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# EVO: Engine Mechanicals

## Crankcase Ventilation

See also in the REF section of the Sportsterpedia:

- [Breather Valves \(1957-Up\)](#) (list of breather valve changes)
- [Breather Venting / Relocation](#)
- [Wet Sumping](#)
- [Engine and Primary Oil System Modifications](#)
- [Evo Crankcase Pressure and Engine Breathing](#)

A mixture of crankcase air and oil mist is produced on each piston down stroke.

This forced mixture helps to splash lube the moving parts in the engine.

It also creates unwanted pressure in the engine.

The oil mist is then separated from the crankcase air and the excess air pressure is vented out of the engine.

86-90 engines vent through a valve in the cam cover.

91 and up engines vent through a valve in each rocker box and out the hollow breather bolts in each head to the air cleaner.

## Late 1984-1990 Sportster Breather Valve

### **An important note:**

Factory engine breather valves on all Evo Sportsters are inside the engine.

The lines / hoses that leave the engine and any apparatus to route the air to different places are part of the venting system.

Many aftermarket manufacturers advertise that they are selling "Engine Breathers" when they are actually only selling the vent line / tube assemblies.

See the link at the top of the page for aftermarket breather and venting solutions.

- 1986-1990 engines continued the breather baffle tube system (implemented in L1984) incorporated into the cam cover in the area behind the oil filter.
- The baffle tube mounts into the cam cover and the rubber umbrella installs into the center of the baffle tube. <sup>1)</sup>
- On each piston downstroke, crankcase pressure (air and oil mist) is routed to the breather baffle at the front of the cam case.
- Oil is separated from the air pressure by the one-way umbrella valve.
  - The oil then drains into the cam chest through a drain hole in the breather valve

compartment.

- Exhaust air escapes past the one way umbrella valve in the baffle tube and into a vent fitting on the cam cover.
  - The air is then routed into the rear of the air cleaner via an oil hose to the cam cover.

### Umbrella check valve comparison: <sup>2)</sup>

Outside diameter:

26856-82 - 1.25"

26856-89 - 1.0"

Edge thickness (1/8" in average): <sup>3)</sup>

26856-82 - 0.036"

26856-89 - 0.041"

- The pic below shows the left side (filter side) that faces into the cam box.
  - It's center inside diameter is slightly larger than the 1.25" OD (-82) umbrella valve.
  - The two 'C' shaped slots that do the breathing have an OD of 1".
  - As a result, the (-89) umbrella valve with its diameter of 1" may not perform correctly as there is likely to be leakage.



This looks like a good factory alternative replacement umbrella valve that comes in a replacement kit for Twin Cams.

(Thanks to crb2855 of the XLFORUM for the umbrella replacement idea)

You just need to remove the umbrella from the kit and install it as you normally would in the baffle tube. Or if you can order just the umbrella from HD, the part number is (26858-99).



1999 Dyna Twin Cam style umbrella (26858-99) <sup>7)</sup>



89 cam cover with breather baffle tube attached (it should be tight but still pull out) <sup>8)</sup>

## 1991-2003 Sportster Breather Valve

### An important note:

Factory engine breather valves on all Evo Sportsters are inside the engine.

The lines / hoses that leave the engine and any apparatus to route the air to different places are part of the venting system.

Many aftermarket manufacturers advertise that they are selling "Engine Breathers" when they are actually only selling the vent line / tube assemblies.

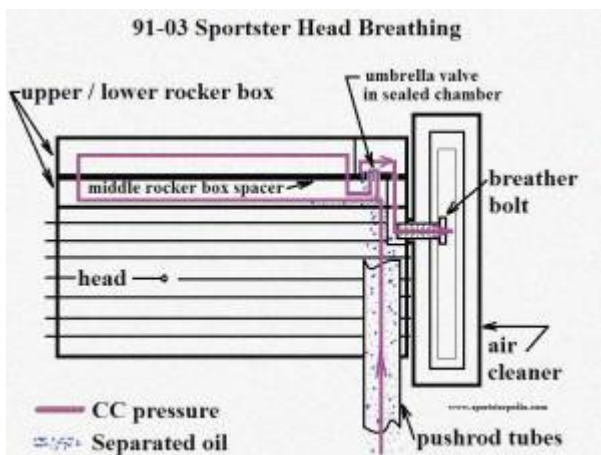
See the link at the top of the page for aftermarket breather and venting solutions.

