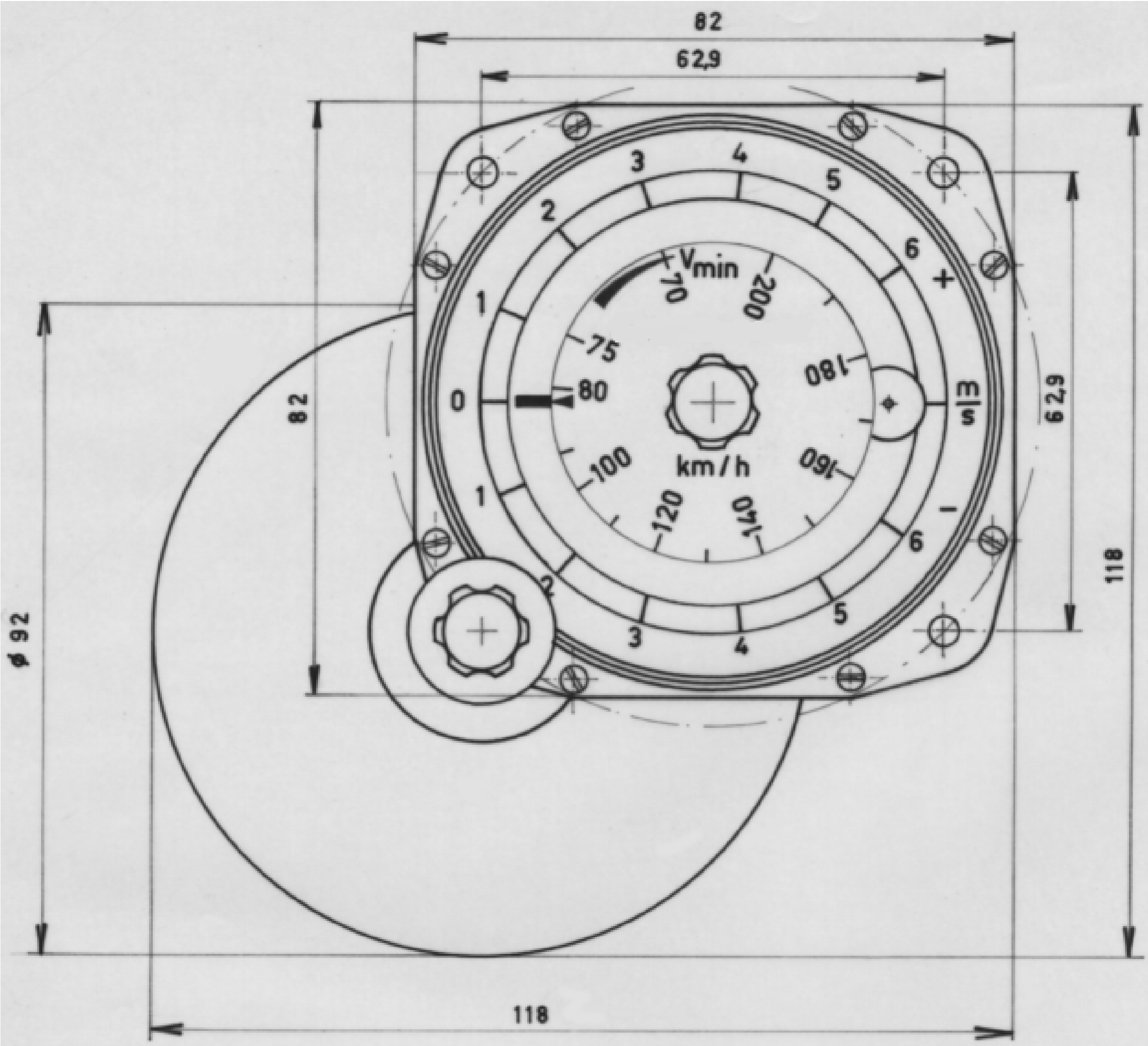
BOHLI MAGNETTECHNIK AG
Dammstrasse 15 CH-4500 Solothurn
Telefon +41 32 622 0433
Telefax +41 32 622 1482
Postcheckkonto 45 - 2348 - 4

