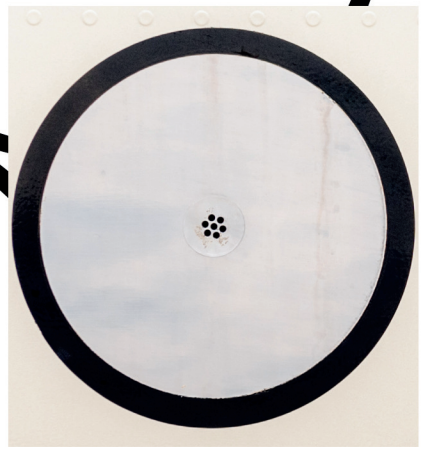
Pitot Static System

Airspeed Indicator

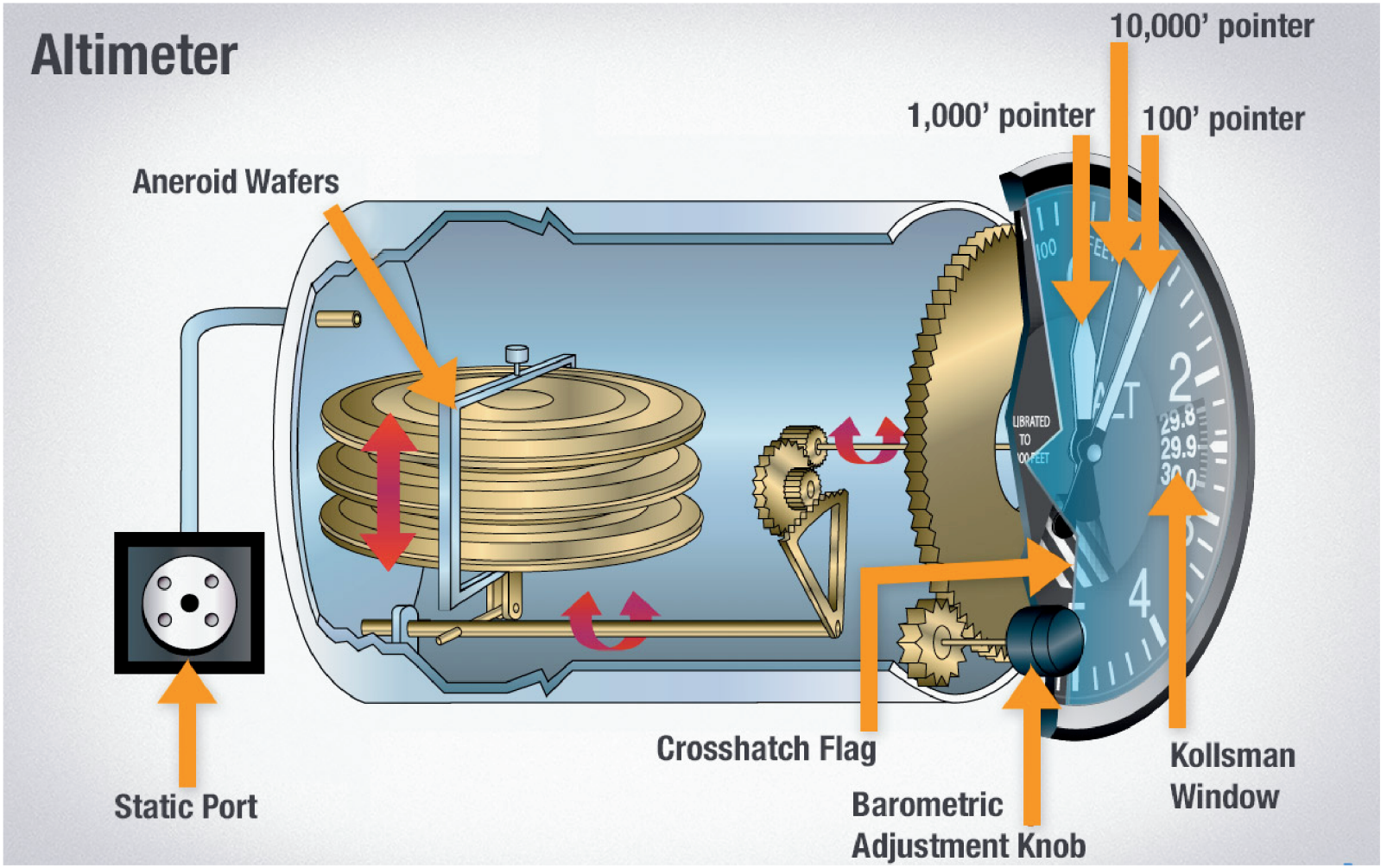
Altimeter

Vertical Speed Indicator

Pitot Tube



Static Port



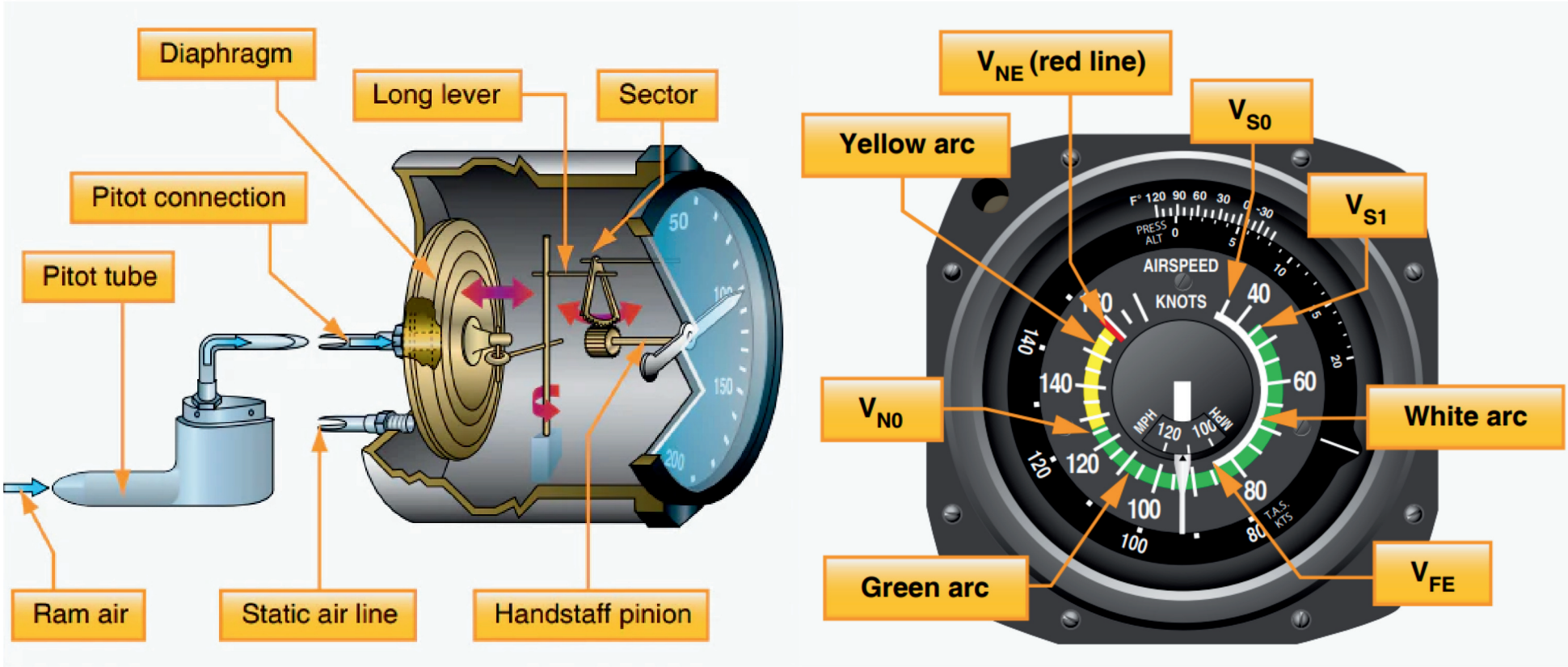
Reading a standard 3-hand altimeter
The long pointer measures altitude in intervals of 10,000 feet (2 = 20,000 feet). The short, wide pointer measures altitude in intervals of 1,000 feet (2 = 2,000 feet). The medium, thin pointer measures altitude in intervals of 100 feet (2 = 200 feet).

