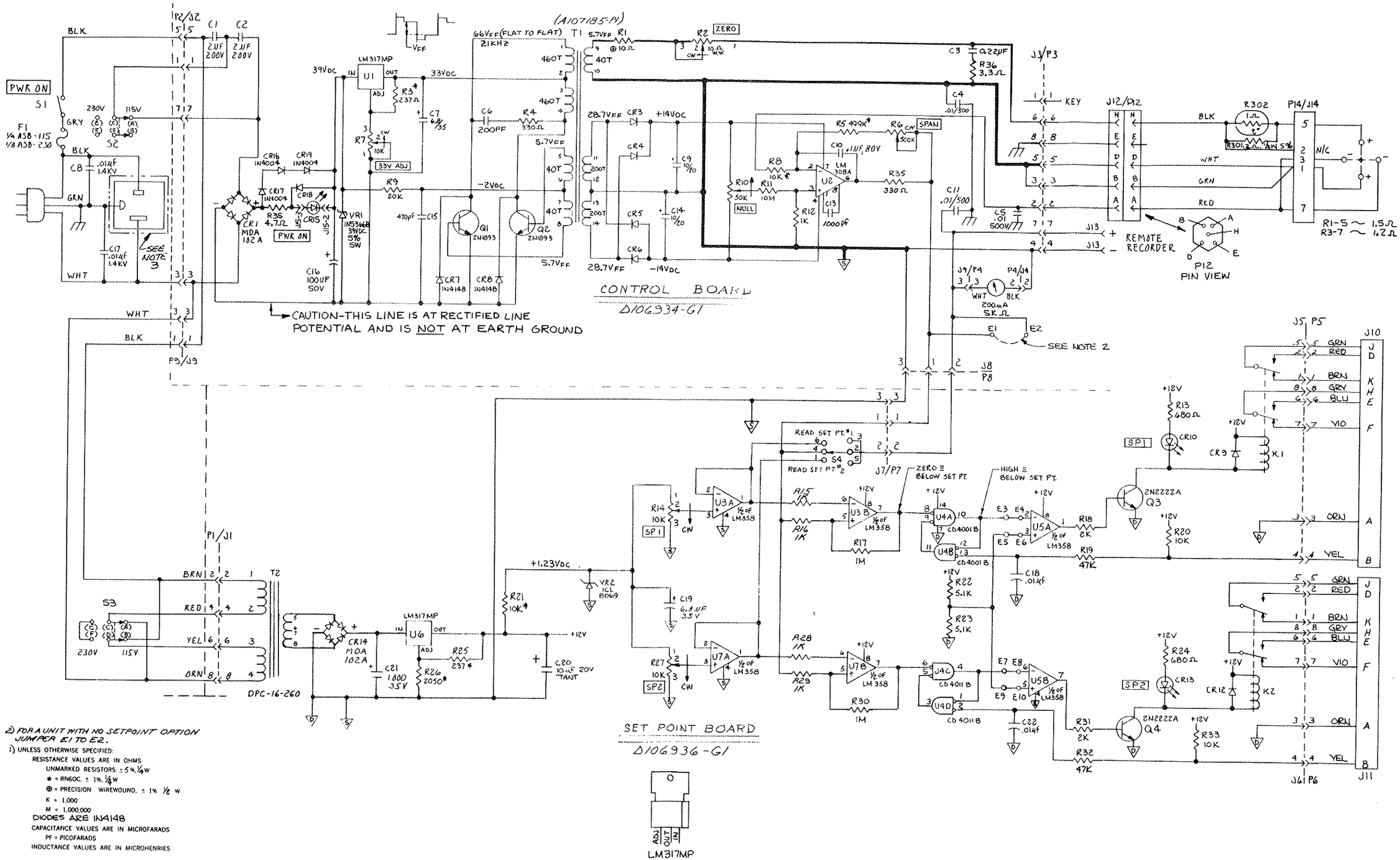
2. Check for cable continuity as indicated in wiring schematic.

