OPERATING MANUAL

Model CH3F
Recording Gas Analyzer

Manufactured by

TUURE INSTRUMENT COMPANY

P.O. BOX 143

Roscoe, Illinois 61073

815-623-6822

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TUURE INSTRUMENT COMPANY

Model CH3F Recording Gas Analyzer

General Description

This instrument is designed to measure CO2 or H-1301 volume concentrations in air using the principle of thermal conductivity of the sample gas. It monitors three sample lines simultaneously and records the results on individual strip charts at 5 second intervals.

Its primary application is for testing total flooding type fire extinguishing systems using CO2 or H-1301. When needed a third range can be provided for use with H-1211 or other similar gas. The cell circuits are thermally compensated to maintain calibration span for instrument temperatures ranging from 32 to 100 degrees F. The cell filaments are dynamically balanced by means of an adjustable mounting arrangement so as to minimize zero drift through this same temperature range.

Field calibration capability is provided in the form of convenient apparatus for preparing precision mixtures of test gas with air. Since this is a true volumetric device, it will give accurate results with any test gas such as H-1301, H-1211, or H-122 (Refrigerant 12). It is usually more convenient to calibrate with H-122 rather than H-1301 because it is readily available in light weight containers and it gives the same readout as H-1301.

The complete kit including analyzer, three 50 foot lengths of 1/4 O.D. X 1/8 I.D. sample tubing, and the calibration kit are packed in a sturdy carrying case measuring 13 X 18 X 7 inches deep. Total weight is approximately 28 lbs. An external 120 volt A.C. power supply is required for operation.

Normal Scale Ranges:

CO2	0-100 % by Volume	
H-1301	0-10 % by Volume	
H-1211	0-10 % by Volume	(when ordered) (Model CH3F3)

Chart Speed 12 inches per Hour

Printout Frequency 12 Points per Minute (60 Hertz Power)

Operating Temperature Range 32 to 120 Degrees F.

Zero Drift at Constant Humidity:

H-1301 Range	1 % of Scale
CO2 Range	0.5 % of Scale

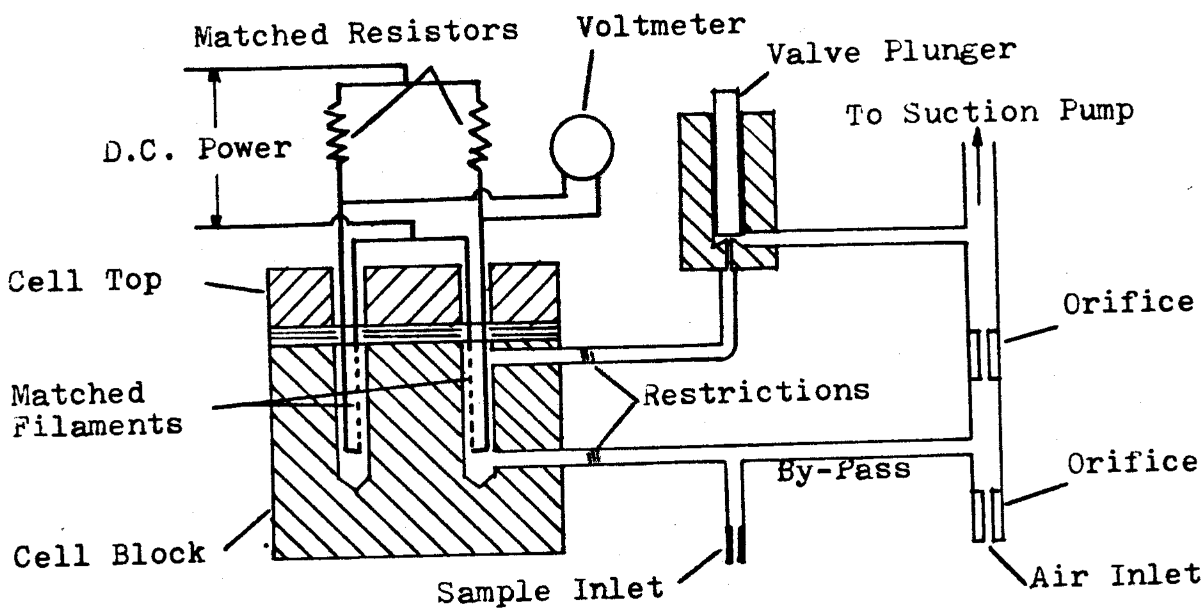
Maximum Span Error:

70 F (Hazard Location)	2 % of Reading*
80 F	2.5 %
90 F	3 %
100 F	4 %

* Error may increase at higher temperatures because of potentially higher absolute humidity.

Principle of Operation

In the simplified diagram below, the readout on the output voltmeter will be zero when the resistors and the filaments are perfectly matched and the gas surrounding each filament is the same. Filament resistance depends on filament operating temperature which depends partly on the thermal conductivity of the gas surrounding the filament.