The altimeter measures the height of an aircraft above a fixed level. Using the ambient air pressure from the static port, the air is plumbed through the back case of the altimeter. Inside the altimeter is a sealed disc called an **aneroid wafer**.

As the aircraft goes up, the pressure inside the case decreases and the wafer expands. The opposite happens as the aircraft descends. The aneroid wafer is mechanically connected to the face of the instrument through gears.

It is Kollsman's invention that assists the pilot: The window on the front of the instrument allows the pilot to set the altimeter to the current local pressure, so it will display an accurate height above sea level.

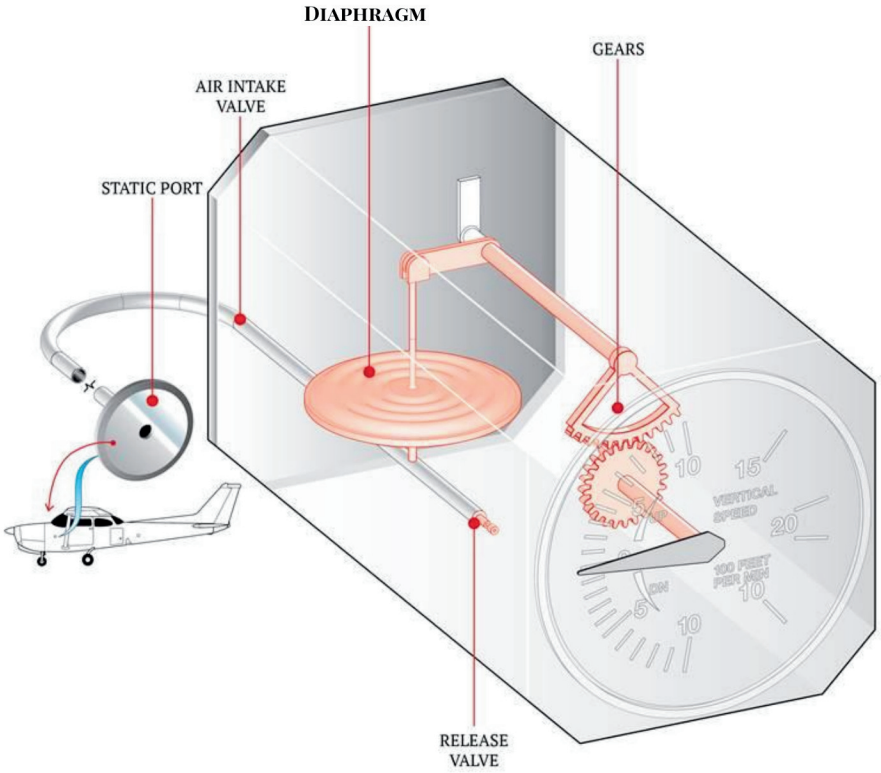
Airspeed Indicator



The airspeed indicator measures dynamic pressure. It's the same pressure caused by your airplane's movement through the air. However, in order for your airspeed indicator to measure dynamic pressure correctly, it needs to measure static air as well. That's because the higher you go, the lower atmospheric pressure is.

So how does the measuring work? It starts with your pitot tube, which measures combination of static and dynamic pressure, otherwise known as "ram air". If you're sitting on the ground, your ram pressure only includes the static component. But once your start moving forward, static and dynamic pressure are measured.

Vertical Speed Indicator



The diaphragm is also connect to a set of gears and rods that move your VSI's needle up and down, and that happens when the diaphragm expands and contracts.

The calibrated leak is a tiny hole that connects the casing of the VSI to the static source, but there's a catch. The hole in the calibrated leak is small enough that is restrict airflow, so it can't move in and out as fast as the diaphragm can.

