

YELLOW SPRINGS  
INSTRUMENT CO., INC.

YELLOW SPRINGS, OHIO 45387

**INSTRUCTIONS**

**FOR**

**YSI MODEL 80**

**LABORATORY**

**RECORDER**

**INSTRUCTION BOOK YSI MODEL 80 RECORDER  
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**220 VOLT INFORMATION**

If this instrument has been purchased as a 220 VAC Model, the following notes should apply to statements made in the instructions.

**Power Requirements:**

1. 220 VAC — Operable from 190-250 VAC.
2. Wattage as stated in instructions.
3. Current requirements of instrument is  $\frac{1}{2}$  that stated.
4. Motor speeds and chart drive as stated in instructions.
5. The schematic contains notes indicating changes which have been made to the circuit.

# MODEL 80 LABORATORY RECORDER

## GENERAL DESCRIPTION

The Model 80 Laboratory Recorder is a versatile general purpose D.C. voltage and current recorder. The effective range of this instrument extends from low level D.C. voltages and currents of 200 microvolts and 20 millimicroamperes up to 500 volts and 100 milliamperes. This exceedingly wide range capability makes it a suitable instrument for a multitude of laboratory and industrial applications.

The recording stylus is completely inkless and free from maintenance. The stylus continuously follows the input signal, and every two seconds is pressed against the pressure sensitive chart paper to mark a dot. These dots join together to form a line. When input varies rapidly the record becomes a dotted line with the change in input in two seconds represented by the horizontal distance between two dots. The recorder will follow full chart width changes during the two seconds between marking.

The Model 80 circuit consists of an input network followed by a chopper and a four-stage A.C. amplifier. The chopper converts the D.C. input into a proportionate A.C. carrier signal which is amplified by the A.C. amplifier. The output of the A.C. amplifier is synchronously rectified and filtered. Stability, linearity, and high input impedance are maintained by the use of a large amount of inverse feedback.

Speed change is achieved simply by the interchanging of gear assemblies. The recorder is furnished with gear assemblies to drive the chart at 1 inch per hour and 15 inches per hour. Six additional assemblies (2, 3, 6, 10, 12 and 30 inches per hour) are available, see chart characteristics.

Three input terminals, HI, LO and GND are provided for either grounded or floating input operation.

Input sensitivity may be selected in decade steps on the RANGE switch. Intermediary sensitivity may be obtained with the SPAN control which provides continuous adjustment between calibrated ranges.

The multi-turn ZERO OFFSET control permits zero left, zero center, or zero right as well as up to 4 times full chart width zero suppression in either direction on all ranges.

## SPECIFICATIONS

Effective Instrument Range:

1. 200 microvolts to 500 volts.
2. 20 millimicroamperes to 100 milliamperes.

Sensitivity:

1. With the SPAN control in the RANGE CALIBRATED position, ten calibrated ranges provide sensitivities from 200 microvolts per chart division to 2 volts per chart division, and 20 millimicroamperes to 200 microamperes per chart division, accuracy  $\pm 2\%$  of range setting.
2. The SPAN control provides continuous adjustment between calibrated ranges and extends the minimum sensitivity to approximately 20 volts per chart division or 2 milliamperes per chart division.

Input Characteristics:

1. Either grounded or floating input (200 volts maximum above or below ground).
2. Non-polarized input terminals and a continuous multi-turn ZERO OFFSET control permit zero left, zero center, zero right, as well as up to 4 times full chart width zero suppression in either direction on all ranges.
3. 1 megohm input resistance on all voltage ranges.
4. 10 millivolts drop at full chart deflection for all current ranges except 100 millivolts on 10 milliamperes range.

Chart Characteristics:

1. Chart width: 2.31 inches.
2. Speed: 15 inches per hour and 1 inch per hour standard. Six additional assemblies, 2, 3, 6, 12 and 30 inches per hour are available. For 117 volt instrument operated on 50 Hz line Chart Speeds are 5/6 of above. For 220 volt instrument operated on 60 Hz line Chart Speeds are 6/5 of above.
3. Chart length: 63 feet.
4. Chart divisions: 50.
5. Response: recorder samples once every two seconds and will follow full chart width changes within sampling period without lag.
6. Chart take-up: built-in chart take-up reel or may be operated "tear-off."
7. Readability:  $\frac{1}{2}\%$ .

