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EVO: Oiling & Lubrication

Engine Oil System

More pathway details at Engine Oil Routes

And in the REF section of the Sportsterpedia, see these:

- Engine and Primary Oil System Modifications
- Sportster Oil Pressure (57 to Present)
- Installing an Oil Pressure Gauge

A good discussion on the XLFORUM including rubbermount crankcase pressure: 04s and up and oil use.

Engine Oiling

General Statement

The Sportster Oiling Cycle is defined in the FSMs. However, that description is vague in some of the intricate transitions of the oil path in the engine. This article is an attempt to clarify some of the gray areas from the FSM's descriptions with further description and pictures. ¹)

Engine Pressures

Different areas have different types of pressure applied and from different sources. ²) ³)

Oil Pump Pressure

The oil pump doesn't make pressure. All it does is create flow. It's non-regulated and delivers its entire volume of oil under pressure to the oil filter mount. Measurable oil pump pressure is a result of engine restrictions on the pressure side of the pump. (i.e. lines, routing, holes and galley sizes)
The engine has a force-fed (pressure type) oiling system incorporating oil feed and return pumps in one pump body with a check valve on the feed side.  

- The feed side of the pump forces oil to the engine to lubricate;
  - Lower connecting rod bearings
  - Rocker arm bushings
  - Valve stems
  - Valve springs
  - Pushrods and tappets
- The scavenge side of the pump returns oil from the bottom of the gearcase and crankcase sump to the oil tank.

Also, it's not unusual to get air out the oil return line (to the tank).  
It's a dry-sump system with a gerotor oil pump that's designed to keep the engine sump as dry as it can. When there's no oil to suck up, it pumps a little air instead into the oil tank. That's the way it's supposed to work. 
See also, Oil Tank Pressure in the REF section of the Sportsterpedia.

Crankcase Pressure

See also Evo Crankcase Pressure and Engine Breathing in the REF section of the Sportsterpedia.

Crankcase pressure is mainly generated by the up and down movement of the pistons. The downstroke of the piston causes the volume underneath the pistons to decrease which puts pressure on the oil in the sump.  
This pressure is multi use;

- It helps to push sump oil up and out the scavenge passage to the return side of the oil pump. 
  (the scavenge side of the pump also pulls a vacuum on the sealed passage from the sump outlet to the pump)  
- It also initiates the splash and mist process as the compressed air above the oil is ready to spring up when the piston rises.

Then the upstroke of the piston creates an upward vacuum bringing some of the oil from the sump with it. 
With little to no (piston ring) blow-by and a check valve on the breather system; 
Crankcase pressure is essentially cycling between atmospheric and negative (pressures) as the pistons go down and back up. 
(remember, due to the common crankpin 45 degree design, a Harley motor is a variable volume crankcase, unlike most motors) 

This creates splash oil which is bounced about in the crankcase. This also creates an air / oil mix when tiny particles intertwine with the oil in suspension. 
The two don't actually mix as does sugar and water. So separating them back apart is fairly easy if you add an obstacle for that 'mix' to collide into. The obstacle is widely known as the breather or umbrella valve although anything the mix touches in the
motor could accomplish the same thing in theory.

The piston motions create a pulsating blast of air pressure (push pull condition as each piston rises and falls).
Static oil pump pressure has already been dissipated by the time it reaches the crankcase.
(although it takes static oil pressure to get the oil from the pump to the crankcase)

Likewise, crankcase (CC) pressure will have a constant change in velocity.
Oil in the crankcase adds resistance to the air pressure generated (raising the pressure).
2004 and up models have feed oil piston squirters which adds more oil into the crankcase.
04 head drains were diverted to the gearcase instead of the crankcase as in previous models to help offset the difference from the squirters.

The movement of the pistons and flywheels splash oil around in the engine.
Gravity oil (from the drain ports in the heads) returns to the crankcase or gearcase (respective to year model);

- On 86-03 engines, gravity oil falls into the crankcase sump area.
- On 04 and up engines, gravity oil falls into the gearcase.

**Some CC Pressure is needed**

Some of the oil is picked up by the piston upstroke and mixed with the air pressure in the form of mist.
The mist and splash oil lubricates crankcase components.
And they are also carried into the gearcase compartment to help lubricate the cams and pinion / oil pump gears.
Splash and gravity oil from the connecting rods, crankshaft, rocker boxes and head/cylinder drainage holes serve to lubricate;

- Cylinder walls
- Pistons, piston pins
- Cam gears and bushings
- Main bearings

**Excess CC Pressure is vented out of the engine**

See also [Crankcase Ventilation](http://sportsterpedia.com/) in the Sportsterpedia.