Magnetsysteme, Dauermagnete, Haftmagnete
Magnetische Messuhrhalter und Spannplatten
Instrumenten- und Bremsmagnete
Kleinst- und Miniaturmagnete
Segelflugzeugkompass und -Variometer

Total energy variometer 68-PVF-1

Description and installation



Description

The variometer is based on the aneroid principle. But deviating from the conventionally used lever system with gear segment, this variometer uses a twisted metal band for transmitting the diaphragm motions to the pointer. The twisted band converts the linear diaphragm motion into a revolving motion which actuates the pointer directly. As a consequence, this system works without any friction. The resulting gain in sensitivity is evidenced by a time constant of 1,3 seconds (which corresponds to a resetting time of 6 seconds). These figures are usually achieved with electrical variometers only.

On physical grounds, the system permits very accurate results and, in addition, transmission is fully linear. There is no altitude error. The only and insignificant small error stems from the fact that the viscosity of the air increases with temperature which creates an indication error of 3 % per 20℃ (e.g. with a temperature of 40℃ (104℉) a true 1 m/sec climb will show 1,03 m/sec on the variometer).

A major advantage of this frictionless system is the complete absence of hysteresis, for the zero point or any other indication.

The weight of pointer and twisted band together is 1,5 mg. This low mass and the 50 g tensile strength of the twisted band, together with a built-in over-deflection protection make it a robust instrument.

A combined system is used for Total Energy compensation. Partially it makes use of the under-pressure created by the fuselage (0,2 – 0,3 x pitot pressure). This hypotension does not change with altitude and it is nearly constant along part of the fuselage. The remaining pressure difference (0,7 – 0,8 x pitot pressure) is applied to a simple metal membrane which is backed-up by a spring with adjustable tension. When turning the knob to the right the compensation is increased and vice versa, without influencing the accuracy of the instrument. Calibration of the compensation is done in flight and the relevant altitudes may be marked on the little dial provided for the purpose.

The low-speed range on the scale of the McCready ring has especially been extended for dolphin style flying. The scale is calculated for 2000 m a.s.l. It is possible to add a second outer ring (perspex) with a scale for rain conditions, etc.

Thunderstorm-flights and rain showers

Thunderstorm-flights through rain showers have shown that the variometer may become useless through the penetration of water and can even be destroyed.

The following precautions must be taken:

In place of the T-joint (connection static pressure taps - variometer), a depletable water separator must be installed.

Plastic or silicone-rubber-hoses are to be replaced with instrument hoses from nature-rubber with tissue-envelope. (Plastic and silicone-rubber-hoses are not moistened so that the penetrated drops are pulled through the whole management as stoppers.)

After longer flights through rain, the water-sack is to be emptied.

Technical data

Measuring range	± 6 m/s 24°/m	340° scale
Calibration accuracy	± 5 %	
Calibration temperature	20° Celsius	
Time constant	1,3 seconds	
Linearity	within calibration accuracy	
Altitude error	none	
Temperature coefficient	0,15 %/° Celsius	
Zero point accuracy	-20° to + 60°C	±0,2 m
Compensation indication with 15°C rise of ambient temperature	+0,2 m	(-15°C -0,2 m)
Temperature equilibrium time	50 – 60 minutes	
Volume of air container	80 cm^3 built-in	
TE compensation	65 – 200 km/h	± 0,2 m
Static pressure error and operating altitude	adjustable	
McCready scale extended for dolphin flying and calculated for	2000 m a.s.l.	

General

- Heat insulation against temperature changes
- White dial to prevent heating by sun
- Standard 80 mm diameter
- Weight 520 grams (18 ½ oz.)

Flight characteristics

The low time constant causes a somewhat sensitive indication, mainly at high speeds, but one gets quickly accustomed to it. Additional damping is available upon request. However, it appears more advantageous to fly with the instrument unmodified. This permits optimal use of lift in dolphin flying and provides better and faster information on the strength and core location of thermals which are to be entered for circling. The compensation works perfectly and, when adjusted properly, follows the values of the polar curve. Accelerations do not cause indication errors, since the measuring system is located inside the compensating air container. Pressure differences within the container, created by accelerations, have no influence

Installation on the instrument panel

The drilling plan (see page 8) gives details on the required cut-out and mounting holes. It also shows the closest distances that are possible for neighbouring instruments. Note that on the bottom left somewhat more distance is required due to the space taken up by the TE compensator.