THERMAL CONDUCTIVITY BRIDGE CIRCUIT

Sample gas is drawn continuously through the by-pass connection to the suction pump. Periodically the valve plunger is automatically lifted to permit a flow of sample gas through one filament cell. The movement of gas in the cell cools the filament but its temperature returns to normal when the valve plunger is lowered shutting off the sample flow. If the sample gas contains CO2 or H-1301, the normal filament temperature will increase because of the reduced thermal conductivity of the sample gas. This unbalances the circuit causing a voltmeter reading that is proportional to the volume percent of CO2 or H-1301 in the sample gas.

The complete cell circuit must have a number of additional features. The output is amplified to match the requirements of the recorder and variable resistors are included to attenuate the output for calibration purposes. Means must be provided to adjust the zero output position to existing conditions. In addition thermistors are embedded in the cell block and wired into the attenuation circuits to maintain a constant output when the cell block temperature changes as a result of operation or ambient temperature changes.

Handling and Storage.

In transporting and handling do not drop or subject the instrument to severe jolting or vibration since this might damage meter movements or other mechanical and electrical parts. Pack the instrument snugly in its carrying case with sufficient padding to prevent movement. Store in a clean dry place free of any corrosive atmosphere that could impair electrical components and contacts.

Operating Procedure.

Remove instrument from case and set on a stable horizontal surface. Avoid hot locations or direct exposure to radiant heat from the sun or other source. Connect to a 120 volt A.C. grounded power outlet that will not be shut off during a fire system test.

To remove or insert chart paper set the recorder switch to "OFF" and lift off the cover plate by pulling down and lifting out the bottom end first. To replace cover plate hook the top end in place first before pressing bottom end into position.

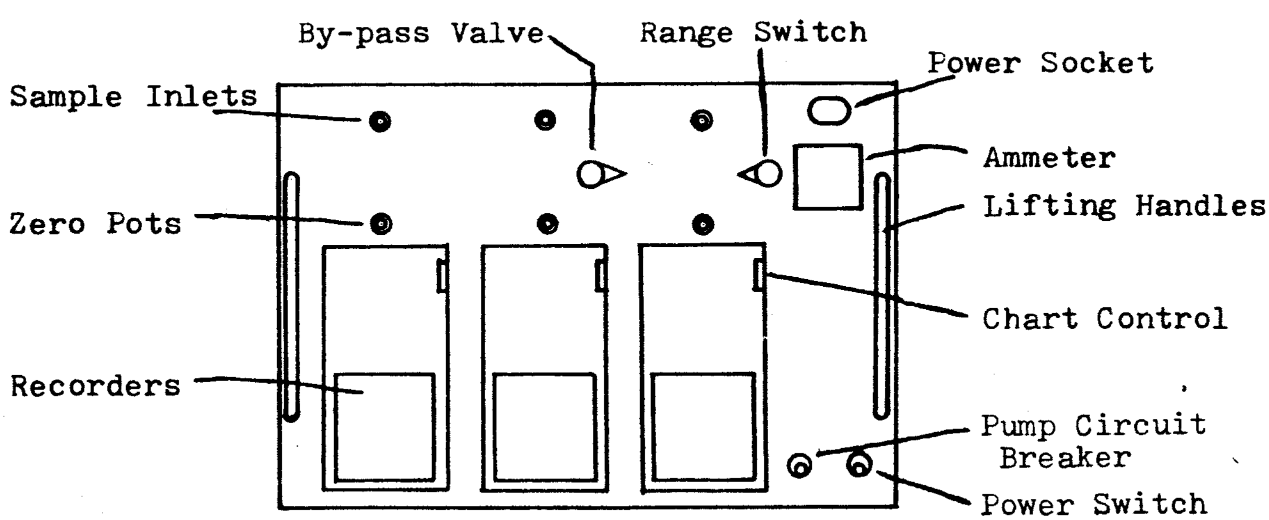
Before running an actual fire system concentration test it is good practice to begin with a Calibration Check to make sure that everything is functioning properly. See separate calibration instructions beginning on the next page.

1. Attach sample tubing lines from system test area.

2. Set by-pass valve to "RUN" and operate instrument for 5 minutes to clear out sample lines.

3. With range switch set for desired test gas, adjust zero position on recorders.

4. Make sure that the recorders are printing properly, the by-pass valve is in the "RUN" position, and the range switch is set on the proper range before discharging the fire system.



INSTRUMENT PANEL

Calibrating Procedure.

