• *Electric Variometer*

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Because the thermistors are more sensitive than the platinum anyway, only two thermistors are used in the bridge in conjunction with two fixed resistors which are also necessary in order to limit the current. The 200 ohm potentiometer is used to balance the bridge at zero and the 500 ohm potentiometer is used to select the desired sensitivity. Even if minute, these thermistors are much easier to handle and tend to break in use much less than the .000080" diameter platinum wire used in the hot wire type.

The thermistor type rate of climb is definitely more easily made sensitive than the hot wire type and is much more rugged in service. Contrary to what one might suspect the thermistor units are not voltage sensitive. Recent calibration curves taken at 4½, 6, and 7½ volts showed only a few percent variation in performance. Two possible drawbacks are the greater sensitivity to ambient air temperature since the thermistors operate at only about 100°C as compared to about 400°C for the platinum filaments, and the greater time lag. The time constant of the thermistors used is 1 second, however the lag in flight tests to date does not seem a hindrance.

General Discussion

Since the platinum filaments operate in much the same manner as lamp filament, one can readily visualize the action. The resistance of the filament increases rapidly as the temperature increases, and air blowing over it cools it and lowers the resistance. The characteristic curves for three sizes of filaments are shown in figure C. For "C" and "D" see back.

The characteristic curve for the thermistors used is shown in figure D. In this case the resistance rapidly decreases as the thermistor temperature increases. Therefore the tendency would be for the thermistor to quickly go to a low resistance and burn out in current were it not limited by the fixed 500 ohm resistor in the circuit. Air blowing over the thermistor which is hot because of the I/2/R loss in it, cools and increases the resistance.

The arrangement of either the platinum or thermistors in the air stream is quite clearly shown to scale in figures A and B. It is easier to direct the air on the tiny thermistor bead than on two filaments. The heat is so small that position of the heated elements chamber has little effect on balance of output; however when 1/32 amp fuse wire is used, drawing about 50 MA current, tilting the chamber shows a very noticeable effect. The 10 MA fuse wire has proven the most practical size. There is still improvement to be made in mounting the heated elements and in the air nozzles. The present units tend to have a deadband between about plus or minus 100 ft. per min. rate of climb. I plan to eliminate this by decreasing the nozzle size below the present relatively large 1/16 diameter and then adding more resistance in series with the meter to achieve the same sensitivity.

Tips On Construction

Very fine platinum wire may be obtained. Also available is Wallaston wire, silver plated platinum wire making it easier to handle. The silver is acid etched off after assembly. Plastic coated platinum is sometimes used to make it easier to handle. The wire used is so fine it is at first rather difficult even to see it. The source of wire I have used to date has been taken from fuses, 10 MA being the best size. Remove the metal ends, carefully take out the glass bead and larger wires supporting the platinum, and solder lead wires to the large wire. Don't feel too badly if you break the first dozen. In order to properly balance the bridge all filaments used should be matched carefully preferably by applying 3 volts and checking the resulting current flow.

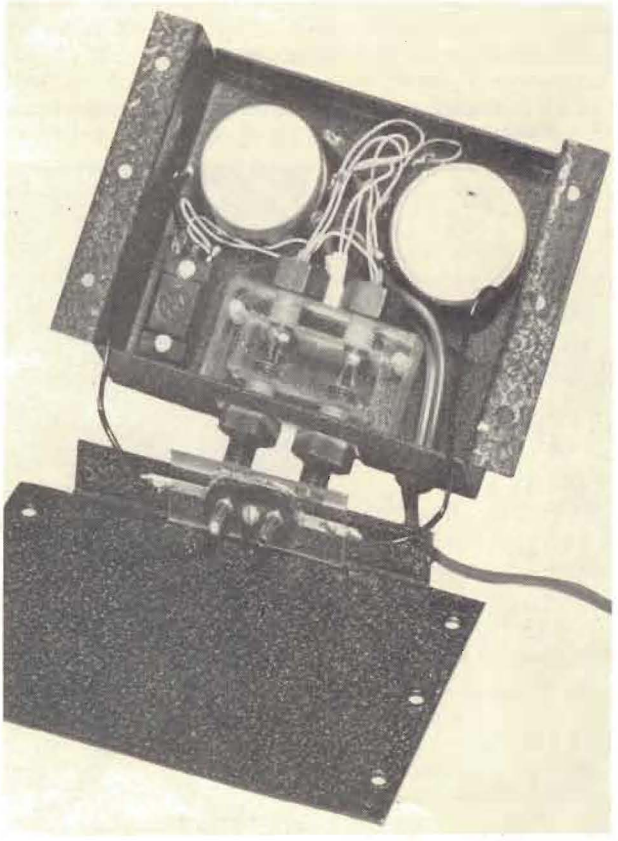
The meter used is not very critical but should be a zero centered microammeter. I at first used 100-0-100uA meters with 1000 ohm resistance with excellent results except that the compass was effected and required enclosing the meter in soft iron to shield it. These were war surplus. I am now using 150-0-150 uA meters with about 500 ohms resistance. These have a 270° needle travel which is excellent and furthermore do not effect the compass. This summer I am planning to add a second meter in series with less sensitivity such as a ½-0-½ milliammeter so as to have both a sensitive and a less sensitive meter together. I personally do not like changing the sensitivity with the knob.

It might be well to mention that I have switched to thermistor rate of climbs only because everyone I loaned the platinum type to got them broken. I haven't had any trouble this way myself except once, but do have to treat them gently.

PRESENT SOARING EXPERIENCE WITH ELECTRIC VARIOMETERS

The first winter I worked on electric variometers I used flashlight bulb filaments* and a one stage amplifier, and in fact was using two small aluminum foil one way valves to get up and down readings. Let this pass as history.

In the spring of 1948, a friend, Ned Bigelow,



View of the rate of climb unit with back cover and dry cell battery removed to show wiring. This is a hot wire type unit.