Stability: Better than 1% with normal variation in line voltage and room temperature, less than 2 minutes warm-up time required.

Power Requirements: 117 or 220 volts; 50-60 Hz, 15 watts.

Dimensions:

1. Size:  $9\frac{3}{4}'' \times 5\frac{3}{4}'' \times 7\frac{3}{4}''$ .
2. Weight: 11 pounds.

## WARNING

Absolute Maximum  $\pm 500V$  for voltage recording.  
Absolute Maximum 100 ma for current recording.  
200 Volts max. for floated input  
above or below ground.

Care should be exercised in unpacking the Model 80 recorder. It is advisable to remove the back grill and perform a visual inspection to check for seating of vacuum tubes, tube shield. It is important for proper operation that the cable connector between the amplifier chassis and the back of the recorder be securely plugged into the receptacle on the back of the recorder box. After inspection replace the back grill.

The extra gear assembly supplied with the recorder is held in a hinged compartment inside the recorder box. The compartment should be snap fastened to the top of the recorder box. An extra gear assembly retaining spring is also in the gear compartment. This is a reserve spring in case of accidental loss or damage.

## OPERATING INSTRUCTIONS

1. Mechanical zero adjustment: The stylus is the pointer of a meter movement, and should be mechanically aligned with the left chart line with no electrical input to the movement. The alignment is correct when the stylus, clamp bar, and left chart line intersect. This adjustment should not be attempted with the POWER switch ON or with the stylus clamped. Adjustment is accomplished with a screwdriver from the front of the recorder unit. Accurate mechanical zero is not necessary since small misalignments can be compensated with the ZERO OFFSET control.

2. Set RANGE switch to 0; rotate SPAN control clockwise to RANGE CALIBRATED position.

3. Connect line cord to 117 v. 50-60 Hz outlet. If connected to a two-wire supply system, using the line cord adaptor provided, ground the green wire on the adaptor to a good earth ground. With a three-wire supply system, external grounding is automatically provided and further grounding is unnecessary, and (except in extraordinary circumstances) should not be used.

4. Turn POWER switch ON and CHART DRIVE switch on.

5. Allow instrument to warm up for 2 minutes.

6. Adjust ZERO OFFSET control (a ten-turn control) for the desired zero position which can be any position on the chart. In addition, the zero may be set to 4 times chart width in either direction for suppressed zero or expanded scale operation.

7. Connect input to HI and LO terminals and select desired range. If input characteristics are not known zero should be set in the center of the chart and consecutively lower ranges should be tried until a deflection of the stylus is noticed. A deflection of one major division on the chart paper represents full-scale deflection on the next lower range. Stylus deflects to the right for a positive signal connected to the HI terminal.

## INPUT CHARACTERISTICS

The Model 80 uses a conventional chopper amplifier provided with heavy input filtering which discriminates against hum voltages applied to the recorder input terminals by the signal source or the external wiring. In some extreme cases, it may be necessary to provide shielded leads for all external wiring in order to avoid the small recorder offsets (additive or subtractive) resulting from the presence of too much hum at the input. One of the most effective methods of reducing hum pickup at the input is to ground one side of the input (LO or HI) to the GND terminal. This method should always be used when it is electrically permissible to ground one side of the input signal source. If, in addition, the signal being recorded is floating with respect to ground, it may be necessary to add an external capacitor between the LO terminal and GND.

## ZERO OFFSET CONTROL CHARACTERISTICS

The polarity and magnitude of the offset signal is adjusted by the ZERO OFFSET control, enabling one to set a zero anywhere on the scale (or on specific applications up to 4 times scale deflection off to the right or left).

The ZERO OFFSET signal is placed in series with the INPUT signal to produce a total signal to the amplifier. However, to avoid confusion or interaction with other controls the ZERO OFFSET signal is **not** affected by the input RANGE switch or the SPAN control. Since the ZERO OFFSET signal and the INPUT signal are connected in series to produce a total input to the amplifier, the ZERO OFFSET signal can be viewed as adding to or subtracting from the INPUT signal depending on polarity.