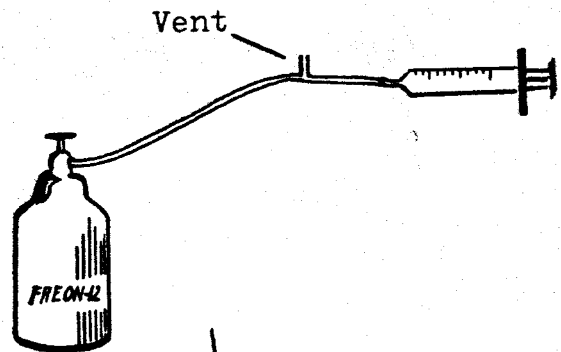
1. SAMPLE TUBE. The calibration sample tube provides a convenient means of preparing accurate volumetric mixtures of any test gas with air. It is designed to have an internal volume of 250 cc with a simple push rod mechanism for sealing the openings at each end. A plastic 20 cc syringe is used to inject a measured volume of test gas into the bottom inlet. The sample is then trapped with the remaining air in the tube by depressing the push rod. Mixing is accomplished by inverting the sample tube so that the disc assembled on the push rod will slide from one end to the other. The sample tube must be inverted at least ten times to assure thorough mixing while keeping the push rod depressed. The volume of test gas injected determines the concentration of test gas in the sample.

Syringe Volume in CC	5	10	15	20
Concentration in % by V	2	4	6	8

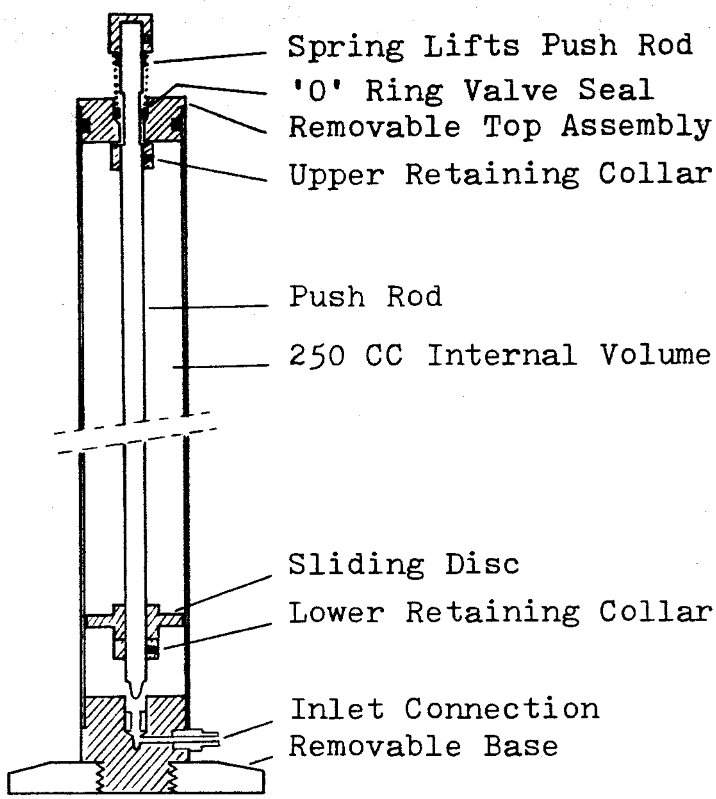
2. FILLING SYRINGE. Connect the syringe to the test gas supply by means of a short length of tubing containing a side tee vent. Block the vent with your thumb while slowly cracking the test gas supply valve until the flow is just enough to force the syringe plunger out in one or two seconds. Release the vent when the syringe is full and depress the plunger to expell all of the gas out of the side vent. Purge the syringe two or three times before taking a final sample. On the last fill adjust the end seal on the plunger directly over the desired volume mark with the vent open before closing the supply valve. Allow a few moments for temperature stabilization before detaching and connecting to the bottom inlet of the sample tube.

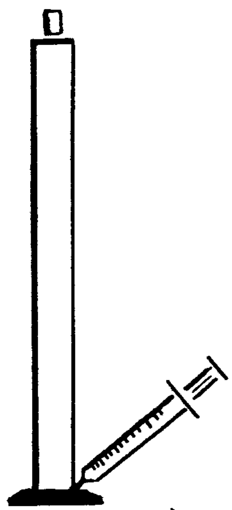
3. CALIBRATING HALON RANGES. For the H-1301 range, either H-1301 or H-122 (Refrigerant 12) vapor may be used since the readout will be the same within measurable limits. On units with a range for H-1211 use only pure H-1211 vapor. Operate the analyzer for at least five minutes to stabilize the electrical system. Set the by-pass valve on the panel to the 'CALIBRATE' position and set the range switch to the proper range. Block two of the three sample inlet tips with short lengths of plugged tubing leaving the third inlet (preferably the center one) for connection to the sample tube. Adjust the zero printout on all recorders before connecting a prepared sample for analysis. When the push rod is released the sample will be drawn into the analyzer while air enters the top of the sample tube. The sample should give a relatively flat response for nearly two minutes before the air interface begins to dilute the output. Continue operation until the printout returns to zero to check instrument linearity (uniform sample decay) and to flush the sample tube so it is ready for the next sample.

4. SPAN ADJUSTMENTS. It is recommended that span adjustments for calibration correction be made only on the basis of results with 8% mixtures (100% for CO2) and repeated testwork. The span adjustment is accessible through the openings on the front side of the casing and clearly marked on the inside. If there is any doubt that the unit is operating properly, check the Service Information section of these instructions.