Fasten the instrument **moderately** using the four M4 bolts and self locking nuts. With screw threads in the flange, the locking nuts must be used for securing.

Static pressure

For accurate compensation the variometer needs negative static pressure, which will best be tapped a short distance forward of the largest fuselage cross-section. Somewhere close to the instrument panel is usually right; this also results in short connections.

Possible deviations of the target-value are being taken into consideration when setting the compensator.

The under-pressure is fairly equal along part of the fuselage surface. (Tapping the static zero point would be much more demanding since small deviations from the ideal point would result in PLUS or MINUS variations of static pressure).

Provided no static pressure taps are built-in, the included connections are to be installed.

For this purpose, drill on each side of the fuselage a ø 4 mm hole through the fuselage shell. These holes are to be located approximately 3 – 5 cm forward of the instrument panel and where the tangent of the fuselage is vertical. On the inner side of the shell an area of ø 30 – 40 mm around the hole must be roughened with sandpaper.

Next, use cold hardening Araldit or Epikote mixed with flock cotton to glue the flange to the inside of the shell. For this purpose apply resin on both surfaces of the flange and on a length of approximately 5 mm along the tube. The flange must be positioned so that the inner socket shows forward and up at an angle of approximately 45°. The fixture shall be held in place during curing with the tension spring which is included in our supply. After curing, cut off the outer tube as shortly as possible with a nail file and then file it down flush with the fuselage skin. (If you have little practice at this type of work, put masking tape around the file, leaving only a short part to work with. This avoids scratching the fuselage).

Remove burrs with a ø 2.9 to 3 mm drill by hand (don’t drill through the socket). Apply final finish and clean.

The sockets are connected by tubes (inside ø 4 mm) of equal length to a T-joint. The free end becomes connected to the pressure socket "S" of the variometer. The other socket on the compensator (marked "P") must be connected to the pitot tube.

Adjustment of the compensation

No two gliders have identical pitot and static pressure characteristics. Thus, the variometer cannot be fully calibrated at the factory. The compensation must be adjusted in the particular aircraft at chosen altitudes.

Settings of l, 2, 3 and perhaps 4 km altitude are recommended. Narrower spacing is not necessary.

In preparation, a small arrow (of self adhesive tape) is placed on the instrument panel, pointing horizontally towards the blank scale surrounding the compensator knob. This knob ”R” is then turned all the way to the **left** and the scale is marked by pencil opposite the arrow, adding a ”0”. This is the position for minimum compensation.

For an easy in–flight calibration proceed as follows: from your polar curve you must know exactly how much the sinking speed in stationary flight should differ between two speeds, e.g. between 70 to 100 km/h. On a calm day, at an altitude of approximately 200 m above the height to be calibrated, accelerate from 70 to 100 km/h and the decelerate again to 70 km/h. A well compensated instrument must show exactly the increase of sinking speed as shown on the polar curve.

If, when accelerating, the indicated sinking speed increases more than it should (according to the polar curve) and if, when pulling up, it shows less sink (than the polar curve says) or even shows climb, then the compensation is too low. The knob ”R” must be turned 10 – 20° to the **right**. Follow the same test as described and keep adjusting with the knob ”R” until the compensation is correct and the variometer follows the sinking speed pattern of the polar curve. When this is reached, mark the scale and add the corresponding altitude. The procedure is repeated at different altitudes. Fly at a steady 70 km/h for 10 sec. before every acceleration in order to allow the instrument to stabilize.

During the season, further possibilities emerge for controlling and putting in of other heights. Always proceed the same way.

You may add some checks at higher speeds, but this is usually unnecessary since the compensator acts linear.

Once the scale is marked with all desired altitudes, the markings may be done properly or engraved.

It should be added that the instrument itself compensates for increased sinking speed due to higher g–loading when pulling the stick, or analogous when pushing.