The subtracting feature of the ZERO OFFSET can be used to advantage in certain application known as "Expanded Scale" or "Suppressed Zero" operation. For example: If a D.C. voltmeter indicates at all times in the upper half of the scale (i.e. meter readings are always in the range from mid-scale to full-scale) it is possible to connect the input of the recorder across the meter and record the upper half of the meter on the full-chart width. Select a suitable range on the recorder and proceed to use the ZERO OFFSET control to buck out the lower half scale signal from the meter, so that the recorder reads zero when the meter reads half scale and adjust sensitivity so that the recorder reads full-scale when the

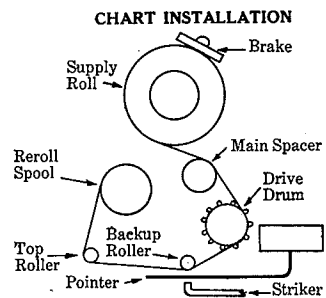
meter also reads full-scale. **These two operations must be repeated several times until both settings are correct.** The above example gives a scale expansion factor of two.

## UNCLAMPING OF THE STYLUS

The Model 80 can be used as an indicating vacuum tube voltmeter or microammeter without performing trace recording. During such operation the stylus should be completely free to deflect with the CHART DRIVE switch turned OFF. Turn off the switch when the clamping bar is just beginning to leave the stylus; the momentum of the drive motor will then lift the clamping bar completely clear of the stylus.

## CHART DRIVE INSTRUCTIONS

1. Loop paper around drive drum sliding between meter pointer and backup roller.



2. Lift brake and insert supply roll.  
3. Release gear train and pull paper through to correct time. (Time indications printed on the chart are of meaning only in terms of one inch per hour operation. Time references for other chart speeds should be marked on the chart through the flip open window.) To release the gear train push the gear assembly in the direction of the arrow and hold.

4. Attach paper to reroll spool with tape.

5. Run the recorder chart to insure correct feeding of the paper.

To change chart speeds change the gear assembly as follows: Remove retainer spring by pulling top of spring toward paper drums and twisting to remove from the hole at the bottom. This allows the gear assembly to pivot far enough to completely disengage the retaining tabs. The gear assembly can then be lifted up and out from the bottom. Reverse procedure to install a gear assembly.

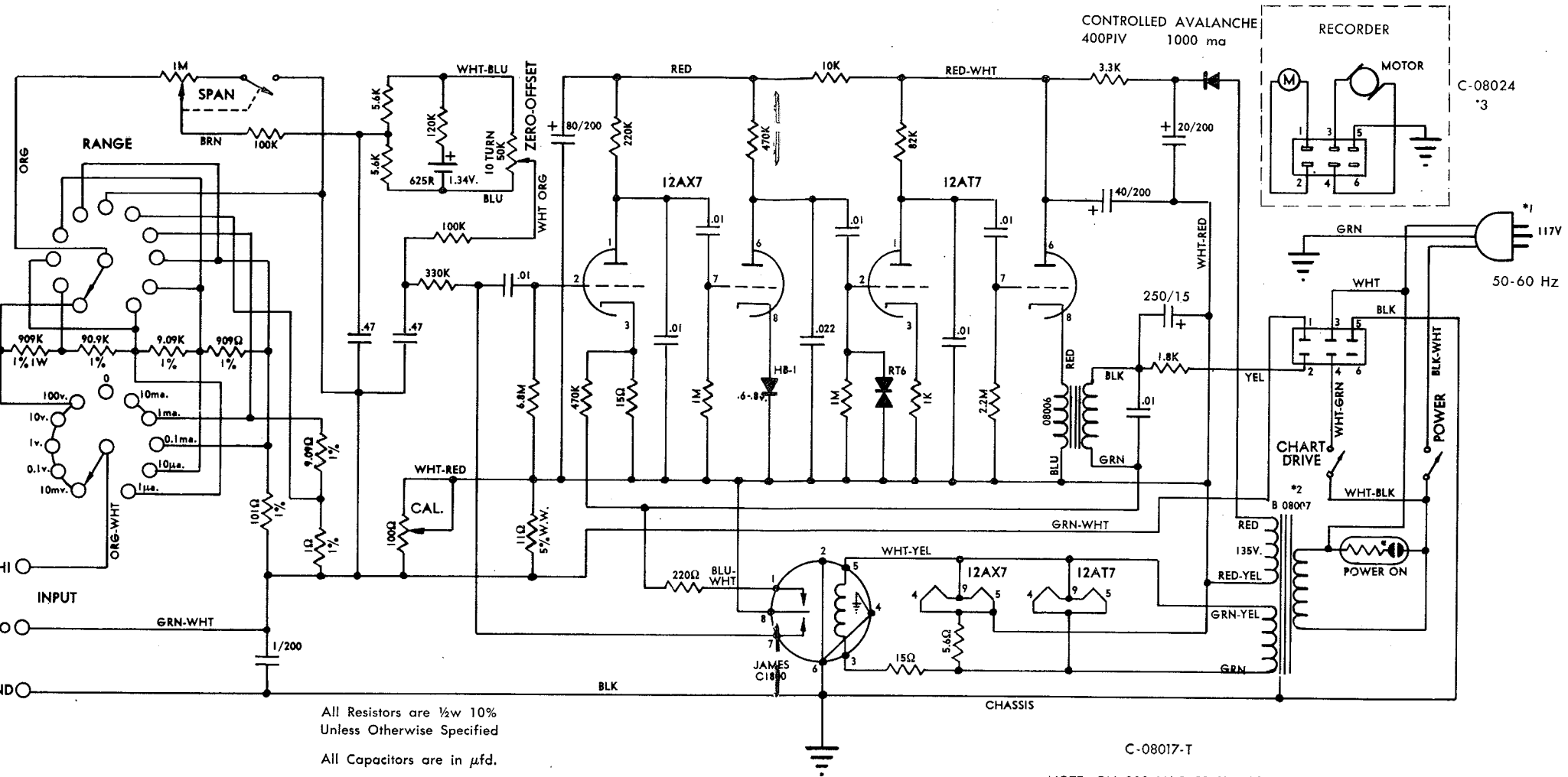
Adjustments and Maintenance: There are no adjustments required. This unit is factory adjusted for optimum performance. No oiling is required, nor should ever be done.

