

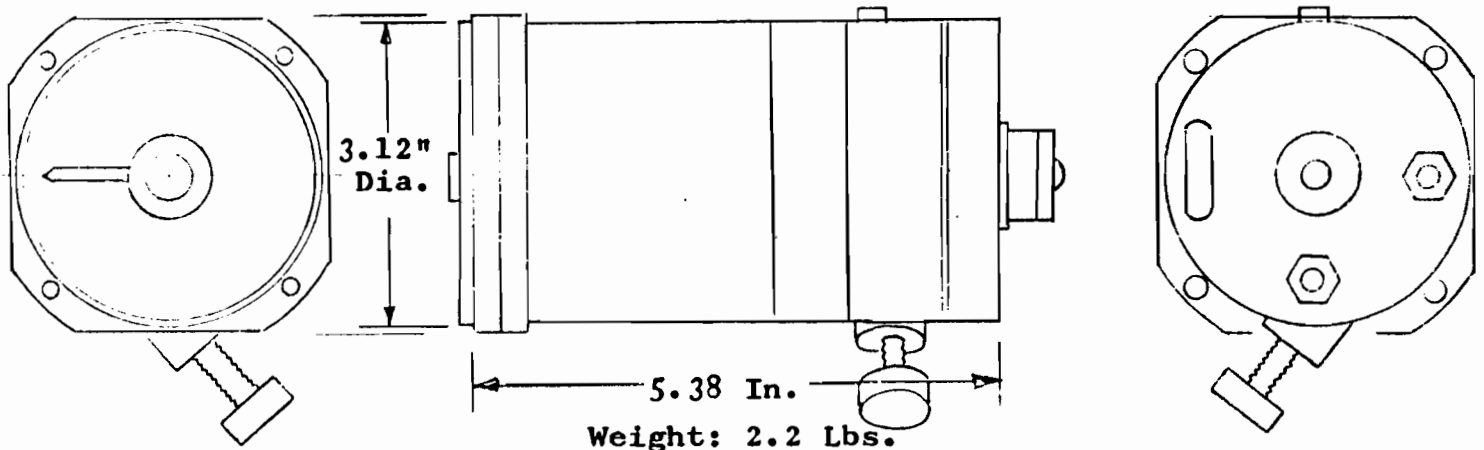
12 V BATT.

**DESCRIPTION AND OPERATING INSTRUCTIONS FOR  
BALL ELECTRIC VARIOMETERS MODELS 401/3 & 401/6**

(U.S. Patent 3451265)



**THE BALL ENGINEERING COMPANY**  
A COLORADO CORPORATION  
2140 KOHLER—BOULDER, COLORADO  
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**PRINCIPLES OF OPERATION**

This is a diaphragm-capillary leak type instrument which measures the diaphragm deflection electrically by means of variable inductors. As no forces are imposed on the diaphragm an extremely free, sensitive and rapid response is obtained. Self contained in the instrument is a pitot pressure operated total energy compensation device to cancel the effect of stick induced climb.

**DESIGN FEATURES**

Model 401/3 operates on 3 volts at only 1 milliamp current! Gain is proportional to the battery voltage. Excellent for Club sailplanes.

Model 401/6 has a voltage regulator added and operates on any voltage from 4.8 to 20 volts. The current drain is only 4 milliamps. This model is preferable when Audio or Cruise Control is used.

