



DOCUMENT
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DOCUMENT TITLE
FLIGHT INSTRUMENTS

CHAPTER 5 – THE VERTICAL SPEED INDICATOR

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THE VERTICAL SPEED INDICATOR (VSI)

The purpose of the VSI is to indicate the aircraft's rate of climb or descent in feet per minute. The Altimeter measures altitude from static pressure whereas the VSI measures rate of change of altitude from rate of change of static pressure.

PRINCIPLE OF OPERATION

Static pressure is directed to the VSI where it is fed to the inside of a capsule and to a metering unit. The capsule will react when the pressure inside the capsule is different from the pressure outside the capsule.

The air flows through the metering unit but the flow is restricted, causing a pressure difference between the inside and the outside of the capsule. The amount of capsule expansion or contraction depends on the size of the pressure difference. If the pressure change is small (slow climb/descent), the pressure difference will be small and so the indicated rate of climb or descent will be low. However, during a rapid climb or descent the pressure change is large, the metering unit restricts the air flow and a larger pressure difference is created, keeping the indicated rate high.

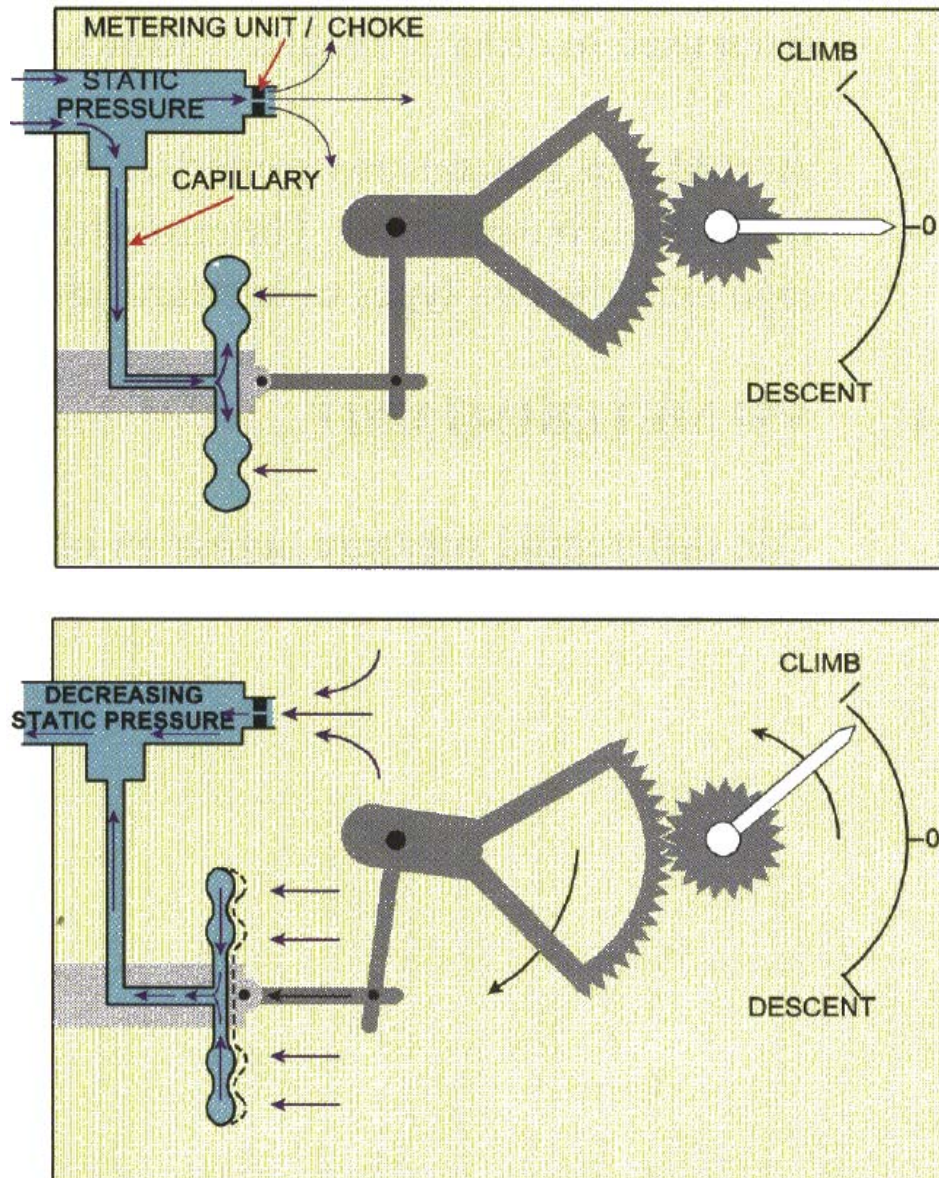
The pressure VSI is not a very responsive instrument. It is slow to react as some time is needed for the metering unit to create the pressure difference when the altitude change occurs. This instrument is always slow to respond and this is known as 'lag'.