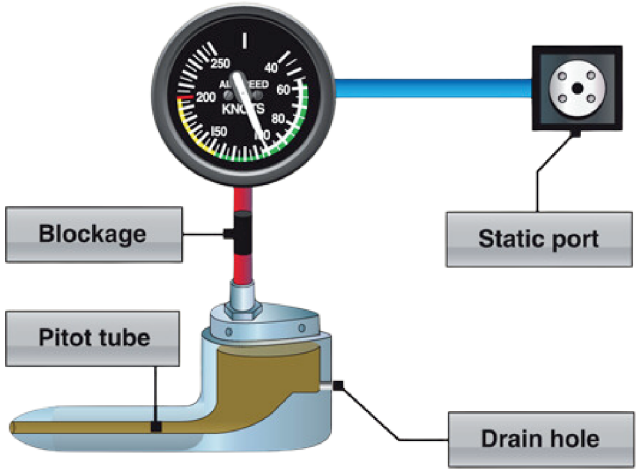
The greater the pressure differential, the more the needle moves up.As you climb, your static pressure decreases, and as it decreases immediately in the diaphragm. But the instrument casing is a different story.

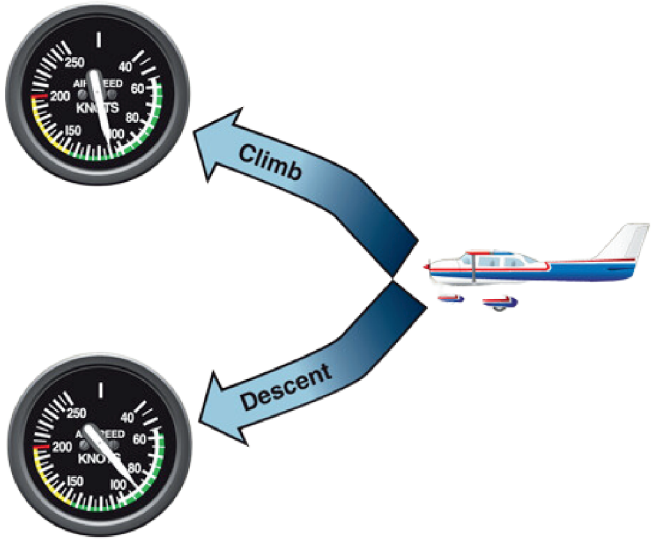
Since the calibrated leak lets air out slowly, it creates a higher pressure in the casing than the diaphragm. When that happens, it creates a pressure differential, the diaphragm is squeezed down, and the gears connected to the VSI needle make it move up.

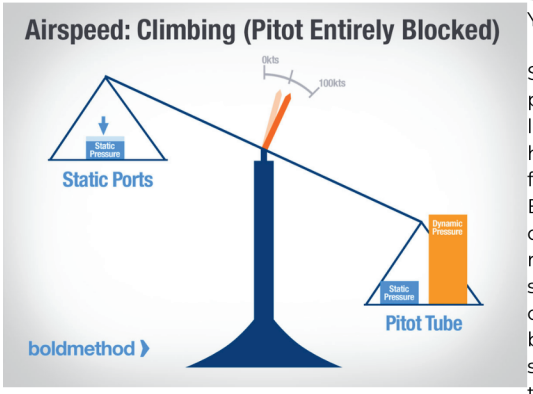
Pitot Static Blockages

Situation	Airspeed	Altimeter	VSI
Blocked Pitot Open Drain Open Static	Zero	Works	Works
Blocked Pitot Blocked Drain Open Static	High in Climb Low In Descent	Works	Works
Open Pitot Open Drain Blocked Static	Low in Climb High in Descent	Frozen	Frozen at Zero
Using Alternate Static Air	Reads High	Reads High	Momentarily Shows Climb Then, Reads High
Broken VSI Glass	Reads High	Reads High	Reverses

Blockages & the Airspeed Indicator







Scenario 1: Your Pitot Tube Clogs, But Your Static Ports Stay Open

So what happens if your pitot tube ices over, but your static ports stay open? There are a couple different cases here, but let's stay the whole thing iced over, including the drains. If this happens, your ram pressure gets trapped. And just like the first scenario, if nothing changes, you're fine.
But what happens if you start climbing? Your static pressure decreases, and the trapped static pressure component of your ram air is too great, which means you're indicating a faster speed than you're actually flying. And if you descent, the exact opposite happens. (If the pitot tube and its drain hole are blocked, then as the aircraft climbs, the trapped air in the pitot system will be compared against decreasing air pressure in the static system.)