- In 1991, along with the 5-speed transmission, the MoCo moved the crankcase breathing from the cam box cover outlet to breather bolts in the heads. Previously, these bolts were just used to mount the carb and air cleaner to the heads.
- The new breather system uses (2) one-way umbrella valves (26856-89) placed in the rocker boxes (1 each placed on the intake side).

The part number was later updated to (26856-89A).

These expel crankcase vapors through vents in the top of the cylinder head and into the carb to be burnt.<sup>9)</sup>

- On each piston downstroke, crankcase pressure (air and oil mist) is routed up the pushrod tubes into the rocker box (bypassing the falling oil from the rocker boxes).
- Collected air pressure and oil mist in each rocker box is routed up into a sealed cavity in the lower portion of the box.
- This mixture passes up from underneath a rubber one-way valve (umbrella valve) sitting over the cavity inlet.
  - The oil is designed to separate from the air by hitting the underside of the umbrella valve and dropping back down into a recessed area behind the umbrella valve in the cavity.
    - From there it should drain back into the main rocker box through a tiny hole behind the umbrella valve and then back to the lower end.
    - The separated oil flows into drain holes in the rocker boxes and back into the gearcase.
  - Air pressure is designed to continue up past the umbrella valve and exit a hole in each head on the intake valve side.
    - Air pressure escapes the head through the hollow bolts (one in each head) that hold the air cleaner mount.



- The Parts Catalog and FSM are a bit confusing regarding how many umbrellas are used and where. The information is there but it's just not clear. The parts catalog only shows an exploded diagram of one rocker box assembly on the Rocker Arms, Covers and Pushrods page. Yet, the description shows that 2 umbrellas are required. It's the same for all of the parts on that page as well as each newer parts catalog (1 pushrod, tube, lifter and related parts). This is the norm mostly throughout the subsequent catalogs with multiple (same) parts. It's assumed this was done to save money on printing the catalogs (replicated information deleted). The FSM displays the same exploded diagram as the parts catalog in the front of the Cylinder Head section. It's only at the end of the Installation article does it say to install new gaskets on the middle rocker box (with the breather valve on the intake side). There is no dedicated section on the rocker box or umbrella valves (which seem to be regarded as

mere gaskets).

## Installation

- The middle rocker box is symmetrically cast so that it can be used on the front or rear head. And, there is a spot (seemingly) for two umbrellas. <sup>12)</sup>
- **However, only one umbrella is used in each middle section.** (only 2 umbrella valves are used in the entire engine.) <sup>13)</sup>
- Each umbrella is placed on the intake side on each head (only).
- It is not always green as in the pic below (depends on what brand you buy).



## 2004-Present Sportster Breather Valve

### An important note:

Factory engine breather valves on all Evo Sportsters are inside the engine.

The lines / hoses that leave the engine and any apparatus to route the air to different places are part of the venting system.

Many aftermarket manufacturers advertise that they are selling "Engine Breathers" when they are actually only selling the vent line / tube assemblies.

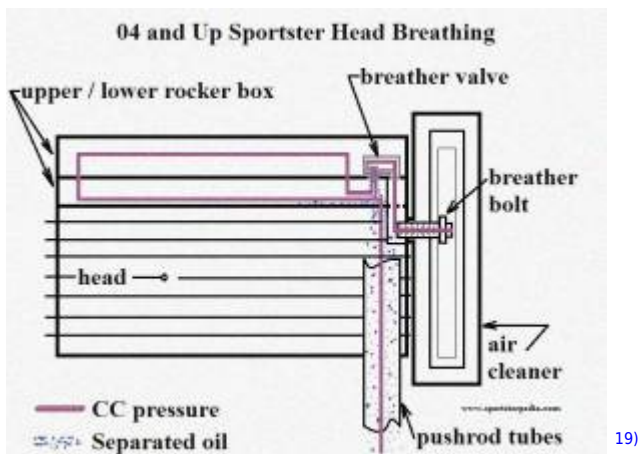
See the link at the top of the page for aftermarket breather and venting solutions.

- In 2004 the MoCo made some changes to the umbrella valve configuration. The umbrella was retained but now inside a plastic housing with a pre-umbrella oil separating screen. Each 'breather valve' is assembled into a plastic fitting that is sealed over the outlet hole in the

lower rocker box to the head breather bolt.

The new breather valves were also accompanied with new style hollow air cleaner mounting bolts for the pressure to escape.