3. Check for a blown fuse and/or 110-220 switch in proper position.

NOTE: Adjusting any pots other than the meter zero and Instrument Zero (on front panel) will destroy the factory calibration.

Should any difficulties be encountered in the use of your instrument, it is recommended that you contact any authorized MKS Sales Office or Home Office for repair instructions.

IF IT IS NECESSARY TO RETURN THE INSTRUMENT TO MKS FOR REPAIR, PLEASE CONTACT MKS' HOME OFFICE FOR AN ERA NO. (EQUIPMENT RETURN AUTHORIZATION NUMBER), TO EXPEDITE HANDLING AND ASSURE PROPER SERVICING OF YOUR INSTRUMENT.



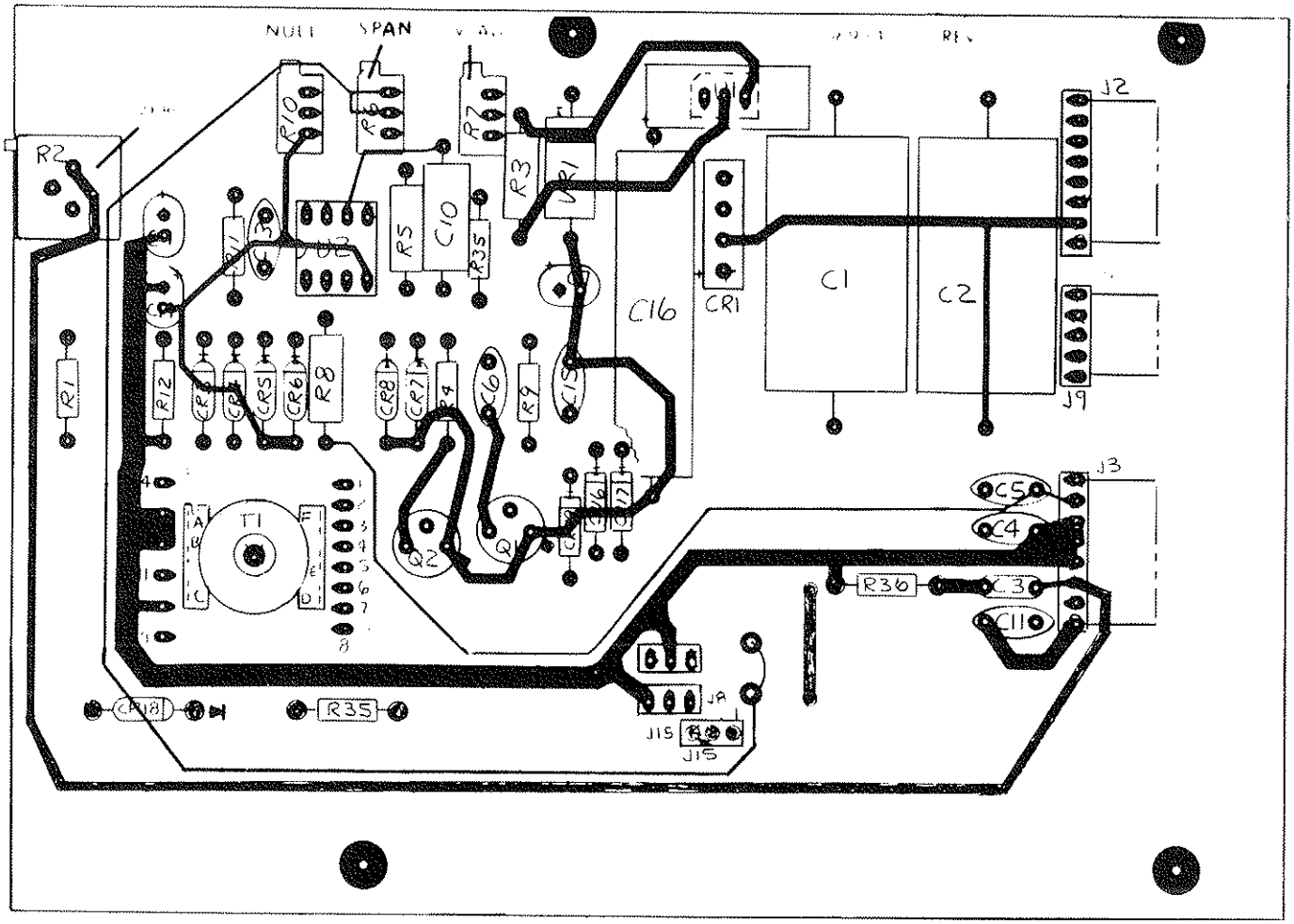
2) FOR A UNIT WITH NO SETPOINT OPTION JUMPER E1 TO E2.