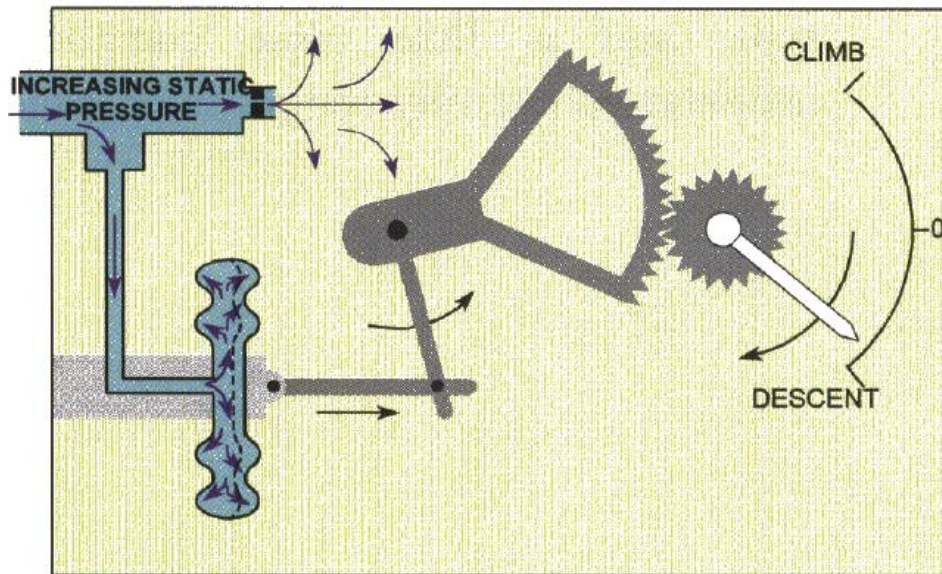
The pressure will equalise only after the static pressure stops changing, i.e. after levelling from a climb or descent and this again creates a lag in the indication.

To summarise:

- The VSI measures the rate of change of static pressure.
- Rate of climb or descent is indicated in feet per minute.







ACCURACY

To maintain reasonable accuracy, the metering unit is internally compensated for density, temperature and viscosity.

VSI ERRORS

POSITION/MANOEUVRE INDUCED ERROR

Sensed static pressure variations are often caused by airspeed changes and manoeuvres. The position of the static vents is never ideal for all angles of attack or manoeuvres, resulting in sensed static being slightly different to the actual static. Changes in static pressure resulting from changes in position error are indicated as false climb or descent causing some inaccuracy in the VSI.

INSTRUMENT ERROR

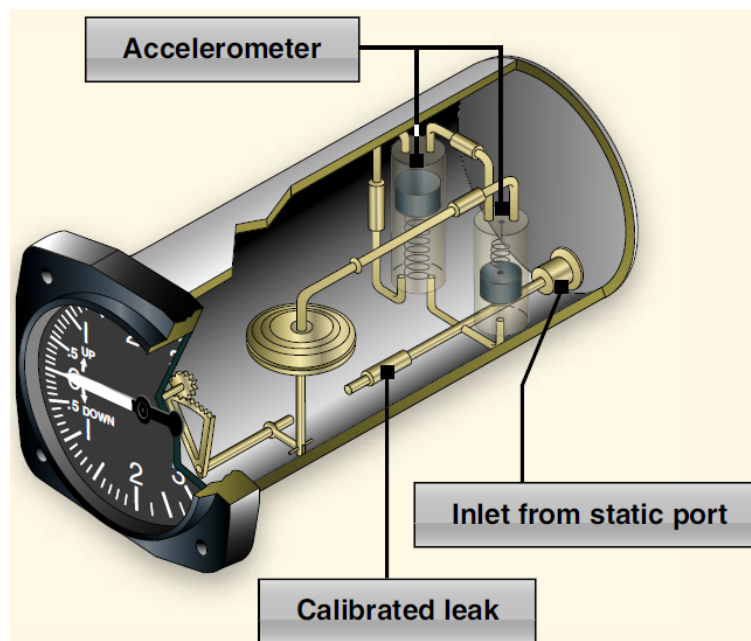
Errors due to small manufacturing imperfections and the mechanical amplification required are known as instrument errors. Instrument error increases with altitude as the rate of pressure change decreases. The VSI suffers from hysteresis and friction but the main error is **LAG**. The VSI responds to a change in static pressure resulting from a climb or descent. It takes time for the pressure difference to be created and transferred to the pointer consequently the indication occurs a few seconds after the actual event.

BLOCKAGES

If the static system becomes blocked (icing, insects, etc) during a climb or descent, the VSI readings will gradually return to zero. The pressure inside and outside the capsule will soon equalise through the metering unit. If no pressure (static) change can be sensed by the capsule the instrument will indicate zero. If a partial blockage occurs, the indication will be very sluggish.

INSTANTANEOUS VERTICAL SPEED INDICATOR (IVSI)

As the main error in the conventional VSI is lag, the IVSI has been designed to improve instrument response. It is sometimes called an 'INERTIA LEAD VSI'. A small accelerometer pump is fitted to create an artificial pressure change immediately when a vertical acceleration occurs. This pressure change immediately causes the capsule to react and an instantaneous indication is presented. The accelerometer generated pressure decays after a few seconds, and the changing static pressure (conventional operation) then maintains the climb or descent indication until the next change occurs.



Note : In the IVSI, lag has been practically eliminated, however other sources of error described above remain. In addition, during turns the accelerometer pump (otherwise described as a 'dashpot') may be displaced introducing a **TURNING** error. The IVSI is considered unreliable during steeply banked turns.

SERVICEABILITY CHECKS

During pre-flight, the VSI should read zero or be within permissible limits.

1. ± 200 ft/min at temperatures -20°C to $+50^{\circ}\text{C}$.
2. Glass clean and no apparent damage to the instrument.