VW5KB Variometer

1. General Description

1.1 Mode of operation

The principle used in VW5KB was originally described in an article by E.Brückner, which appeared in the journal "Luftsport" (issue No. 6/1970).

The variometer section works by the well-known hot-wire method. The equalizing air flow between the variometer flask (0.40 l) and the static pressure is measured by the aid of a metal probe. The resultant voltage is transmitted to the variometer amplifier.

Similarly, the equalizing air flow between a further (0.20 l) flask and the total pressure (dynamic pressure) is measured with another metal probe. The resultant voltage is transmitted to a compensation amplifier.

The TEK calculator is fed, concurrently, with these two amplifier signals. It determines whether the variometer signal is the result of a change in speed - i.e. an exchange of energy; speed against height or vice versa - or whether there still remains a positive or negative residue after the deduction of this control stick thermal. Only this part is registered by the instrument and the tone generator.

The tone generator works after Brückner's well-tried double-tone principle: A deep, pleasant, permanent tone rising abruptly in pitch from approx. -8 m/s to +8 m/s. From zero and upwards the signal repeats with increasing frequency.

1.2 Construction

The use of integrated amplifiers in the variometer section, the compensation section and the TEK calculator, makes for compact electronics. All three units are mounted on one printed circuit, while the tone generator is mounted on a separate circuit. The two circuits are connected by means of multi-pin gold-contact plugs.

The indicator and all controls necessary during flight are lead out to a front panel, 80 mm in dia.

The compensation intensity can be readjusted at top right by means of a screwdriver (see adjustment instruction 3.4).

2. Mounting instructions

2.1 Mounting the main unit in the instrument panel

The front panel of the compact-unit has an outer diameter of 79.5 mm; the diameter of the pitch circle for the four mounting screws is 89 mm. Hence VW5KB will fit into any standardized 80 mm hole in the instrument panel.

When installing, remove the four mounting screws next to the front panel. Hold the unit against the instrument panel from the rear, using the four screws to secure it to the front of the panel.

The magnetic field of the disc-type indicator instrument is heavily screened to prevent compass interference. As an extra precaution, however, it is recommended that the compass be fitted at least 15 cm away from VW5KB.

2.2 Fitting the hose connections

The four hose nipples at the rear of VW5KB should be connected in accordance with the chart below:

P static
0.40 l
P total
Battery cable, secondary instrument 0.20 l

a) From hose nipple (1) to static pressure.

b) From hose nipple (2) to the 0.40 l flask supplied. The 1.5 m hose attached to this flask ought not be shortened or lengthened by more than 1 m.

c) From hose nipple (3) to total pressure (= measuring pressure from impact tube).

d) From hose nipple (4) to the 0.20 l flask supplied.

The material supplied (approx. 3 m hose 7 x 4 dia. and approx. 10 cm hose 6 x 4 dia; hose union and T-pieces for standard gauge 4 mm) facilitates reliable, tightly bunched wiring.

For adaptation to instrument hoses with 5 mm standard gauge place a 6 x 4 mm hose on the T-pieces supplied. The 5 mm hose will then fit tightly.

The 0.20 l flask must be fitted behind the instrument panel. Where space allows fit both flasks behind the panel.

2.3 Electric current supply

The screened battery cable extending to the rear of VW5KB ends in a triple plug connection with terminals.

Connect the white lead to the positive terminal of the battery and the blue lead to the negative terminal.

Connect the third lead to the screening round the battery cable and to the VW5KB housing. The housing and the negative terminal of the battery are connected internally.

VW5KB requires a battery voltage of 12 ± 2 volts and has a power consumption of approx. 110 to 130 mA., depending on the sound intensity. If terminals are connected wrongly the unit will cut-out automatically (wrong - terminal - diode).

VW5KB is not fused. Generally, the supply mains should be safeguarded against short-circuiting at the battery itself.

2.4 Connection of secondary instruments.

VW5KB's main amplifier permits operation with more than one indicator.