1) UNLESS OTHERWISE SPECIFIED:
- RESISTANCE VALUES ARE IN OHMS
- UNMARKED RESISTORS: ± 5%, ¼W
- * = RN60C, ± 1%, ¼W
- ⊕ = PRECISION WIREWOUND, ± 1% ½ W
- K = 1,000
- M = 1,000,000
- DIODES ARE IN4148
- CAPACITANCE VALUES ARE IN MICROFARADS
- PF = PICOFARADS
- INDUCTANCE VALUES ARE IN MICROHENRIES

NOTES

SCHEMATIC 106852-E

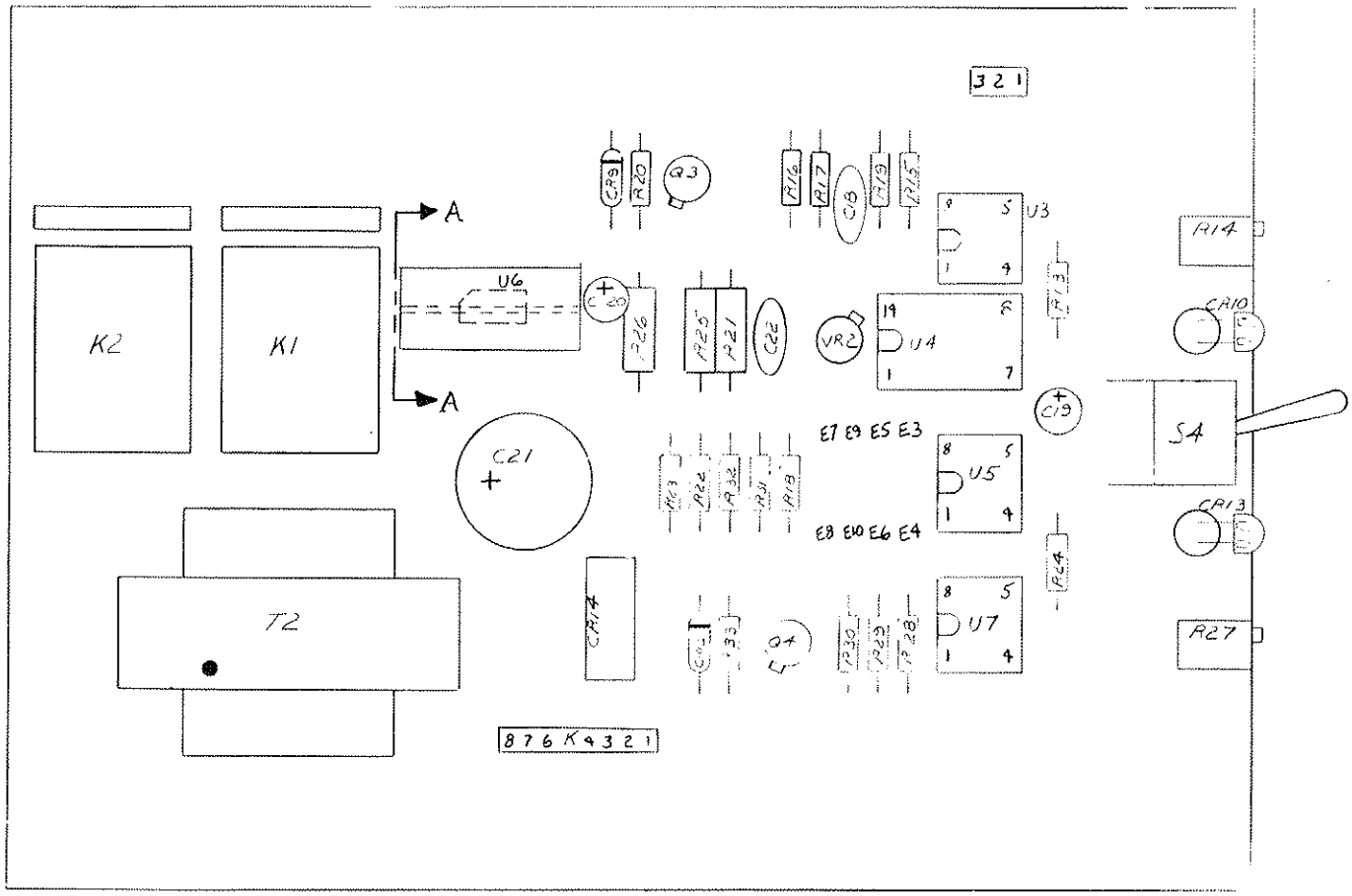
Section 6 PARTS LISTS



CONTROL BOARD
106934-E

GI	ITEM	PART NO.	DESCRIPTION	REMARKS
QTY	LIST OF MATERIALS			
1	52	064-2558	RES 3.3Ω 1/4W 5%	R36
1	51	064-2560	RES 4.7Ω 1/4W 5%	R35
1.00IN	50	093-3828	WIRE #26 AWG STRANDED GRN	
↑	49	↑ 3829	↑ ↑ ↑ YEL	
|	48	| 3836	| | | ORG	
|	47	| -3827	| | | RED	
↓	46	↓ -3831	↓ ↓ ↓ BRN	
1.00IN	45	093-3826	WIRE #26 AWG STRANDED BLK	
3.00IN	44	169-3598	TUBING, HEAT SHRINK .093 DIA	
1.00IN	43	093-2100	BUSS WIRE, 22GA.	
1	42	110-6421	HEADER, 5PIN, RIGHT ANGLE	J9
1	41	185-3743	WASHER, I.T. LOCK, #2	
1	40	185-3739	WASHER, FLAT, #2	
1	39	146-3149	NUT, HEX #2-56	
REF	38	D106852	SCHEMATIC	
1	37	A107135-P1	TRANSFORMER	T1
3	36	110-3474	HEADER, 3PIN	J4, J8, J15
2	35	110-6422	HEADER, 8PIN, RIGHT ANGLE	J2, J3
1	34	005-2523	CAP .22UF 20% 50V CER DISC	C3
1	33	123-6426	HEAT SINK	
2	32	181-2752	TRANSISTOR PAD	XQ1, XQ2