SAMPLE TUBE ASSEMBLY

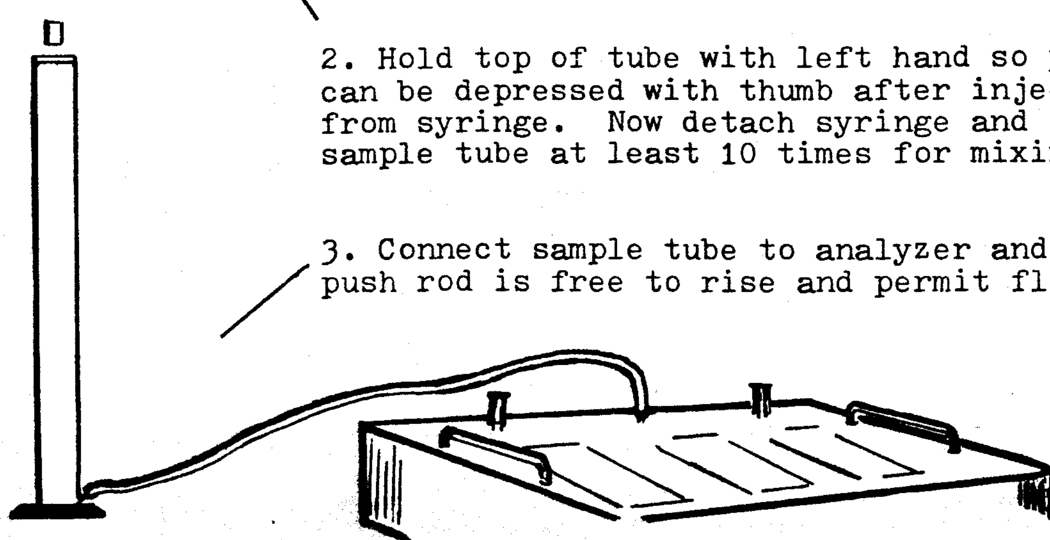




1. Hold syringe with small fingers of left hand so thumb is free to stop vent while opening valve.

2. Hold top of tube with left hand so push rod can be depressed with thumb after injecting gas from syringe. Now detach syringe and invert sample tube at least 10 times for mixing.

3. Connect sample tube to analyzer and release so push rod is free to rise and permit flow of gas.



5. CO2 VAPOR SAMPLE. The sample tube provides an ideal means of collecting a sample of pure CO2 vapor for calibrating purposes. Connect the CO2 vapor supply to the bottom inlet of the sample tube by means of the short length of tubing containing a tee side vent. Crack the supply valve to flow vapor at a reasonable rate out of the vent. Close the vent with thumb or finger to force the vapor through the sample tube until the inside has been purged with 4 or 5 volumes of gas.

6. CALIBRATING CO2 RANGE. Both the air used to zero the analyzer and the CO2 sample gas should be humidified by passing through a moist saturater before entering the analyzer. The saturater consists of a short section of enlarged tubing filled with cotton batting. The cotton is moistened by drawing in <u>cold</u> water and then blowing out all of the excess water. A fresh dry tube should be inserted into the saturater section for connecting to the analyzer to eliminate any chance that a droplet of water could be drawn into the analyzer. Continue the calibration test as described in (3).

7. EFFECT OF HUMIDITY. Water vapor in the air or sample will depress the output reading in direct proportion to the percent of water vapor present. This tends to be self compensating if the humidity of the sample mixture is nearly the same as the air used to zero the recorders. When calibrating with an 8 % concentration of test gas, the mixture will retain 92 % of the original air so the change in humidity is not great. In the case of CO2, none of the air is retained and the CO2 sample contains almost no water vapor unless humidified with a saturater.

8. AMBIENT TEMPERATURE. The model CH3F analyzer is compensated for changes in cell block temperature so changes in ambient temperature will not in itself have any appreciable effect on calibration accuracy. However, there is an indirect effect in that the amount of water vapor that the air can hold increases rapidly at higher temperatures. Below 70 F the effect is nearly negligible but at 100 F the potential error can become appreciable especially when the relative humidity is high.

9. PURITY OF TEST GAS. The commercial purity of test gases available is very adequate except for the presence of some lighter noncondensable gases such as air in the initial vapor phase. Most of the agent is liquified but air or nitrogen tends to concentrate in the vapor space over the liquid. Fortunately, such gases are drawn off first so that by the time 5 or 10 % of the contents are withdrawn the purity of the remaining vapor will be essentially 100 % for calibration purposes.

10. WATER IN SAMPLE LINES. From an operating viewpoint every effort should be made to avoid the presence of liquid water in the sample tubing lines. This could happen if the room to be tested is wet or has a high humidity and a temperature higher than that where the analyzer is located. If water is drawn into the analyzer, the operation may be severely upset until the internal circuits have been completely dried out.