Connection of a secondary disc-type instrument (± 100 u A, 910 Ohm) or a circular-scale instrument with a needle travel of 250° (± 200 u A; 1-8 kOhm) is allowed for in the wiring diagramme of each unit. Additional units can be connected later by the manufacturer or under the supervision of an expert.

The circular-scale instrument (standardized, 80 mm in dia.) has the same design and the same scale as the 5 m/s diaphragm-type rate-of-climb indicators (25° per 1 m/s).

Connection of such an instrument as secondary to VW5KB facilitates the use of a marketed McCready ring, and in this way nominal-speed flying by the electronically compensating VW5KB method can be realized.

The outer threaded ring of the McCready rings (made by the Winder Co.) is fastened in the cone of the circular scale secondary instrument by means of artificial resin adhesive. The plug of the secondary instrument is pressed into the bushing until it locks in the outer position (locking can be heard and felt).

The secondary circular-scale instrument and the built-in "disc-type" instrument are connected in series electrically. Therefore, the instrument circuit is broken, when the plug of the secondary instrument is removed.

Our nominal-speed accessory, SGN, presents a far simpler means of attaining nominal-speed flying than does the McCready ring. Mounting of the SGN unit is uncomplicated and is described in the instructions supplied.

3. Operating instructions

3.1 Main switch and volume control

Switch on VW5KB by turning the volume control (bottom left, on front panel) in a clockwise direction. The tone signal will then increase in strength until the volume can be increased no more. It is advisable to set the volume somewhat higher than the flying noise.

3.2 Interrupter - switching-in regulator

The cut-in point for the tone interrupter can be set by means of the adjusting knob VE (above volume control knob). Exact adjustment of the UE regulator is made by moving the zero point of the instrument (by means of the zero adjustment knob at the rear.

If the UE regulator is moved to the right, the interrupter signal will first commence at, for example, +1 m/s. In this way, upwinds lying below this strength are sorted acoustically.

Conversely, by moving the UE regulator to the left (e.g. to - 0.8 m/s) it is possible to discover an upwind region. By setting the UE regulator exactly vertically upwards, the tone interrupter will cut-in - stably, and largely independent of temperature - at a variometer indication of + 10 cm/s.

3.3 Attenuation switch

The attenuation switch permits a choice of three indicator speeds.

Normally the "fast" setting (.) can only be used for calm thermals (time constant approx. 0.7 s). The "slow" setting (...) corresponds, approximately, to the function of good mechanical variometers (time constant approx. 3.5 s). The "normal" setting (..) with a time constant of 1.8 s, is used for normal thermal situations.

The speed of the tone signal changes simultaneously with attenuation switch selection, so that the signal speed matches the position chosen.

3.4 Adjustment of total energy compensation

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In order to ensure optimum function of the electrical compensation system in your VW5KB metal probe variometer the following conditions must be observed:

1. VW5KB must be equipped with a separate input for static pressure[x)], where the connection of other instruments is prohibited. Consult the glider manufactur as to the most suitable spot for the input. The longer the hose, the longer should be the cross-section of the conducting wire chosen (e.g. 5 mm dia. hose for the line to an inlet point between wings and tail section.

2. VW5KB's compensating intensity must be set carefully by the KO slide potentiometer at the top right-hand corner of the front panel.

The KO potentiometer has been set, prior to delivery, in conditions which were, theoretically, an exact simulation of actual flying conditions. This resulted in the following setting:

Stop	left right	KO = scale divisions

(Plotted, for example: KO = + 3.5 scale divions)

Set the speed of the variometer to match that of the compensation throat (see 1.1) by means of flow resistors R_v and R_k fitted in the housing.

[x)] Practical hints regarding an inlet for static pressure

Despite careful adjustment during testing, inlet defects with static pressure and measuring pressure often make it necessary to reset the KO slide potentiometer. This adjustment can, of course, only be made in flight and therefore stable, preferably thermal-free, weather conditions are essential. Before starting, it is advisable to memorize the following adjustment instructions; having done so only a little experience will be required to carry out the few corrections necessary.

Test flights always begin at a fast initial speed, v_1 (e.g. 160 km/h), which should be followed by a quick reduction of speed, v_2 (this with a large radius of curvature to avoid acceleration effects) e.g. 100 km/h.