- The new bolts are the same thread size as previous. But instead of a simple hex, it also has a shoulder past the hex for an O-ring to be fitted between the hex head and the air cleaner.
- The breathing system is functionally the same as 1991-2003 with the one-way umbrella valves in the rocker boxes. These exit crankcase vapors through vents in the top of the cylinder head and into the carb mouth to be burnt. <sup>18)</sup>
  - On each piston downstroke, crankcase pressure (air and oil mist) is routed up the pushrod tubes into the rocker box (bypassing the falling oil from the rocker boxes).
  - Collected air pressure and oil mist in each rocker box is routed up into the breather valve unit in the lower portion of the box.
  - This mixture passes up from underneath the breather unit.
    - The oil is designed to separate from the air by hitting the underside of the screen / umbrella valve and dropping back down into the rocker box.
      - From there it is routed back to the lower end.
      - The separated oil flows into drain holes in the rocker boxes and back into the gearcase.
    - Air pressure is designed to continue up past the breather unit and exit a hole in each head on the intake valve side.
      - Air pressure escapes the head through the hollow bolts (one in each head) that hold the air cleaner mount.



Just as with the 91-03 umbrella valves, only 1 breather valve per side is used. And each one is placed on the intake side of each lower rocker box.

However, unlike the single umbrella valves in 03, each breather valve in 04 and up engines is directional. (as in there is one for the front and a different one for the rear)

Each one consists of a poly fiber over a rubber flap. <sup>20)</sup>

The fiber pieces are the same as the brown Scotchbrite pads that are sold in the body section of auto parts stores.

You can cut your own put them in the breather valves. They are aluminum oxide and won't hurt the



engine. <sup>21)</sup>



## Buell (XB type) Breather Valve

See also, [Installing a Buell Rocker Box / Breather System on an Evo Sportster](#) in the REF section of the Sportsterpedia.

Buells use a reed in the gearcase to exhaust excess crankcase pressure to the gearcase. Then air/oil travels to the rocker boxes and separates via the breather valves on the rocker boxes.

2003 Buell XB-9R breather valve (17607-00Y), along with a grommet (17606-00Y), installs into the big hole in each rocker box cover.

A vent hose connects each breather valve to the air cleaner backing plate.

The Buell breather valve (PCV as it is called in the parts book) is nothing more than a variation of the HD umbrella valve with a woven mesh insert and oil separator labyrinth under it.

This is not actually a PCV valve in the conventional sense. PCV valves don't act as quick as the umbrella valve.

The Buell type breather has been thought of by some as a much improved version of the Sportster breather system.

The Buell breather is similar to the 2004-up Sportster breather valve but without the oil drain-back. Since 1979, HD Sportster breather valves have a drain back into the motor past the umbrella.

2004-up XLs also have a matt type strainer below the umbrella with a labyrinth past the umbrella with a drain hole there.

Both the Buell and 04-up Sportster umbrellas are in their own sealed containment so changing the umbrella if needed consists of replacing the whole unit.

It appears the mesh doesn't stop up the center as it has that hole in the middle and the umbrella should have a little clearance in the installed hole.

The umbrella is a slight loose fit when popped in there. So it will rise and fall a little.

However, the mesh material in both types can still gunk up with old oil.

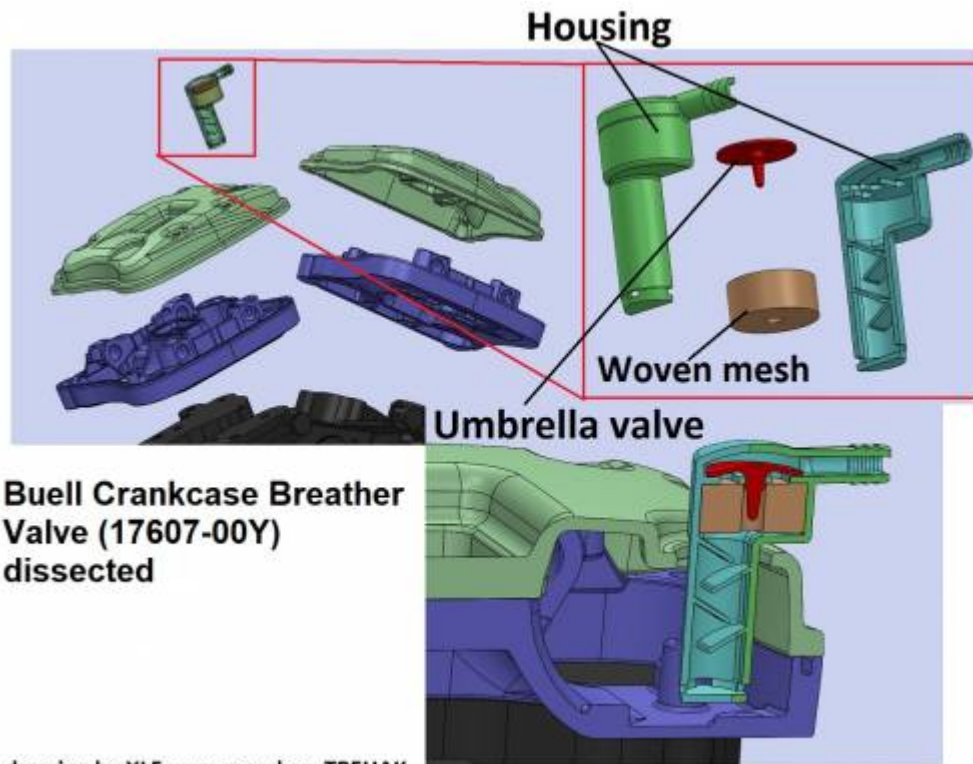
You can see the loading of oil on the mesh in the pics below. The shelving partitions in the lower end do help separate oil from air.