Important notes

1. The connecting sockets on the instrument (for static and pitot pressure) must **never be closed** or covered with rubber caps or tape, especially not for transport. The sudden pressure change when removing such caps may damage the membrane.
2. **The instrument must not be opened up**. Although it is of robust construction, the twisted band may get damaged.
3. Before take-off it is recommended to protect the instrument (and others) from being heated up by direct sunlight. (In a hot instrument the zero-point will be off by -0,2 m/sec for every 15℃ of temperature change. It may take one hour to come back to accurate reading).
4. Do not adjust the zero–point position shortly before take-off. Setting the zero-point takes some time. A change can be corrected with the setting of the McCready ring. Adjust the zero–point only early in the morning when the instrument has adapted to the surrounding temperature
5. Setting the zero–point, if necessary: Using a screwdriver, turn the adjusting screw in the center on the back of the instrument to the right or left, no more than 140°. When facing the instrument from the front, the direction of turning is reversed. The movement will revolve the protection spring, where the twisted band is attached to. After every adjustment a slight turning movement must be made in the opposite direction, just enough so that this protection spring is freed and the rear diaphragm is able to work without touching. This can be observed from the front through the instrument glass. The slot in the actuator must be parallel to the protection spring. This will allow a clearance of approximately 0,5 mm on each side. Since the pointer might come off the 0 during the second manoeuvre, the entire adjustment may have to be repeated.
6. If, contrary to our recommendation, it is desired that the instrument should have more damping, the following must be observed: the two damping restrictions must always be in a ratio of 1:9, as otherwise an accurate compensation is not possible. A restrictor of 45 mm length on the variometer requires one of 5 mm length on the compensator, etc. With these lengths and a capillary diameter of 0,5 mm in the restrictors, the time constant will be increased approximately thee times.
7. The static pressure in the neighbourhood of largest fuselage cross section is fairly even with an under-pressure of approximately 18 – 20 % of pitot pressure. Satisfactory compensation of the variometer is only possible if the instruction for static tap location is followed.

BOHLI MAGNETTECHNIK AG
Dammstrasse 15 CH-4500 Solothurn
Telefon +41 32 622 0433
Telefax +41 32 622 1482
Postcheckkonto 45 - 2348 - 4

Internet: http://www.bohli-magnete.ch E-Mail: bohli_1@bohli-magnete.ch

Some hints

This variometer will help you to make best use of lift.

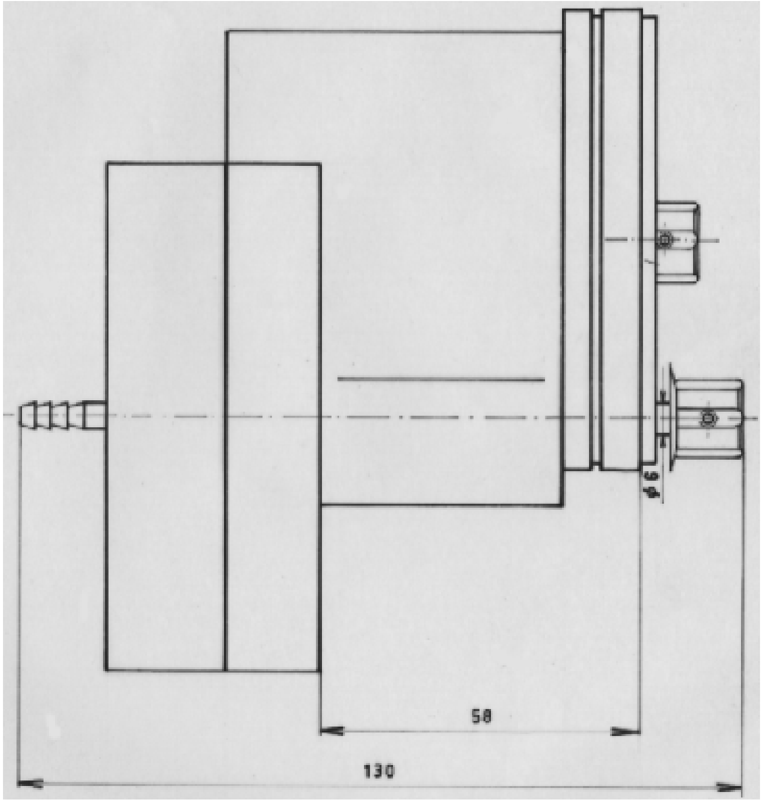
Accept the somewhat sensitive response at high speed. It would be a pity to add damping.