The initial speed v_1 and final speed v_2 must be kept exact for about 10 seconds.

Observe the variometer deflection during the transition from v_1 to v_2; ideally this should follow exactly the drop in relation to the polar curve of the aircraft. Deviations from this optimum state are corrected by means of the KO control.

It is also necessary to know the KO corrections which correspond to possible erroneous deflections. To this end some typical errors are shown in the following. In each case is given the cause of the error and the corrective action necessary.

Eventually, corrections will constitute only 0.1 - 0.2 divisions on the scale of the KO control.

If the aircraft loses height the deflection errors from compensation will react correspondingly, but in reverse. Therefore, no further mention is made of these in the following.

(fig. 1)

Compensation setting OK.

Re. fig. 1.

Fig. 1 illustrates the optimum indication progression of the compensated variometer.

Until time t_1, fly steadily at initial speed v_1. According to the polar curve this is equal to a certain drop (in the example on fig. 1. -2.0 m/s.). After this accelerate to speed v_2 without large radius of curvature - v_2 is reached at time t_2 and kept steady for about 10 seconds.

The drop of the polar curve is reduced from -2 m/s (at t_1) to -0.8 m/s (at t_2) and remains constant again from t_2. This optimum indication progression is added to all the following figures as a dotted line for comparison purposes.

(fig 2)

Cause: Compensation inadequate

Correction: Turn KO control in clockwise direction

Re. fig. 2.

a) Error shown:
At an increase in altitude the variometer will give an upward deflection, thus indicating too little drop or even a rise. It exhibits the tendencies of a non-compensated variometer.

b) Cause of error:
The compensation intensity is set too low.

c) To correct this, increase the compensation intensity (KO control) by turning in clockwise direction.

(fig. 3)

Error: Compensation too intense.

Correction: Turn KO control in anti-clockwise direction

Re fig. 3.

a) Error shown:

On gaining height the variometer will give an downward deflection and during the transition from v_1 to v_2 it indicates constantly excessive fall values. This is due to over compensation

b) Cause of error:

Compensation intensity set too high

c) To correct this, reduce the compensation intensity (KO control) by turning in an anti-clockwise direction.

(fig. 4)

Error: Compensation takes effect too quickly

Correction: Connect a flow resistor in series to R_k.

Re.fig. 4

a) Error shown:

On gaining height the variometer initially shows excessive fall values and later inadequate ones.

b) Cause of error:

Compensation takes effect too quickly

c) This can be corrected by reducing the compensation speed. For this purpose an extra damping resistor is inserted in the measuring pressure line as a supplement to the internally fitted Rk. Its values must be changed to eliminate the error mentioned in fig. 4.

In practice, the error referred to in fig. 4 occurs only where, for example, the static pressure is connected to extra delaying instruments. In such a case a needle valve (available from the manufacturer) will facilitate speed correction.

Since compensation line and compensation flask (1x0.20 l) are always under measuring pressure, and thus operate with an excess pressure, great care should be taken, when fitting this line. Here leakages of any sort would result in serious indicating errors.

The screw-jointed, quadruple hose connections are often the cause of leakages in the measuring pressure line. Should leakage be traced to this source, then try to circumvent them by means of a direct hose connection.

4. Maintenance

It is recommended that your VW5KB be returned to the manufacturer for inspection after the first season's use. Our metal probe variometers are renowned for their durabilit and will give many years of reliable, trouble-free service provided that the instructions are followed.

If you suspect that water has penetrated to the probes (hose nipples 1 and 3) return the unit to the manufacturer for examination (see also 5.1).

Zero point errors are corrected by means of the zero-adjustment knob located at the rear of the unit. Such corrections cannot be made until several minutes after cut-in. If the range of the zero-adjustment knob is no longer adequate, the unit must be returned to the manufacturer or sent to an authorised repairer for balancing.

As a general rule all defects should preferably be referred to the manufacturer rather than attempt your own repairs.

5. Hints for use

5.1 Static pressure inlet; use of water separator

VW5KB's electronic compensation system will only operate perfectly, if it has its own static pressure line, i.e.

other units must not be connected to this line.