Scenario 2: Your Pitot Tube Clogs, But The Pitot Drain Stays Open, & Open Static Port

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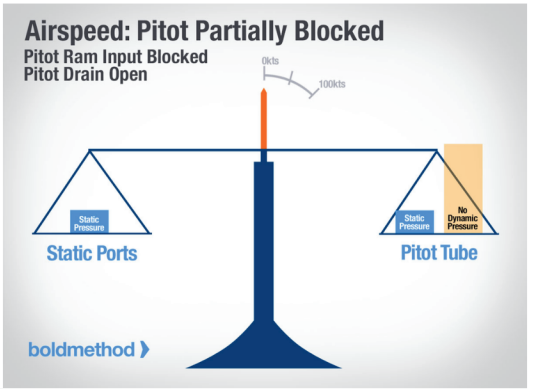
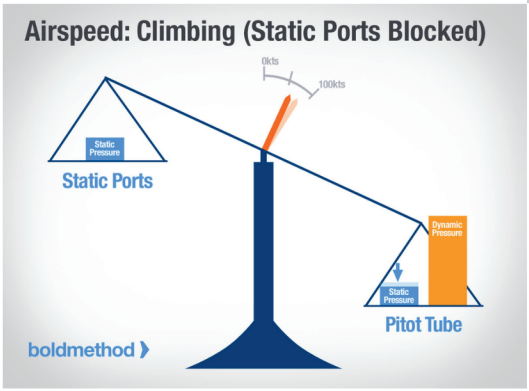
If this happens, all of your ram air will leak out the drain, and you're left with nothing but static pressure. And if that happens, your airspeed goes to 0s





Scenario 3: Your Static Ports Clog, And Your Pitot Tube Stays Open

The most likely scenario here is that your static ports ice over. And when they do, they trap whatever static pressure was in your airspeed indicator at that exact time.

That works out fine as long as your barometric pressure doesn't change, and you stay at the same altitude. But, if that's not the case, things are going start going wrong. Let's look at what happens if you start climbing.

The airspeed indicator measures the difference between ram and static pressure to get dynamic pressure which is what we call airspeed.

Alternate Static Air

If **the static system is blocked:**

Altimeter: The altimeter will freeze at whatever pressure is trapped in the system. If it gets blocked at 9,000’ the altimeter will indicate 9,000’ until the blockage is removed.

Vertical Speed Indicator: The vertical speed indicator will fail to indicate any rate of climb or descent because the controlled leak will “drain” the remaining pressure into equillibrium.

Airspeed Indicator: The airspeed indicator will continue to work as long as the pitot tube is not blocked.

However, since the static pressure is blocked and not changing with altitude, errors will occur based on the difference between the actual outside static pressure and the pressure in the static system lines when the blockage occurred.

The airspeed will read slower at altitudes above the blockage and higher at altitudes below the blockage.

Broken VSI Glass & Blocked Static Port

Why is this important? Because the VSI is one of those things on an airplane that can be intentionally broken to resolve a problem.

A blockage generally will cause the airspeed indicator (ASI) to show higher speeds in a descent and lower ones during a climb. That's a bit insidious, since that's what happens normally.

To verify the blockage, slow the airplane by reducing power and maintaining altitude. If the ASI doesn't change, you've got a blockage

If the VSI is not damaged in the process of breaking the glass, consider that it will indicate backwards because the **"flow" of static air pressure into the instrument would be reversed**. A positive VSI indication would indicate a descent, and vice versa.