Unvented crankcase pressure will simply build up inside the engine and eventually blow out gaskets / seals in the engine.
The pressure (even though needed) would build high enough to be detrimental to the engine.
So unusable high pressure is vented out of the engine to keep in (regulate) a certain amount of usable internal pressure.
91 and up engine oil cycle from the FSMs

- The oil pump sends pressurized oil up through a cavity in the filter housing to the oil filter.
- Filtered oil dumps into the filter adapter opening a check ball between 4-6 psi (28-41 kN/m²) into the crankcase feed galley to the tappet blocks and lifters.
- Cross drilled passages intersect the main feed galley and carry oil to each lifter.
  Oil also enters an intersecting passage in the gearcase cover to the crankshaft area via a hole through the pinion gear shaft.
  Oil then travels to the right flywheel and routed through the crankpin thus lubricating the rod bearings.
  (oil is fed under pressure to the crank pin and is forced out the holes in the pin)
  Some lubing of the piston skirts also happens from the 'splashing effect' of the oil exiting the bearings and being thrown around by the rotating flywheels, before it settles in the sump area of the oil pump.
- Oil flows up the holes in the pushrods to the rocker arms and shafts.
  Oil is supplied to the valve stems via drilled holes in the rocker arms.
- The oil then flows off the pushrod side of the heads through the pushrod covers into the gearcase, lubing the cams and is collected by the scavenge (return) side of the pump.
- Oil flows from the rocker area of the heads into the crankcase by way of passages in the heads and cylinders.
  Oil in the sump area of the crankcase is splashed onto the pistons, cylinder walls and flywheel components.
- Oil collected in the crankcase sump is passage-routed back to the scavenger side of the pump.
  (via the ladle, half spoon, duck bill scavenge port protruding from the back of the pump)
  It is fed by the scavenging effect of the pump and pressure generated by the downward stroke of the pistons.
- Return oil fills a cavity above the pump's return gears which pumps the oil back into the oil tank.
  A small amount of oil flows from the feed galley in the right crankcase half through a restricted orifice and sprays oil onto the rear intake cam gear.

Oil Pump Feed

See also the Evo oil pump section of the Sportsterpedia.

Oil is gravity fed from the oil tank to the oil pump.

- In essence, the oil tank is mounted above the oil pump and the feed line runs down to the pump.

However, there is also a vacuum on the feed line to the pump.

- Once the oil pump feed gerotors begin spinning, they also pull a backdraft (or vacuum) on the incoming oil supply line.
  It's an added part of the system once the pump starts turning(in addition to the force of gravity).
- As the volume between the feed gerotor gears increase (with engine RPM), the suction on the feed line also increases.
- Likewise with lower RPM, the suction decreases.
86-90 engines

- Oil is gravity fed to the oil pump from the oil tank.
- Then the oil pump feed gerotors send pressurized oil up through a cavity in the filter housing via an external hose to the oil filter.
- The oil leaves the filter via an external hose and returns back to the oil pump.
- Then it is routed through a check valve or check ball inside the oil pump and into a passage in the cam cover.

91 and up engines

- Oil is gravity fed to the oil pump from the oil tank.
- Then the oil pump feed gerotors send pressurized oil up through a cavity in the filter housing via an external hose to the oil filter.
- The oil leaves the filter and is routed through a check ball and into the case feed galley.
- 91-03 engines:
  - From the feed galley, feed pressure is sent to the lifters and pinion bushing / shaft.
  - A drilled passage also connects the feed galley down to squirt excess feed pressure to #2 cam gear.
- 04-Up engines:
  - In addition, oil is fed from the feed galley (through a drilled passage) to the piston squirters.
Oil Pump Return (scavenge)

Positive crankcase pressure (piston downstroke) aids scavenging.\textsuperscript{17} Negative pressure (piston upstroke) makes the pump's job harder since the pump is fighting the crankcase vacuum.

There is a vacuum on the scavenge side of the pump just as and for the same reason as is on the feed side.
Both crankcase pressure and oil pump pressure (including a vacuum on the sealed passage between the two areas) work together to push oil out of the crankcase.
The sump outlet is below the scavenge pump inlet so the oil has to flow uphill to get to the pump to return to the oil tank.

The return gerotors are taller than the feed gerotors.
This equates to a larger pumping volume of oil returned to the tank than oil fed to the engine.
See more pics in the Evo Oil Pump section of the Sportsterpedia.
Oil Passages From The Filter Pad

Below are different cam chest pics showing the oil passages from the filter pad.