With the 2004-up breather, a large portion of oil that gets past the umbrella can drain from the separator "ladders" back into the rocker box.

And some, usually in the form of mist will blow into the air cleaner.

Any oil that gets past the umbrella with the Buell breather will blow out the vent hose routed into the air filter.

After some time it forms a puddle of condensed oil inside the airbox under the air filter. <sup>27)</sup>



<sup>28)</sup>



## Check the breather to gasket seal

There is an anomaly when it comes to the seal around the stock breather port under the rocker box. <sup>32)</sup>

The rocker box cover gasket is part of the seal for the breather port.

It's possible to make a mistake when installing the breathers into aftermarket gaskets and end up with oil puking out the breathers.

This could result in a leak which would bypass the umbrella (since the only seal would be down-pressure of the umbrella housing against the rubber).

The hold-down bolt for the breather is on the other end of it.

Using OEM valve cover gaskets, you would not need the orange seal.

However, using Cometic rocker box gaskets, you do need the orange seal.

### Using OEM Rocker Box Gaskets:

The pictures shown with the brown breather and no orange seal are of the original configuration. There are no known sealing issues here. There is a thicker area on the gasket that fits down into the rocker-box hole. Also there is a bump to take up extra space next to the umbrella housing and it fits nicely in the hole of the gasket.



### Using Cometic Rocker Box Gaskets:

The pictures with the white-ish (newer) breather which comes with the orange seal included. The Cometic gasket has a hole sized to fit the rocker-box port which is much larger than the umbrella valve housing that fits in it. To make this seal properly you would need the orange seal but you would only have the orange seal if you bought new breathers also.



## Head Breather Bolts

## Sub Documents

- [Making 91-03 Breather Bolt Holes Smaller](#)

See also [Evo Crankcase Pressure and Engine Breathing](#) in the REF section of the Sportsterpedia.

Since 86-90 engines breath through the cam chest cover instead of the heads, the air cleaner bolts are solid (not hollowed).

91 and up engines breath out the heads through hollowed out air cleaner mounting bolts (or breather bolts).

Without the hole through the bolts, the engine can't breathe.

The size of the orifice in the hollow head breather bolts makes the crankcase pressure rise higher (or lower) in the process of expelling the gas. <sup>37)</sup>

### 1991-2003

91-03 breather bolts.

Outside threads are 1/2" x 13 (hole through the middle is 5/6" nominal).



38)



39)

### 2004 and Up

Crankcase pressure was increased in 2004 by several means.

One of which was the reduction of the hole size in the breather bolts on the engine side (more restriction).

The smaller hole creates higher pressure in the crankcase on piston downstroke which aides in oil scavenging.

They also allow the air to leave the vents at a faster rate.

04+ breather bolts.

Outside threads are 1/2" x 13 (2 different sizes thru the middle - nominally 1/16" (1.5875 mm) in the rear and 5/16" in the front). <sup>40) 41) 42)</sup>



If you know someone with a lathe, you can have some stainless steel breather bolts made. <sup>46)</sup>



## Symptoms of Breather problems

Read more here on the [Evo Crankcase Pressure and Engine Breathing](#) in the REF section of the Sportsterpedia.

The most noticeable signs of breather valve problems are weeping gaskets or oil excessively leaking out the breather or puking oil out of it.

When the umbrella(s) gets hard, it doesn't flex well to allow the engine to breath out on exhale.