1	31	156-3251	SOCKET 8PIN, DIP	XU2
1	30	064-2586	RES., 330Ω, 1/4 W, 5%	R4
1	29	064-2428	↑ 1K , 1/4 W, 5%	R12
1	28	065-2450	| 10K , RN60C, 1%	R8
1	27	064-2398	| 20K , 1/4W, 5%	R9
1	26	064-2714	| 10M , 1/4W, 5%	R11
1	25	066-2928	| 10Ω, WW, 5%	R1
1	24	065-2416	| 237Ω, RN60C, 1%	R3
1	23	064-2586	↓ 330Ω, 1/4W, 5%	R35
1	22	065-2451	RES, 499K, RN60C, 1%	R5
1	21	053-4896	POT, 10Ω, END ADJUST, WW	R2
1	20	053-4314	POT, 10K, END ADJUST, CERMET	R7
1	19	053-4148	POT, 50K, END ADJUST, CERMET	R10
1	18	053-4242	POT, 500K, END ADJUST, CERMET	R6
7	17	015-2412	DIODE IN4148	CR3 THRU 8, CR18
1	16	015-4348	DIODE BRIDGE MDA-102A	CR1
1	15	017-4894	DIODE, ZENER, 39V, 5W, IN5366B	VR1
3	14	015-4323	DIODE IN4004	CR16, 17, 19
1	13	030-4398	IC, LM308A	U2
1	12	033-4341	IC, LM317MP	U1
2	11	082-2015	TRANSISTOR 2N1893	Q1, Q2
2	10	006-4895	CAP, 2 uF 200V, MYLAR	C1, C2
1	9	007-3188	CAP, 100uF 50V, ALUM. ELEC.	C16
1	8	005-2517	CAP, 470 PF, 10%, 1KV, CERAMIC	C15
1	7	007-4029	CAP, 6.8uF 35V, TANT	C7
1	6	005-3043	CAP, 200PF, 10% 1KV, CERAMIC	C6
2	5	007-2962	CAP 10uF, 20V, TANT	C9, C14
3	4	005-3259	CAP .01uF 500V CERAMIC	C4, C5, C11
1	3	006-4294	CAP, .1uF, 80V, MYLAR	C10
1	2	005-2961	CAP 1000pf, 1KV, CERAMIC	C13
1	1	D106933-P1	PC BOARD MACHINING	