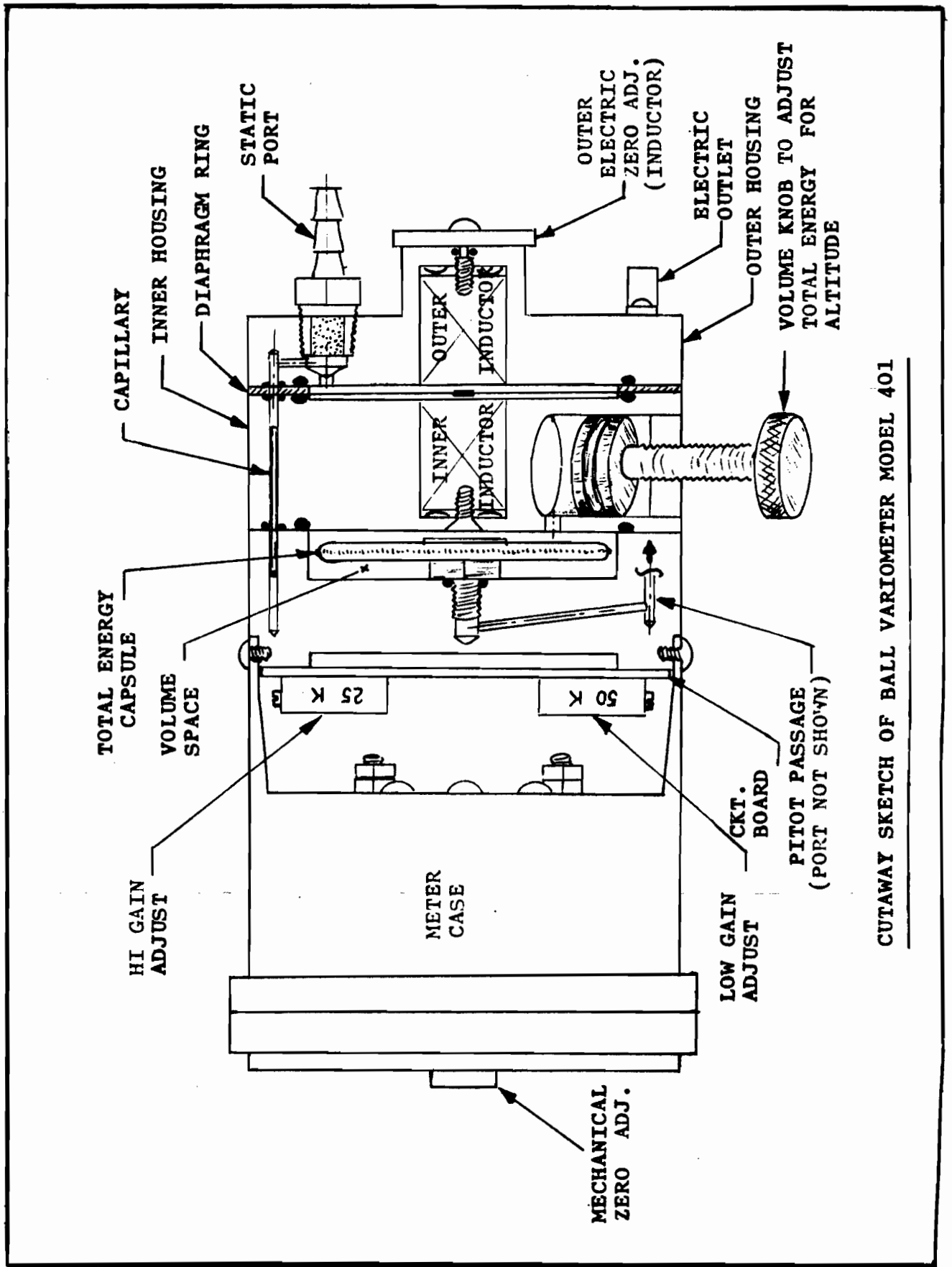
No air flask is required as the 1 cubic inch reservoir is built inside.

Calibration is independent of altitude with negligible change to 30,000 feet. The total energy compensation may be adjusted to any altitude; however the compensation changes versus altitude. If much flying is anticipated above 8000 feet ASL it is recommended that Model 400 and venturi total energy compensation be used. If the pitot and static ports are connected together the total energy operation is prevented and Model 401 operates exactly like the basic Model 400 vario.

**ORDERING INFORMATION**

Specify Model 401/3 or 401/6 and battery box size for 3V model. Meter scale 1000 FPM, 1500 FPM, 10 KNOT, 15 KNOT, 5 M/S or 10 M/S.

Specify Options: Audio, 2 Gain, Variable Damping, blank speed ring, Netto, Cruise Control, 2nd Meter, or Audio Selector Switch. For Netto or Cruise specify details of sailplane polar wet and dry.



CUTAWAY SKETCH OF BALL VARIOMETER MODEL 401

## OPERATING INSTRUCTIONS FOR BALL VARIOMETER MODEL 400 & 401

The Ball Engineering Company  
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**INSTALLATION:** Mount in standard 3.12 inch panel hole using #6-32 screws. Connect power lead to battery with red plus and black negative. If rechargeable battery is used install 1/4 amp fuse or circuit breaker. Check polarity again before turning on power however Varios after Serial 1780 are diode protected. Mount power switch and damping switch if used on panel. The 3 volt /3 Varios come with the AA, C, or D-size battery pack which should be mounted open side up. Alkali type batteries are best down to 0°F. For colder operation to -20°F use rechargeable Nicad cells whose lower voltage, 1.25V compared to 1.5v, requires recalibration. For colder operation the battery should be thermally insulated or heated.

Connect Vario static port to the aircraft static, or to a total energy venturi device. On Model 401 connect port "S" to static and port "P" to pitot for total energy compensation; however, for venturi TE compensation connect both "S" and "P" to the venturi. The #10-32 port on the middle housing is for Netto and is open if the connection to the volume has not been drilled and is capped if drilled thru.

**INITIAL ZERO ADJUSTMENT:** With power off set meter on zero mechanically with knob in center of meter crystal. Then turn on power and in the case of 2 gain varios to the highest gain. Now readjust the meter to zero electrically by turning the red knob on the port end of the Vario with the fingers. This red knob zero adjustment is useful in setting gain, checking the meter for freedom of movement, and checking out the audio. In flight normally zero the meter with the knob in center of meter crystal and only periodically use the red knob.