Then the trapped in air is compounded on the next stroke. The excess air contributes to more vacuum created and implodes the gaskets.

Or it contributes to too high of oil density and slings excess oil out.

Other factors are involved so results will vary.

## Breather Valve Testing

[Click Here](#) for information on testing crankcase pressure in the Sportsterpedia.

There are no service intervals for the breather valve(s) in the FSMs. Also, there is no method of testing them in the FSMs.

But when they harden over time, you might experience more oil vapor, oil droplets or oil puking out the breather vent(s).

The air coming out the vent(s) pulses according to piston position.

On upstroke, a low pressure is created in the bottom end. On downstroke, positive air pressure is created by piston downstroke.

It's never a bad idea to replace the breather valves if you have any question whether you have a bad one.

From the pics, it looks like the front breather unit is stopped up. 1986-1990 Sportsters have one umbrella in the breather baffle tube inside the cam cover.

1991-2003 Sportsters have (2) umbrellas (one in each rocker box).

2004-up Sportsters have (2) umbrellas (one in each rocker box inside a sealed plastic breather unit).

The 2004 breather units have a removable fiber mesh filter under the umbrella that can stop up with gunked oil.

The mesh disc in the unit can get oil soaked and not pass any air through the umbrella.

The oil on the soaked mesh can vapor off if it doesn't cool on shutdown and gunk up there. If it gunks up, the mesh should be pulled and cleaned or replaced.

## Test for air flow at the vent

You can verify a stopped up breather valve by "feeling" for air moving from the breather vent(s) with the air cleaner off, finger near each vent.

As long as you have know air is moving, then the breather valve isn't stopped up.

That doesn't mean it's working properly though.

It's hard to tell by feel alone if air is moving out or if air is moving in.

But there is a point where you may FEEL both air out and air in at the fingertip near the vent(s).

If there are any questions about the umbrella valves / units working properly, you could just replace them and be done with it.

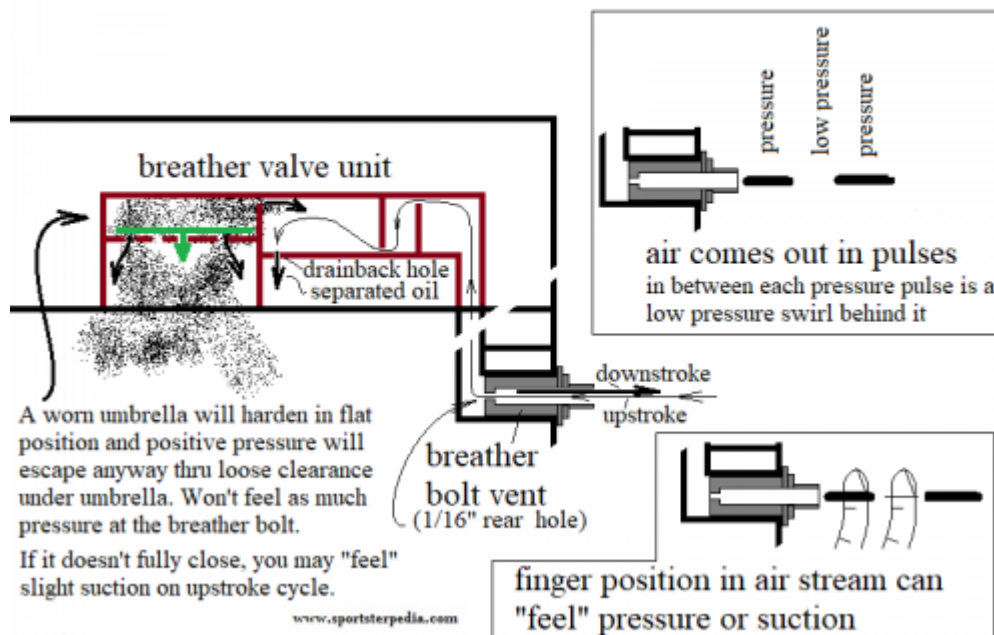
With the rubber umbrellas hardening over time, there is nothing lost by replacing them.