Functional Description.

The function of the various parts of the recording analyzer is described in this section. The purpose is to provide a clear explanation of the operation or function of the various components as an aid in diagnosing and servicing any possible malfunction.

1. 120 VOLT CIRCUIT. The analyzer is energized from an external 120 volt 60 Hertz power supply. It can function from a 50 Hertz power supply but the printing frequency will be reduced to 10 points per minute from the normal 12 point rate.

Power is supplied through a three wire extension cord with the center conductor grounded to the panel. The input lines are routed through 1 ampere fuses that are accessible when the panel is removed from the protective casing. The normal line current is about 0.65 amperes so the fuses will not blow unless there is an internal fault.

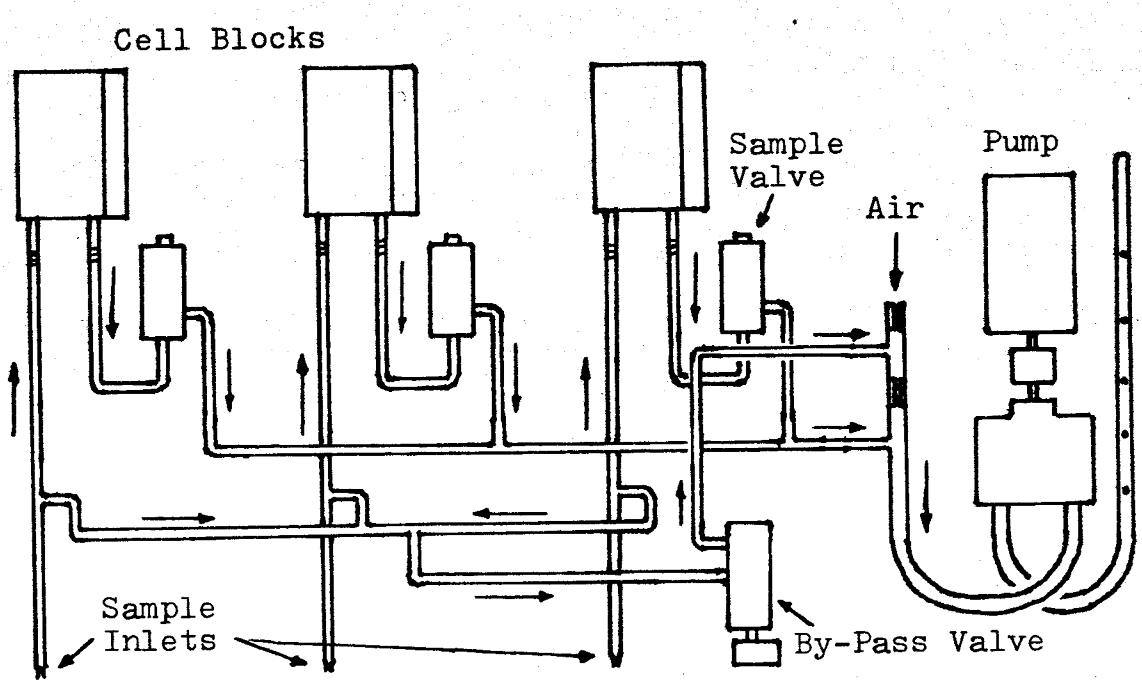
The recorder chart drives are operated directly from the 120 volt supply but the pump motor and cell circuits are operated at reduced voltage from transformers.

2. PUMP AND MOTOR. The sample pump draws gas through the sample lines and internal tubing circuit to provide fresh samples as required. The pump is designed with close fitting graphite vanes for positive displacement performance. Both pump and motor are fitted with prestressed ball bearings with life time lubrication.

The motor is designed for efficient direct current operation using a permanent magnet field. Power is supplied through a transformer that reduces line voltage to 25.2 volts at 1 ampere. This is rectified to provide 24 volts D.C. to operate the motor. The motor shaft will turn clockwise as viewed from the shaft end when the positive line is connected to the motor terminal marked (+). The brush life on the motor is rated at 1000 hours at full load.

A 1 ampere circuit breaker is installed in the D.C. line to the motor to protect against overloads. If this trips,the reset button located on the instrument panel next to the power switch, will pop up. It can be reset after a short cooling period.

3. INTERNAL TUBING CIRCUIT. The internal tubing circuit is designed for a continuous high flow rate from the gas sample lines in order to provide fresh intermittent samples to the measuring cells with minimum delay time. In the diagram on the next page, sample gas is drawn into the restricted tips to which the external sample lines are attached. Most of the flow goes into the by-pass manifold, through the by-pass valve, and into the main suction line to the pump.



INTERNAL TUBING DIAGRAM

Proper operating suctions are maintained by the two orifice plugs in the main line to the pump inlet. The first air inlet orifice regulates the vacuum to from 8 to 16 inches of water column to draw gas through the external sample lines. The second orifice provides an increased vacuum to draw gas through the cell blocks when the sample valves open.