**FLIGHT OPERATION:** For 10 years numerous glowing reports on the good performance of Ball Variometers have come from top ranking pilots; therefore nothing but proper operation should be tolerated. The rapid response may take getting used to but should not be too jumpy. The usual cause of jumpiness is the dynamics of the particular sailplane's static or venturi. The vario response may be slowed by adding the variable damping option. Fixed damping may be obtained by connecting a capacitor across the damping lead or pins 2-6 of the amplifier. A 10 Mfd capacitor will slow response from about 1 to 5 seconds. The voltage is so low that an unpolarized tantalum or aluminum electrolytic capacitor may be used.

**GAIN ADJUSTMENT:** The amplifier gain or calibration of the Vario is adjustable with the rectangular potentiometer("pot") on the circuit board nearest 4 capacitors and 2 parallel diodes. CW rotation of this 20 turn pot increases gain. In the 2 gain option the higher gain switch position connects a second pot on the opposite side of the circuit board in parallel to the basic gain pot. In a 3 gain system the 2 higher gain setting pots are located outside connected to the 4 position rotary switch.

If the vario calibration has shifted off as compared to another vario or as measured with an altimeter and watch, the Vario may be easily and accurately be recalibrated as follows: As an example suppose that the Vario reads 800 for an actual known climb rate of 600. Turn on the Vario and with the red electrical zero knob offset the meter to 800. Then turn the gain pot on the circuit board CCW until the meter reads 600. Rezero the meter and the recalibration is complete.

This same technique is used to set the gain 2/1 higher or lower in a 2 gain system. If the basic vario gain is correct, then the higher gain in a 2 gain system may be easily set on the ground as follows: Suppose the basic vario gain is 1000 full scale and the high gain is to be 500 full scale. Switch to the 1000 position and offset the meter to 500 with the red knob. Then switch to the 500 position and adjust the high gain pot until the vario reads 1000. Rezero the meter and the high gain is now adjusted to 500 for full scale reading.

**ADJUSTING METER ZERO SHIFT DUE TO TEMPERATURE:** The 3 cubic inch air volume in the Vario is insulated only by the plastic housing walls, therefore rapid temperature changes expand or contract the air and cause meter zero to shift slightly. This effect may be decreased by wrapping thermal insulation such as cork around the Vario.

The Vario is an extremely sensitive pressure gauge and unequal thermal expansions of the housings can shift the zero. All Varios are tested for zero shift in a refrigerator freezer then in a 130F oven. The square pot near the center of the circuit board is split in series with each inductor wound with copper wire. If the vario reads down when cold, turning the square pot CW until the meter moves half scale then zeroing with the red knob will tend to correct the drift. Repeat this procedure several times if necessary.

**TO CLEAN METER CRYSTAL:** The meter crystal is unbreakable plastic which tends to pick up static electricity when rubbed. The inside has been sprayed with anti-static record spray. Clean only with windshield type cleaner. If cleaning builds up a charge which offsets the meter blow moist breath on face or spray with anti static spray. New meter crystals may be obtained from the factory and easily installed.

**WATER IN VARIO:** Water in the vario can clog the capillary, jam the diaphragm, and cause corrosion, therefore must be avoided. A cigarette filter is used inside the plastic fitting to deter moisture. An inlet water trap in the static, venturi, or pitot lines is recommended. For a small amount of water ingestion try merely replacing the filter. If the vario is submerged in water as in a water landing it is very desirable to entirely disassemble the vario as soon as practical and to dry it thoroughly in the sun or an oven at about 140°F. In years of varied service water has not been a significant problem.

**SPEED TO FLY RING:** The optional speed ring is held on with a rubber O-ring. Install or remove the ring with a firm twisting motion. If tight a tiny amount of oil will help.

**TOTAL ENERGY COMPENSATION VERSUS ALTITUDE:** When total energy is caused by a venturi device it operates correctly at all altitudes when properly installed. Model 401 Vario must be set to compensate for the particular altitude desired by changing the volume. If the Vario reads too much up in a pull-up or is undercompensated, turn the volume adjust knob CW and decrease the volume. For overcompensation turn the volume knob CCW. About 5 turns per try is suggested.

**CONVERSION BETWEEN 3 VOLT and 6-20 VOLT OPERATION:** On Models /3 the plus power comes in on the black wire and connects to the plus bus. To convert to /6 install a diode, a 2.6V regulator, and a 10 ohm resistor and move the black wire to the regulator input per factory instructions. To convert a /6 back to /3 merely move the black wire. A /3 wiring harness supplies audio power externally while a /6 harness connects the audio power to the vario power in the connector wiring.