HOW-TO-DO-IT

TOTAL ENERGY VARIOMETER OPERATED BY PITOT PRESSURE

by Wolf Mix

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There have been several articles in soaring magazines describing the theory and function of the total energy variometer operated by the pitot pressure. It has been shown that this system has several advantages over the venturi operated T.E. variometer. These advantages are:

1. No outside mounting of a venturi required, thus eliminating drag.
2. No possibility of admitting water to variometer, while flying in rain or cloud.
3. No icing-up of venturi while flying in cloud.
4. Possibility of sticking of variometer appears to be greatly reduced.
5. This type T.E. variometer can be tested by simple means for true T.E. indication and true rates of climb and descent.

The pitot operated T.E. variometer would be more widely in use if it was not for the high cost of the flexible bellows and some lack of practical information as to how to select the proper size bellows.

For anyone not familiar with this type T.E. variometer, here is again a brief description:

The pitot pressure, which operates the A.S.I., is connected in parallel to one or more bellows. The bellows are either built inside the capacity of a variometer. or enclosed in a separate housing which is connected in parallel to the capacity (see Figures 1 and 2). The first arrangement is more elegant and eliminates several more pipes and connections. A change of air speed causes the bellows to deflect, which, in turn, displaces an air volume. The displaced air volume, if properly designed, is equal and opposite to the air flow through the variometer caused by a change of height, resulting from a change of air speed. Therefore, "stick thermals," normally indicated on the variometer, are cancelled by the action of the pitot operated bellows.

REQUIREMENTS

For a certain size capacity, a bellows has to provide a specified volume change per unit pressure difference; the volume change is:

$$V_o - V_1 = (P_d \times V_o)/(n \times P_s)$$

where V_o = capacity of variometer (cubic cm.), $V_o - V_1$ = change in volume of capacity and bellows, P_d = pressure differential (inch W.G.), n = 1.4 for adiabatic expansion, and P_s = static pressure (inch W.G.). For Cosim variometers, V_o = 568 cubic cm. (1 pint), and for European 1 litre variometers, V_o = 1000 cubic cm.

Static pressures (standard air) at sea level, P_s = 407 inch W.G.; at 1000 ft., P_s = 392; at 1500 ft., P_s = 385; at 2000 ft., P_s = 378; at 3000 ft., P_s = 363; and at 4000 ft., P_s = 350.

The T.E. is most valuable at low altitudes in marginal conditions. The bellows should be selected to compensate accurately at about 2000′ A.S.L. However, if the T.E. is built and calibrated at home (in my case about 750 ft. A.S.L.) the deviation from true T.E. indication at lower altitudes is negligible (including errors due to instrument calibration, instrument reading, pitot position error, bellows hysteresis and flying ability).

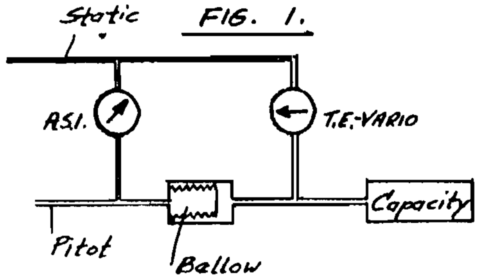

FIG. 1.

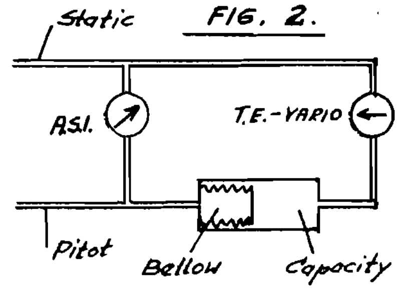

FIG. 2.

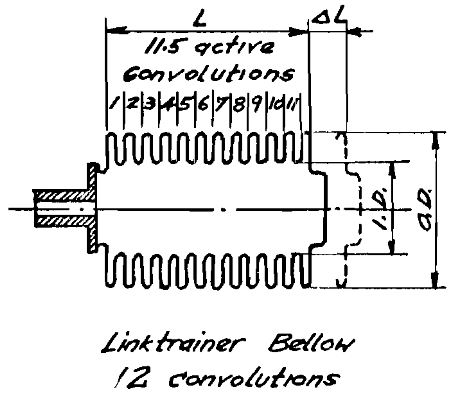

FIG. 3.

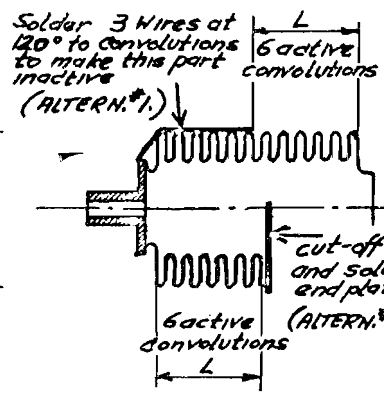

FIG. 4.

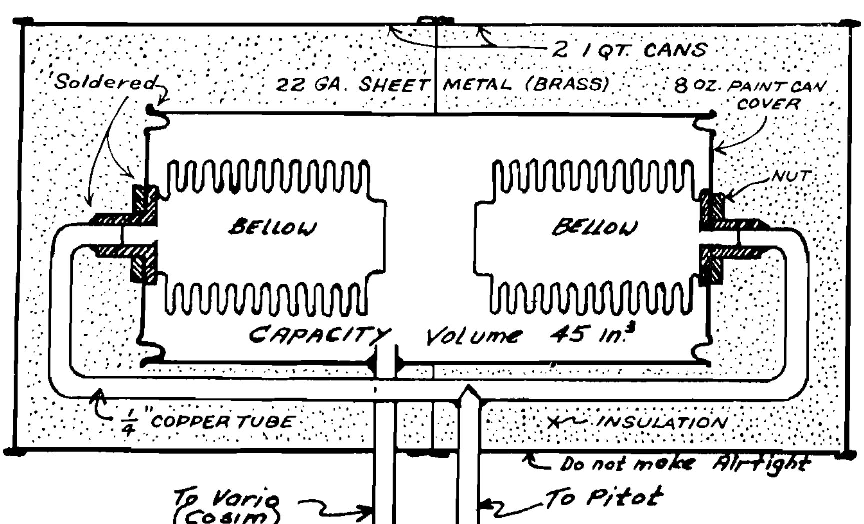

FIG. 5