Get used to flying dolphin whereby you should try to be a second or two ahead with adjusting your speed to where the pointer moves on the McCready ring.

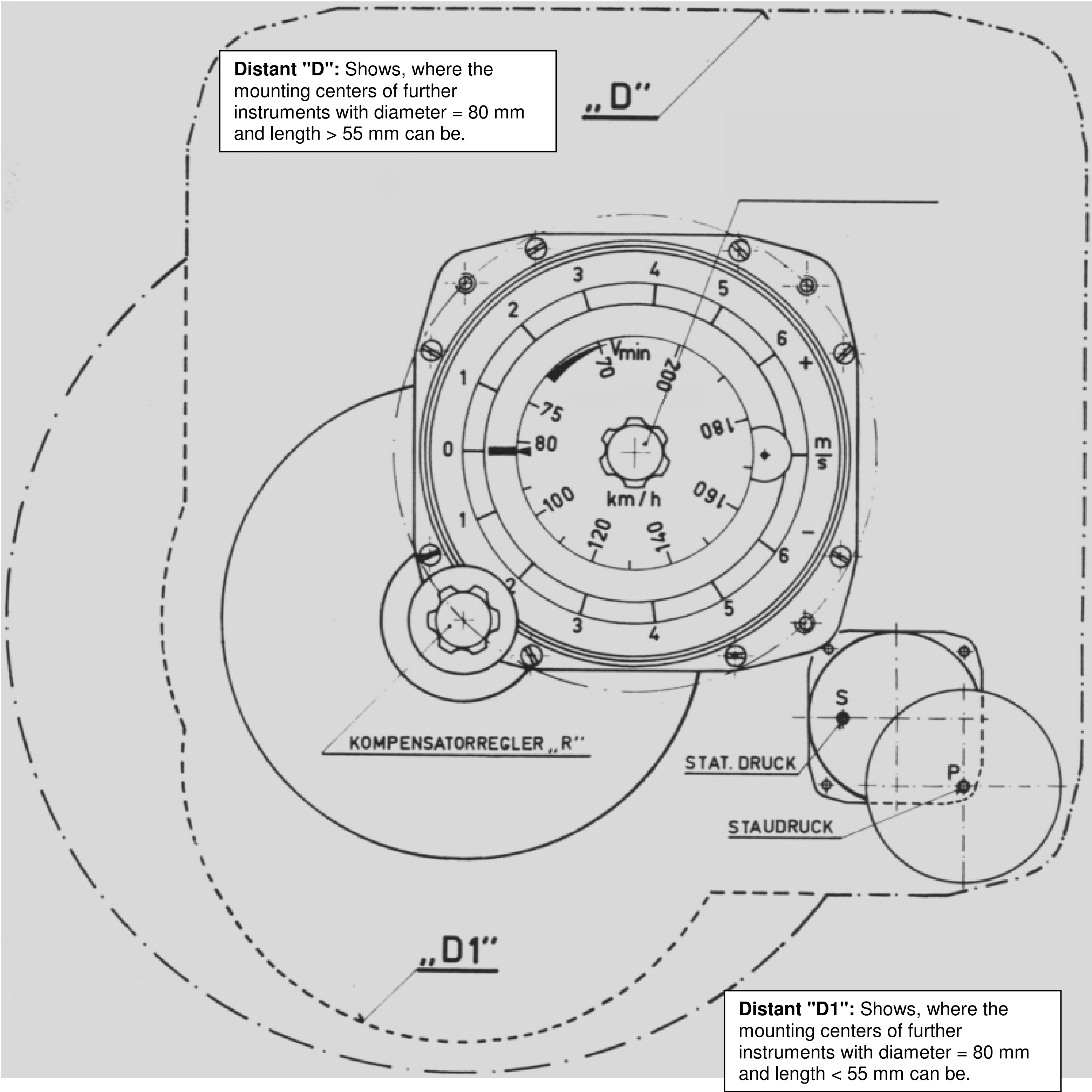
Take not that when circling in thermals the time lag of peak indication is 1 to 2 seconds.

Wishing you much success.

Side view of variometer



Bore plan



Instrument with separated compensator on request.

<u>Attention: Drawing not exactly scale!</u>