Consult the manufacturer regarding a suitable point for static pressure inlet in the fuselage.

The penetration of rainwater into the hose lines of the instruments is a constant source of failures. Therefore, a reliable water separator is of prime importance.

A simple device like a water separator (see cut-away drawing) comprises a dish security sealed, from within, to the wall of the panel by a synthetic resin, and having one or more upturned hose nipples.x) This dish covers that area of the panel in which there are holes for the static pressure. Hole diameter shall be 1 - 1.5 mm. Some of these holes will thus be significantly lower than the others at the lower edge of the dish. When water penetrates into the dish, these lower holes act as outlets, thereby keeping the other holes free from water. The angle of the hose nipple prevents water penetrating into the hose system.

(fig.)

Above

Panel wall

Water-separating inlet for the static pressure (cut-way view).

Should water penetrate the hoses and reach VW5KB, return the unit to the manufacturer without delay giving full particulars. This is the only chance of preventing damage to the probe from slowly drying water. About 80% of all previous probe failures are the result of water penetration.

If the static pressure inlets in the fuselage are located between wings and tail unit they will mostly lead to a manifold from which more static pressure lines lead to the instruments themselves. One such line from the manifold

x) These are available as finished components from Schneider, [illegible] Mühlstrasse 10.

should be used solely to supply VW5KB.

If the static pressure inlets are located in the nose, a separate static pressure line for VW5KB can be made as follows: Insert a T-piece at each inlet point as close as possible to the panel wall. Bring the free nipples of the T-piece together in the centre of the fuselage in the normal way, and use the secondary static pressure thus obtained only to supply VW5KB.

5.2 Erroneous deflection on account of radio units

Screen VW5KB in series against high-frequency interference. Experience shows, however, that despite this precaution erroneous indications can occur as a result of activation of the transmitting key or when flying close to powerful radio transmitters. Therefore, as from spring 1974 the negative lead from the battery will be connected in series to the VW5KB housing. In addition wide-band noise suppressors, from 5MHz and upwards can be built in by the manufacturer. This is necessary if frequent flights are to be made near powerful ground transmitters.

5.3 Adjustment accuracy

VW5KB's TE compensation works perfectly at all altitudes Like the thermic E-variometer the VW5KB system gives deflections which are strictly proportional to the air density. Therefore, its indications are dependent on altitude; indications are reduced by approx. 8% per 1000 m increase in altitude. Since VW5KB is set to 1500 m NN = mean sea level (NSL), the significance of this error in altitude will remain negligible up to an altitude of 3000 m.

The same dependence on altitude is also evident in ordinary velocity head speed indicators. Aneroid and diaphragm-type rate-of-climb-indicators, on the other hand, do not suffer from altitude errors.

Turning the compensation adjustment knob KO on VW5KB will not affect the setting significantly. Rotation of the KO knob from the normal position to the stop at left or right side will give adjustment errors of approx. +8% and ÷ 8% respectively. Having set the KO knob exactly during the test flight, adjustment errors, if any, can be eliminated at a modest charge by the manufacturer or by an authorised repairer.

5.4 Equalizing-flask system

The flasks supplied by the manufacturer are carefully adjusted before leaving the factory. Also, they are filled with wire-wool to ensure isothermal behaviour of the air in the flask. Finally, the built-in flow resistors are set to precisely the size of the flask.

5.5 The influence of horizontal headwinds or gusts

Gliding with total-energy-compensating variometers calls for a certain readjustment of the pilot's reactions to the variometer deflections.

Bear in mind that flying into horizontal headwinds will mean an increase in the impact-pressure. Any quick-rising TEK variometer would register this as an energy gain and thus an increase in altitude. Conversely, the same variometer would register a drop when flying with a horizontal tail wind.

Much of the training time required for readjustment to the new and fast VW5KB system is spent on becoming properly acquainted with those variometer deflections which are produced by horizontal gusts of wind, and learning to ignore them. Not until the variometer deflection and the appropriate seat-pressure signal noise occur simultaneously should the corresponding steering movements be made.

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