The sample valves are mounted on the underside of each recorder and are operated by means of a bell crank that engages the chart drive mechanism so as to lift the valve plunger briefly during the printing cycle. This permits a fresh flow of sample gas into each cell block immediately after the results of the previous sample have been printed. The flow of gas into the filament cavity momentarily cools the filament causing a sudden drop in meter reading. This can be observed by removing the chart paper and setting the chart control to the 'OFF' position during operation.

The rate of sample flow through each cell is limited by restrictions consisting of short 6-32 set screws inserted in the tubes leading to and from the cell blocks. The by-pass valve is used to shut off flow through the by-pass connections during calibration so as to avoid wasting the limited supply of sample gas prepared for the purpose. The discharge from the pump is used to aspirate air through the end openings in the protective casing so as to help induce ventilation for cooling. The back pressure from the discharge manifold also reduces pump noise.

4. REGULATED D.C. POWER SUPPLY. The thermal conductivity measuring circuits operate on low voltage direct current. The supply voltage must be closely regulated because the detecting sensitivity changes substantially with any change in voltage. A type LM317T IC voltage regulator is used to control the rectified transformer output to about 8 volts for the cell circuits. The exact operating voltage is adjustable by means of a 500 ohm trimmer in the resistance network.

5. CELL CIRCUITS. The function of the cell circuit is to compare the resistances of the two filaments in each cell block and amplify the output as required to match the recorder meter. The filaments are mounted on a movable plate for adjustment to an optimum position to minimize zero shifting when the cell block temperature changes. An internal zero adjustment is provided to move the zero point into the range of the 10 turn zero pots mounted on the instrument panel.

The output from the cell circuit goes to the recording meter after passing through attenuation resistors and the range selector switch. The H-1301 range includes a 500 ohm trimmer for calibration adjustment and a 1000 ohm thermistor in parallel with a 470 ohm resistor. The thermistor is embedded in the cell block so it will closely follow cell block temperature and provide variable resistance compensation for reduced cell output as the temperature increases. The CO_2 range requires more compensation which is provided by a 5000 ohm thermistor in parallel with a 1500 ohm resistor.

6. RECORDERS. Modified Amprobe Model FDC-8500 recorders are used to record the output from each cell circuit. These have a nominal range of 0 to 500 microamperes but the circuit is changed to give a full scale reading with about 300 microamperes. It is provided with a thermistor network to compensate for resistance change when the coil gets hot. In addition a sample gas flow control valve is mounted on the back of each meter and a bell crank mechanism is installed on the inside to open the valve during the printing cycle. The function of the valve is to bring a fresh gas sample into the cell block each time the recorder prints the output from the preceding sample.

The recorders are driven by a clock type synchronous motor that prints a point every 5 seconds and moves the chart paper at a rate of 12 inches per hour. Printing and chart advance can be stopped by means of the "ON" "OFF" control on each unit. This should be placed in the "OFF" position when loading or removing the chart paper to make sure that the meter pointer is not pressing on the paper. Since the output is linear with respect to concentration, a linear type chart paper such as Amprobe No. 850D must be used.

Service Information.

The process of running a careful calibration test will serve to detect any internal malfunction that could interfere with normal operation. For service purposes this test should include a 10 second interruption of sample flow by depressing the push rod on the sample tube. Even a small leak will cause a drastic reduction in the reading of the cell nearest the leak. It should be noted, however, that the calibration test does not check the external sample lines nor the possibility that one of the sample inlet tips might be blocked by foreign material. The inlet tips should be checked visually or by poking a wire or no. 60 drill through the opening.

Except for the obvious problems of power supply or fuse failure, the following trouble shooting suggestions may help to identify the cause of some possible malfunctions. Reference is made to a number of special service notes covered in the subsequently numbered paragraphs.

Trouble Shooting Suggestions

Meter Readout	Possible Malfunction
No Response	Check for open circuits between meter, circuit board, and range switch. Check range switch in another position.
Below Zero	Check sample valve (5) and filaments(7).
Above Full Scale	Check filaments (7).
Slow Response	Check by-pass valve (4), sample valve (5), and tubing restrictions (6).
Low Readout	Check ammeter on panel for normal reading. Check for internal leakage during calibration test. Check external sample lines for leakage or blockage.

1. FUSE. The normal A.C. operating current is 0.65 amperes at 120 volts. The 1 ampere internal line fuse will not blow unless there has been a circuit fault or other damage. If fuse must be replaced, check for cause of overload to make sure the equipment will continue to operate properly.

2. PUMP. A broken pump vane or excessive dirt buildup could cause jamming and stall or overload the motor. The locked rotor load will not be enough to blow the 1 ampere line fuse but will open the 1 ampere circuit breaker which is in the low voltage D.C. supply to the motor. This protects the pump motor and the transformer from damage. Make sure the pump rotates freely.

Do not attempt to lubricate the pump or motor. Sluggish or irregular pump operation due to dirt buildup in the vane slots can usually be alleviated by flushing with several teaspoonfuls of recommended solvent while the pump is running.