CONTROL BOARD PARTS LIST
106934-E

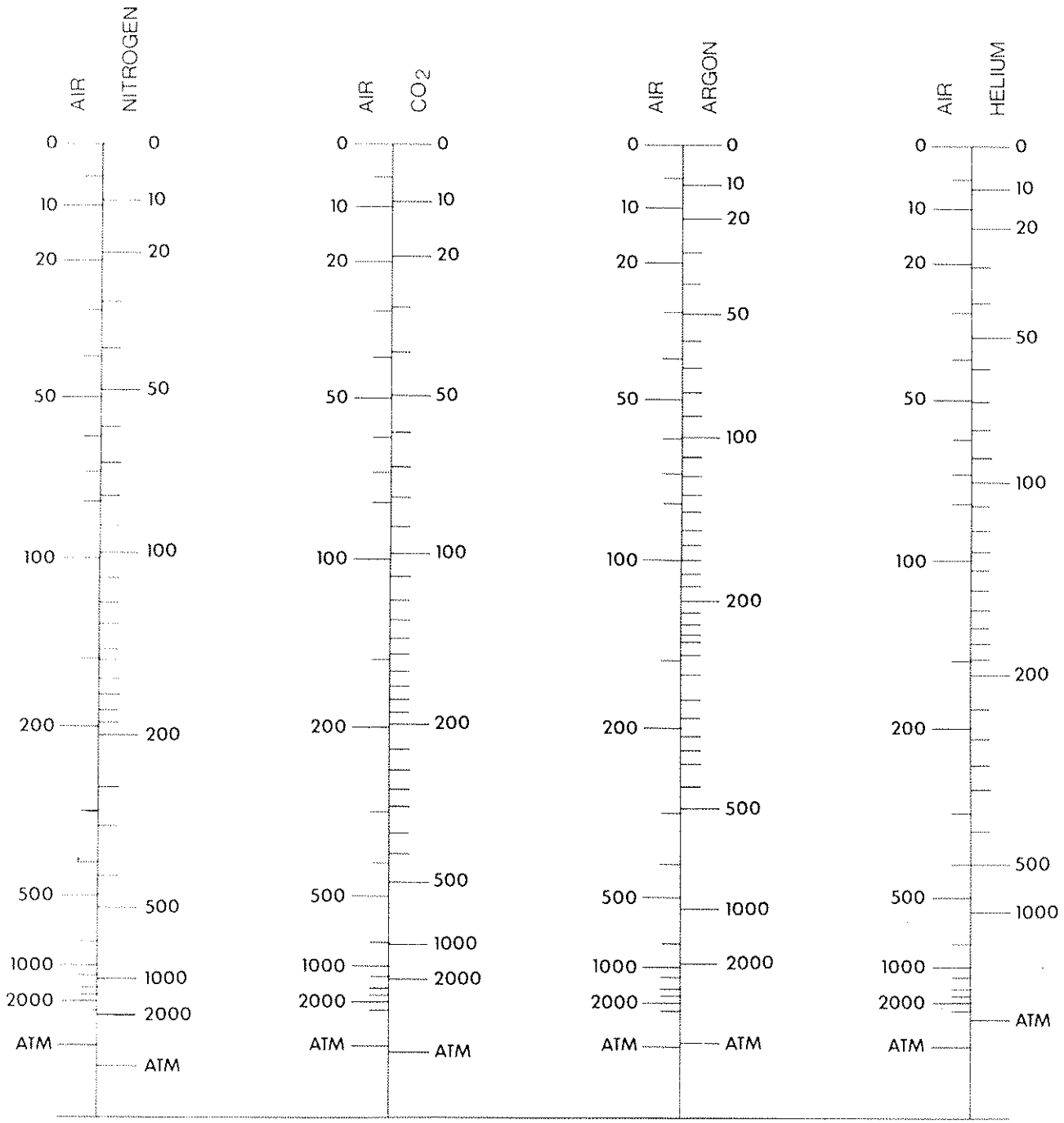


SET POINT BOARD
106936-B

	35			
	34			
1	33	156-2475	SOCKET 14 PIN DIP	XU4
3	32	156-3251	SOCKET, 8 PIN DIP	XU3, XU5, XU7
1	31	072-4342	SWITCH, MOMETARY TOGGLE	S4
2	30	074-2724	SPACER, LAMP MOUNT	
1	29	123-6426	HEAT SINK	
1	28	078-4897	TRANSFORMER, SIGNAL	T2
2	27	057-4898	RELAY, P&B #R50-E2-Y2-12V	K1, K2
1	26	110-3474	HEADER, 3 PIN	J7
3	25	110-3589	HEADER, 8 PIN	J1, J5, J6
1	24	036-9029	IC, CD4001BE	U4
1	23	033-4341	IC, LM317MP	U6
3	22	030-4328	IC, LM358	U3, U5, U7
2	21	082-4261	TRANSISTOR, 2N2222A	Q3, Q4
2	20	064-2587	RES, 680Ω, 1/4 W 5%	R13, R24
4	19	064-2428	1K 5%	R15, R16, R28, R29
2	18	064-2076	2K 5%	R18, R31