However, with the air cleaner off and a finger placed into the vent air stream;

- The exiting air from the vent is being sped up from the umbrella chamber to the vent. This will pressurize the exit vent, hence the "FEEL" of pressure. <sup>47)</sup>  
When the flow stops abruptly (pulse finishes), there is an instant void that is filled with atmospheric pressure.  
Hence the "FEEL" of return flow.
- A new flexible umbrella is designed to allow pressure to move out, not in. However, outside air can still enter through the oil drain back hole on engine vacuum cycles.
- 1986-up breather valves also incorporate an oil drain back hole for engine vacuum to pull separated oil from mist back into the motor.  
The drain hole is past the umbrella between it and the outlet air vent. The drain hole is not controlled by the umbrella but rather engine vacuum.  
So after the drain hole empties separated oil and is still under vacuum at that split second, holding a finger to the vent may feel a slight vacuum.
- If an umbrella is stiff and not closing fully, you may FEEL air both push and pull at the breather vent.  
The umbrella has a loose clearance under it.  
It has a stem that pops into a hole in it's resting place and the stem is slightly longer than the hole is deep.  
If an umbrella hardens, it will do so after cooling down, engine shut off.  
So it will harden in it's flat position.  
On startup, positive air pressure (and oil mist) will still get under and by the affected umbrella, just not as well as if it were flexible.  
So at it's vent, you may feel less air pressure due to a partially opening breather valve.
- The faster RPM, the faster the breather "umbrella" acts (flexing closed on upstroke and open on downstroke).  
If the rubber umbrella hardens over time, it may not be able to act as fast as the pistons.  
So you may "feel" both pressure and vacuum at the vent with your finger tip, air cleaner removed.

### 2004-Up Sportster Breathers

What you may "feel" with a finger over the breather bolt vent hole





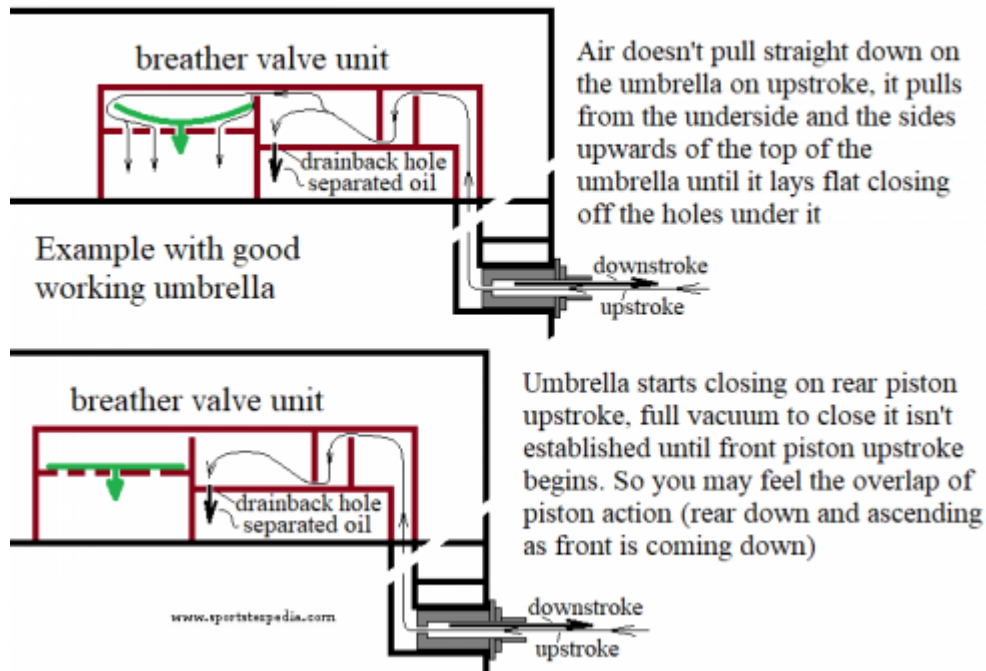
There is an overlap on the bottom stroke cycle where the rear piston is at the bottom of it's stroke and the front piston is still coming down.

Next, the rear piston rises creating a partial lowering of air pressure under the front piston.

Full vacuum is not created until both pistons are on their up stroke.

So there is a lull area in each cycle that can be perceived as both pressure and suction at the breather vent even with good working umbrellas.

## 2004-up Sportster Breather Valve Unit



49)

## Blow testing through the vent

Since it's a one-way valve, air should go out but not come back in (past the umbrella itself).

Before you position the hose, you can use a bit of clean pipe and blow gently through the breather. <sup>50)</sup>

It should close the valve and stop air flow (if you use a quick hard breath).

However, blowing slow and gently will allow a small amount of breath to go into the engine through the tiny oil drainback hole.

You may have to find an aftermarket replacement if the valve is shot and OEM replacements are hard to come by.

The 5 speed (rocker box) umbrellas are smaller than the 4 speed (cam cover) umbrellas and these won't interchange.

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