To do this connect separate tubes to the inlet and outlet of the pump to introduce and discharge the solvent safely. Protect the panel from any solvent that may leak from the joints in the pump housing. Continue to run the pump drawing in air until all of the solvent has been evaporated. Recommended solvents are "Locktite Safety Solvent", "Dow Chemical Chlorothane", "Inhibisol Safety Solvent", or equivalent. Caution -- Do not use kerosene or other petroleum base solvent since these will soften the graphite vanes.

3. PUMP MOTOR. Motor must be accurately aligned with pump to minimize vibration. Gradual reduction in pump speed with sudden return to normal could indicate the possibility of brush hangup. Normal brush life is rated at 1000 hours.

4. BY-PASS VALVE. The response would be very slow if a test is run with the by-pass valve in the CALIBRATE position which may produce delays of 1 to 2 minutes in long sample lines. Conversely, if a calibration test is made with the by-pass valve in the RUN position (open) the entire sample would be used up after printing only a few points.

5. SAMPLE VALVES. If the sample valve (mounted on the back of each recorder) does not close tightly, there will be continual flow through the cell causing reduced and probably variable readings. If the valve fails to open, the sample will not be renewed and the response to a sample change will be slow to none. The operation of the valves can be checked by setting the recorder control to "OFF" and removing the chart paper. Set the range switch on the 0-10 H-1301 range and move the pointers upscale by adjusting the zero setting. Each pointer should move downscale briefly in response to valve opening and then return to the point of highest reading. If the suction line to the pump is disconnected, the down movement stops and the pointers should slowly move up about one more division on the scale.

When the valves are properly adjusted, each plunger should lift about 1/16 th of an inch during the opening cycle. The valve body must be carefully aligned with the bell crank to prevent side forces that might cause sticking.

6. TUBING RESTRICTIONS. The 6-32 set screws inserted into the tubes connecting to the cell blocks are needed to limit flow through the cells. If these become nearly blocked with foreign material, response time will be slow. Check pointer movement as described in (5).

7. CELL FILAMENTS. The panel meter indicates total direct current through all the cell circuits. If one filament should break, the meter reading will be reduced by about 10% and the recorder reading will move to the top or bottom of the scale. The filaments are mounted on an adjustable plate that can be swiveled within limits about the center stud. This changes the position of each filament and will shift the readout through a wide range. The purpose of the adjustment is to minimize zero drift caused by changing cell block temperature.

If the filiments are removed for examination, use the following procedure. Move the zero adjustment on the panel to the maximum upscale position. Set recorder in the "OFF" position and remove chart paper. Disconnect power line and remove the three stud nuts so filament assembly can be lifted from cell block. The underside of the filament plate is coated with stop cock grease to prevent air leakage. Replace the filament assembly on the cell block and replace washers and nuts on the studs but do not tighten. The power may now be turned on with the range switch in the 0-10 H-1301 position. Swivel the filament plate to bring the readout back to the original reading (or near 3.5%) before tightening the stud nuts. The internal zero adjustment on the circuit board is normally not used except to permit proper adjustment when replacing the filaments and adjusting for zero drift.

8. RECORDERS. Very light printing by a recorder would result if the internal spring clips that hold the meter in place against the printing glass plate should be bent or slip out of position. If this happens the glass plate will be noticeably loose. The recorder must be disassembled to correct this problem.