2	17	064-2444	5.1K 5%	R22, R23
2	16	064-2057	10K 5%	R20, R33
2	15	064-2051	47K 5%	R19, R32
2	14	064-2959	1M, 1/4W, 5%	R17, R30
1	13	065-2416	237Ω, RN60C, 1%	R25
1	12	065-4695	2.05K, RN60C, 1%	R26
1	11	065-2450	RES, 10K, RN60C, 1%	R21
2	10	053-4314	POT, 10K, END ADJ, CERMET	R14, R27
1	9	007-2962	CAP, 10uF, 20V, TANT	C20
2	8	005-3259	CAP, .01uF, 500V, CERAMIC	C18, C22
1	7	007-4446	CAP, 1000uF, 35V, ALUM. ELEC.	C21
1	6	007-4029	CAP, 6.8uF, 35V, TANT	C19
2	5	015-2412	DIODE, IN4148	CR9, CR12
1	4	015-4348	DIODE, BRIDGE, MDA-102A	CR14
1	3	016-4379	DIODE, ZENER, ICL8069	VR2
2	2	044-4101	LED, GREEN	CR10, CR13
1	1	D106935-P1	PC BOARD MACHINING	
G1	ITEM	PART NO.	DESCRIPTION	REMARKS
QTY	LIST OF MATERIALS			