## TEAR-OFF OPERATION

For convenience in short run recordings the recorder paper may be operated tear-off. The following procedure will insure correct operation.

1. Loosen thumb screw and open recorder door all the way.

2. Take reroll spool out of slots and remove all paper (if any) from this spool. Replace empty spool and close retainers to lock spools in slots.



### Model 80 Schematic

C-08017-T  
 NOTE: ON 220 VAC 50 Hz MODEL THE FOLLOWING CHANGES ARE EFFECTIVE:  
 \*1. 220 VAC 50 Hz  
 \*2. B-08057  
 \*3. C-08062

3. Push gear assembly to release gear train; at same time pull out about 5 inches of fresh paper, if 5 inches or more of used paper is available it is not necessary to pull out fresh paper. Tear off any excess beyond 5 inches.

4. Lift up recorder door so that end of paper can be threaded through slot on top of recorder box. Close door slowly feeding paper through slot.

5. Pass end of paper under handle. This should leave about 1 inch of paper overhanging the back of the recorder case.

6. To provide a small amount of tension on the paper any small laboratory clamp can be clipped onto the end of the paper or any 1 or 2 ounce weight or a 50c coin can be taped to the end of the paper and allowed to suspend over the back of the instrument case.

At the beginning of each tear-off run, it is recommended that the recorder be run until internal gear train clearances are taken up before starting to record.

### **MAINTENANCE PROCEDURE**

#### **General:**

Excessive drift in the recorded trace and excessive noise in the output resulting in uneven and broad trace line often indicates low gain and noise in the amplifier. Malfunction in tubes and chopper is the major cause of low gain and noise. When failure of these components is severe the amplifier either has no output or the output is erratic and oscillatory.

Replacement of tubes and chopper is recommended as a first step in maintenance followed by recalibration. Step by step procedures are given in the following paragraphs. If compliance with proper procedures fails to give satisfactory results, it is suggested the recorder be carefully packed and returned to the factory for service.

### **REMOVAL OF FRONT PANEL ASSEMBLY FROM RECORDER CASE**

1. Remove back grill — Remove four screws around the periphery of the back grill. Lift out back grill passing line cord through slot at bottom center.

2. Detach front panel assembly from the recorder case — First, remove four screws from the top of the front panel (2 on extreme right and 2 on extreme left). Second, remove the 3 remaining screws on the bottom of the recorder case. Move the panel forward and out of the case. Turn the assembly on its side with the recorder box down.