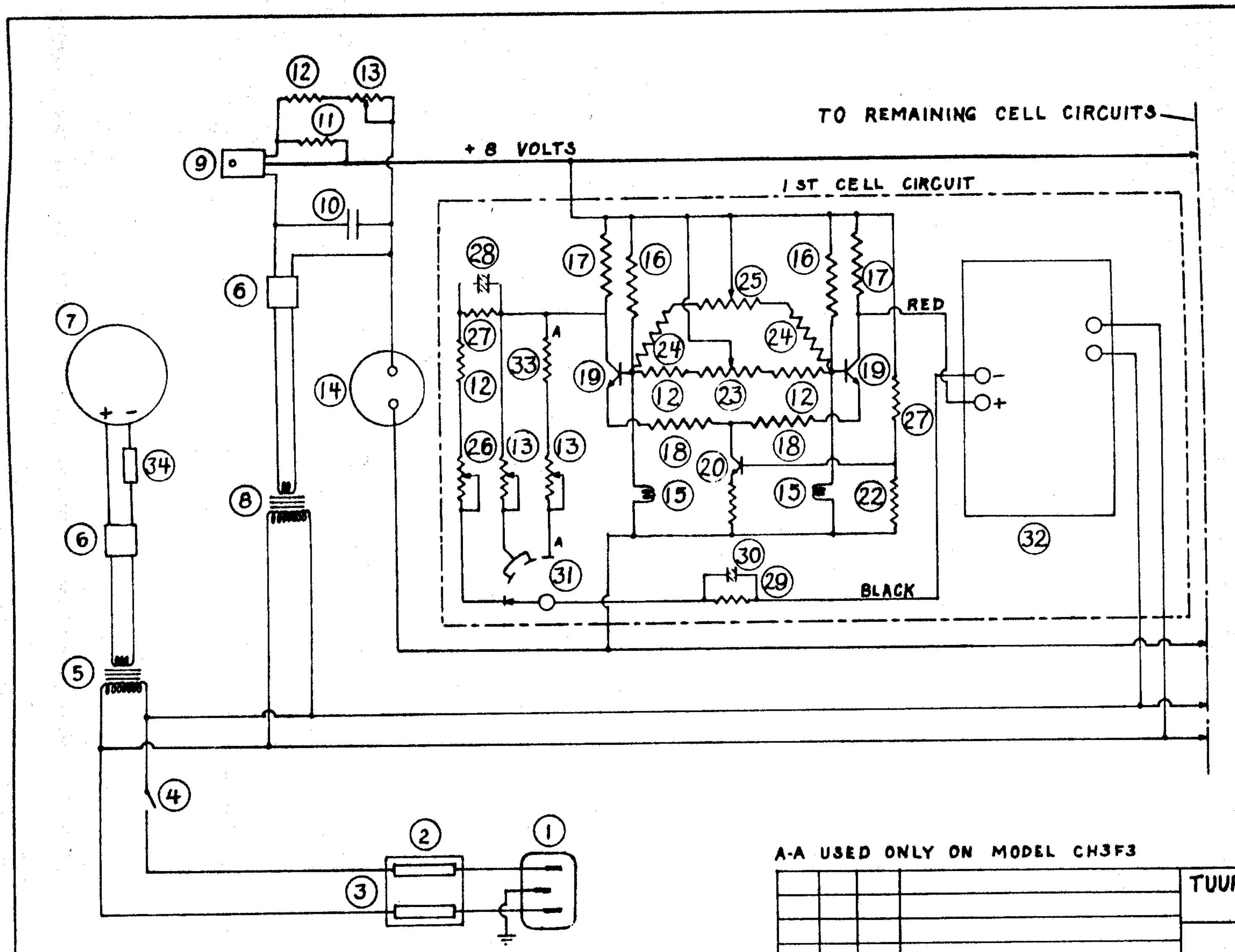
The "ON""OFF" control on each recorder depends on the stiffness of a plastic strip to push the switch into the "ON" position. If this is actuated when the recorder face is over heated such as by exposure to direct sun radiation or other heat, the plastic strip may be bent out of shape so it will no longer be capable of pushing the print mechanism to the "ON" position.

If a meter pointer is bent slightly as a result of shock or rough handling, it may touch the print plate or plastic cover sheet in certain places causing nonlinear print out. This would show up as irregular spacing of the printed dots as the sample decays to zero after a calibration test.

Factory Service

Factory service may be obtained on all units by returning to Tuure Instrument Company. Pack the equipment well to avoid damage in transportation. Alternately, replacement parts are also available. It is advisable to call (815-623-6822) before returning unit.

Tuure Instrument Company
8445 Croix Trail
Roscoe, Illinois 61073



NO.	ITEM
34	CIRCUIT BREAKER 1 AMP
33	RESISTOR 200 OHMS
32	RECORDER-AMPROBE
31	RANGE SWITCH 3-POLE
30	THERMISTOR 1 K
29	RESISTOR 470 OHM
28	THERMISTOR 5 K
27	RESISTOR 1.5 K
26	TRIMMER 1 K
25	ZERO ADJ. POT. 5 K
24	RESISTOR 5.1 K
23	TRIMMER 5 K
22	RESISTOR 390 OHM
21	RESISTOR 75 OHM
20	TRANSISTOR 2N3390
19	1/2 TRANS. 2N2920
18	MATCHED RES. 33 OHM
17	MATCHED RES. 294 OHM
16	RESISTOR 5W 75 OHM
15	MATCHED FILAMENTS
14	PANEL AMMETER 1 AMP
13	TRIMMER 500 OHM
12	RESISTOR 1 K
11	RESISTOR 240 OHM
10	CAPACITOR 1000 MF
9	VOLTAGE REG LM317T
8	TRANSFORMER 0.7A-12 V.
7	PUMP MOTOR 24 V. D.C.
6	RECTIFIER 18DB2A
5	TRANSFORMER 1A-25.2 V.
4	SWITCH
3	FUSE 1 AMP
2	FUSE BLOCK
1	POWER RECEPTACLE

A-A USED ONLY ON MODEL CH3F3

REV.	BY	DATE	DESCRIPTION

TUURE INSTRUMENT COMPANY
ROSCOE, ILLINOIS

WIRING DIAGRAM
RECORDING GAS ANALYZER

MODEL	SCALE
CH3F & CH3F3	NONE

BY	DATE	DWG NO.
H.V.W.	8-24-81	100