SET POINT BOARD PARTS LIST
106936-B

Section 7 APPENDIX



PRESSURE CORRECTION NOMOGRAPHS FOR VARIOUS GASES

SPECIFICATIONS

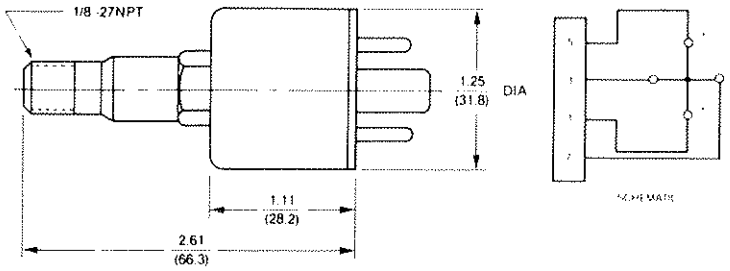
Transducer

	TC-1	TC-2
Materials of Construction	C.R.S. nickel plate Glass, Platinel II	302 SS Glass, Platinel II
Mounting	1/8 NPT or ½" O-ring	2 3/4 Conflat Flange
Temp. Operating range	0–50°C	0–50°C
Temp. Coefficient at zero pressure	<.05μ/°C	<.05μ/°C
Bake out temp-connector removed	100°C	200°C
Junction temperature at zero pressure	250–300°C	250–300°C
Internal volume	19.7 cc	N/A
Resistance **Pins 1 to 5** **Pins 3 to 7**	 1.5Ω 1.3Ω	 1.5Ω 1.3Ω
Achievable accuracy after setting zero, using correction factor	10% of reading	10% of reading

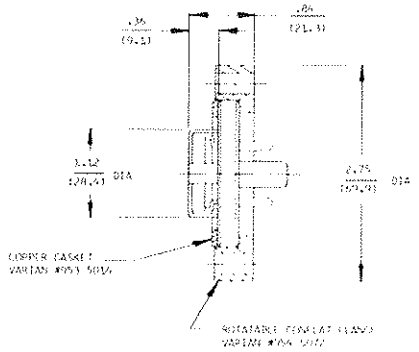
Power Supply/Readouts

	170M-85	285
Input	110 or 220 VAC	110 or 220 VAC
Power	3 watts	3 watts
Fuse	1/4 or 1/8 A	1/4 or 1/8 A
Signal output	0–1VDC into ≥ 10K load	0–1VDC into ≥ 10K load
Meter	0–2000 μHg	0–2000μHg
Setpoints	Dual, Energize on falling pressure, latching option	Dual, Energize on falling pressure, latching option
Contacts	DPDT, 1A resistive at 110 VAC 2 individual rear panel connectors	DPDT–same as 170M-85
Operating Temp. Range	0–40°C	0–40°C
Mounting	1A size module for mounting in 170 Series rack mounts or cabinets	⅓ DIN package, mounts in 138 mm x 68 mm panel cutout

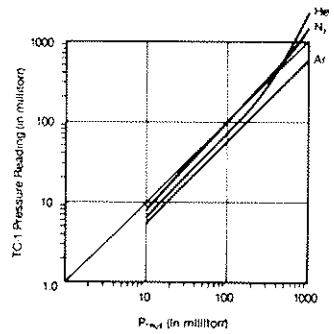
OUTLINE DRAWINGS $\frac{IN}{(MM)}$



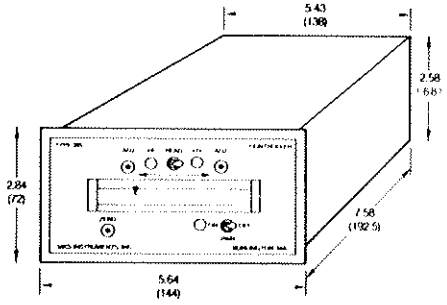
TC-1 THERMOCOUPLE GAUGE



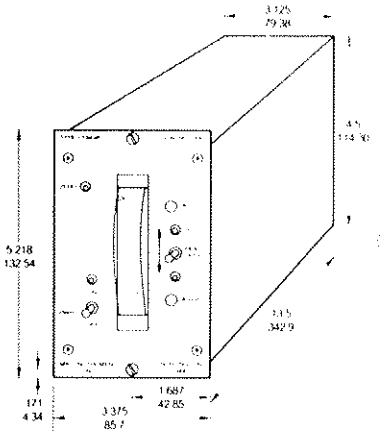
TC-2 THERMOCOUPLE GAUGE



Comparison of TC-1 readings vs. Capacitance Manometer (total pressure) for several gases.



TYPE 285 CONTROLLER



170M-85 CONTROLLER