### **TUBE AND CHOPPER REPLACEMENT**

1. The input tube is an ECC83/12AX7. This tube is located in the socket which has a tube shield.

2. The output tube is a 12AT7. This tube is not shielded. After replacement of tubes or chopper the recorder should be checked for noisy

trace and for possible non-linearity. If either symptom is present, different tubes should be tried. It would also be wise to check calibration in these circumstances.

3. If changing tubes and chopper does not correct the malfunction noted the original tubes and chopper should be returned to the instrument before the instrument itself is returned for service.

## RECALIBRATION

Recalibration of the Model 80 recorder is easy to perform; either voltage or current D.C. standards may be used. A simple circuit consisting of a flashlight battery and variable resistors with an output monitored by the standard (for example: a 1 milliampere or a 1 volt meter) can be used as an input. The recalibration accuracy will be a function of the accuracy of the standard. The following procedure is recommended.

1. Remove the back grill. Do not remove front panel assembly.
2. Perform the OPERATING INSTRUCTIONS as given in an earlier part of this manual; adjust for zero-left operation. Switch SPAN control to RANGE CALIBRATED position.
3. In accordance with the standard being used, select the appropriate full-scale RANGE. (Example: for a 1 ma. standard select 1 ma.)
4. Connect the standard input. Positive side to HI terminal, negative to LO, and connect GND and LO together.
5. Adjust the CAL control located on the back of the chassis for full-scale deflection. Only one range need be calibrated for the complete calibration of the instrument.
6. Replace back grill.

## MAINTENANCE OF MERCURY CELL

The Model 80 uses one 1.34 v. mercury cell in the ZERO OFFSET control circuit. The current drain is negligible and the cell should operate for its full shelf life of 2 to 2½ years. It is recommended that the cell be changed for a fresh unit every two years. Replace with Mallory part number RM625RT (or equivalent). The cell is easily accessible by removing the back grill.

## TEMPERATURE RECORDING WITH YSI TELE-THERMOMETERS

The Model 80 Laboratory Recorder in conjunction with Yellow Springs Instrument Company Tele-Thermometers is a complete temperature indi-

cating and recording system. A concise operating procedure is given as an aid to this specific mode of operation.

All models of YSI Tele-Thermometers are battery powered Wheatstone bridge temperature indicators with a thermistor probe as one arm of the bridge. The indicator is a 50 microampere (1800 to 2000 ohm) D.C. meter in a right hand zero configuration. At full-scale deflection the voltage output (connected to the red and black jacks marked RECORDER) is 100 to 120 millivolts.

1. Connect a lead from red jack on thermometer to LO input terminal, connect another lead from black jack to HI input terminal, and connect HI input terminal to GND terminal on recorder with a third lead. Turn thermometer OFF.

2. Set RANGE switch to **100 mv.**, rotate SPAN control full counter-clockwise (i.e. maximum attenuation or minimum sensitivity) and set stylus to right edge of chart with ZERO OFFSET control.

3. The red line position on the thermometer scale provides a convenient reference on the temperature scale for adjusting the span of the recorder. The percent of full-scale deflection of the red line temperature can be calculated with the following procedure.

a = number of degrees between left hand end of scale and the red line.  
b = total number of degrees in the range of the thermometer.  
percent of full-scale deflection of red line temperature =  $(a \div b) 100$ .

4. Turn thermometer on and set to red line. The recorder stylus should now be set with the SPAN control to the same percentage of full-scale deflection that red line is on the thermometer. For example: with a 0°C to 50°C range (range TD) the red line is at 5°C, or 10% (1 major division) from left edge of the chart. This percentage must be determined for each temperature range.

5. Insert probe in telethermometer. The thermometer-recorder combination is now ready to indicate and record temperature.

A small portion of the thermometer scale can be made to cover full-scale on the recorder by following the techniques for expanded scale operation described under the section ZERO OFFSET CONTROL CHARACTERISTICS. To facilitate this, substitute a decade resistance box for the thermistor probe and vary values of resistance to give the desired temperature points on the thermometer scale. (Example: for YSI interchangeable probes substitute 7336 ohms at 0°C, 2253 ohms at 25°C, and 155 ohms at 100°C.) See YSI probe brochure for resistance values on YSI Interchangeable 400 Series Probes.

The technique of using a decade resistance box to simulate temperature can be used to calibrate exactly the recorder chart to the non-linear scales of certain YSI thermometers such as the TE (-10 to +105°F).



## TEMPERATURE RECORDING WITH THERMOCOUPLES

Since a thermocouple is a voltage generator whose output voltage is proportional to temperature, a complete temperature indicating and recording system is obtained by using the Model 80 recorder in conjunction with the thermocouple in the following manner:

First adjust the Model 80 to the desired temperature range by setting RANGE switch to **10 mv.** Connect a voltage source corresponding to the temperature at the low end of the range to the HI and LO input terminals plus voltage to HI terminal. (If the low temperature is the same as the reference junction temperature this is 0 volts.) The ZERO OFFSET control is then set to give a zero reading on the recorder. A voltage corresponding to the high temperature is then applied to the input terminals and the SPAN control is adjusted to give full-scale deflection of the recorder stylus.

**These two operations must be repeated several times until both settings are correct.**

Now connect the thermocouple to the input terminals of the Model 80 with the plus lead going to the HI terminal, the minus lead going to the LO terminal and connect LO terminal to GND. The instrument is ready for use.

The above description applies to temperatures above the reference junction temperature. To measure temperatures below the reference junction the thermocouple leads are simply reversed at the input terminals of the Model 80.

## pH RECORDING WITH BECKMAN ZEROMATIC pH METER

First the Zeromatic should be modified for use with a recorder as described in Zeromatic instruction book. The descriptions given there are for either a current type or a voltage type recorder. Since the Model 80 is capable of performing as either type of recorder, the user has his choice. There is perhaps a slight advantage to connecting the pH meter for use with a voltage type recorder since a resistor can be put into the pH meter permanently and the pH meter used either with or without a recorder.

For voltage recording **any** stable resistor between 50 and 500 ohms  $\frac{1}{4}$  W or more can be used since the Model 80 has an adjustable span. The higher resistance values are slightly preferable since the recorder is less sensitive to electrical "noise."

After installing the resistor in the pH meter the recorder leads should be attached with the HI lead going to the pH meter +, the LO lead going to —.

With the pH meter at center scale, the ZERO OFFSET control on the Model 80 is used to set center scale on the recorder. Next the RANGE switch is set to the **1 v.** position, the SPAN control should be in the RANGE CALIBRATED position, and the pH meter should be made to read full-scale to the right. The RANGE switch on the Model 80 should then be switched to the position that causes the recorder pointer to go off-scale

to the right (**100 mv.** or **10 mv.**) and the SPAN control adjusted to bring the pointer back to full-scale. The system is then ready for use.

If it is not desirable to install a recorder resistor, the pH meter should be modified for a current-type recorder (as described in the Zeromatic instruction manual) and the Model 80 connected to the pH meter in the manner described earlier.

The Model 80 is adjusted in the same manner as described, except the RANGE switch should start in the **0.1 ma.** position. Then the pH meter is set to read full-scale, and the SPAN control is used to bring the recorder pointer back to full-scale.

If the pH meter is to be used without the recorder when set up for current-type recording, the + and — terminals of the pH meter should have a shorting lead connected between them.

## GENERAL LABORATORY RECORDING

Almost any instrument that has a D.C. voltage or current meter for a readout device can be recorded with a Model 80. This is done by merely connecting the Model 80 input terminals across the meter in the correct polarity and using the Model 80 on voltage settings of the RANGE switch.

This method of recording will work with any of the three common types of meters: zero right, zero center, or zero left. The input terminals are connected with the polarity that drives the recorder stylus in the same direction as the meter pointer. When there is no signal from the meter (i.e. no voltage drop across the meter) the ZERO OFFSET is adjusted so that the recorder stylus is in any desired position (for example: zero left, zero center, zero right).

The recorder can also be used for recording direct current in any circuit that has no more than 100 ma. by merely opening the wire through which the current is flowing and inserting the recorder. The Model 80 can also be used for recording any D.C. voltage between 200 microvolts and 500 volts with one side of the circuit grounded and the LO input terminal connected to the GND terminal, or between 200 microvolts and 200 volts if the circuit and the LO terminal are isolated from ground. This is true for any circuit that is not affected by a 1 megohm shunt resistance which is typical of many vacuum tube volt meters and oscilloscopes.

## GUARANTEE

The Model 80 Laboratory Recorder carries a 1 (one) year unconditional guarantee on all workmanship and components. Damage through accident, misuse, or tampering will be repaired at a nominal charge when the instrument is returned to our plant.