86 Cam Chest

1995 Cam Chest

1995 Cam Chest

1998 Cam Chest

1999 Cam Chest

2000 Cam Chest

2001 Cam Chest

2003 Cam Chest
Oil Filter - Function & Control

Also see the REF section on Understanding Oil Filters

- The oil pump sends pressurized oil to the oil filter.
  - There are two cavities inside the oil filter.
  - Oil enters the outside cavity, passes thru the filter media and exits thru the filter adapter in the center.

86-90 engines

- The filtered oil is sent back to the oil pump.

91 and up engines

- The filtered oil pushes against and opens a check ball in the filter housing between 4-6 psi. (28-41 kN/m²).
- Oil leaves the check ball into the horizontal crankcase feed galley (running along the top of the case beside the tappet blocks and lifters).

General Overview
A) ... Incoming 'Dirty' Oil on Outside of Filter Material (RED color for dirty oil)
B) ... Filter Material inside the Oil Filter
C) ... Bypass Valve - Passes dirty oil when necessary to prevent oil starvation
D) ... Output of Oil from the Filter - (GREEN color for filtered oil - RED for UNfiltered)
E) ... Check Valve keeps oil from draining into engine when not running
F) ... Oil Supplied to Engine - Could be Clean or Dirty depending on Bypass Valve operation

Sometimes, these exist
G) ... Anti-Drain Back Valve in the Oil Filter to prevent the filter being empty
H) ... Pressure Relief Valve on 1986-1991 models (in the oil filter mount)

(This overview is not intended to present or explore every detail of any of these parts. See the REF section on Understanding Oil Filters)

The oil pump is hydraulic and moves oil efficiently. It is very strong due to being directly driven and having minimal gear lash in the pump. It will pump forcibly IF NECESSARY. The flow rate capability (GPM) will vary somewhat based on resistance and the efficency of the pump and the level of wear within the gerotor gears.
The pump is capable of 100's of PSI. The amount of oil passed per revolution is nearly constant, thus the GPMs will increase as the RPMs increase.

It is the resistance to flow that will determine the actual pressure (PSI). If there is little resistance, then the PSI pressure will be low. If there is much resistance, the constant force of the pump will create high (or very high) PSI pressure.

The physical hoses & routing (bends/kinks/etc.) will create some resistance (getting to (A)), the filter material (B) will create some resistance, the check valve (E) will create some resistance and the engine oiling system will create some resistance... Of course, the oil temperature affects the viscosity of the oil. Colder Oil = Thicker Oil, which increases the resistance to flow. Combined at any one specific time, these factors create the PSI necessary to push the GPM load that the pump is supplying.

The density of the filter material (B) (microns) & the level of contaminant saturation in the material will affect the resistance. Of course, the level of contaminant saturation varies with usage.

The bypass valve (C) is intended to prevent oil starvation in the engine when the filter passes oil poorly - but to do so, it must pass UNfiltered oil around the filter material. It does this only when the Bypass Valve PSI rating is exceeded. This only occurs when the filter material cannot pass enough oil THRU it, thereby creating a higher oil pressure on the input side (due to filter resistance to flow). This is sensed by the bypass valve (C), which then opens to continue supplying some oil around (rather than thru) the filter material to keep the engine oiled. Physically, the implemented bypass may be at the top or bottom of the filter, but the function is the same.

The Anti-Drain-Back Valve (G) prevents the oil inside the filter from escaping back out the input side of the filter (A). This maintains an oil reservoir (inside the filter) that is ready to supply the engine immediately on start-up, rather than waiting for new oil to fill the filter cavity once the newly started engine begins to pump oil to the filter.

In a similar way, the Check Valve (E) helps to prevent oil draining out of the filter (or being gravity drained from the oil tank, thru the pump & filter) into the engine oiling system when the active flow stops (engine is not running). It has a very low PSI setting so that even a very low movement of oil will pass thru to begin oiling the engine.

The Pressure Relief Valve (H), which is only on the 1986-91 XL models, is set for about 30psi. This guarantees that the pressure to the oil filter is below that level. But that level of pressure is only present when the oil is cold. Once warm, the normal pressure is below 30psi all the time, even at high RPMS.

While both are differential valves, the Filter Bypass Valve (C) functions on a difference in pressure from one side of the filter material to the other side, while the Pressure Relief Valve (H) functions on absolute input pressure because there is no pressure on the other side of it (in the gearcase or crankcase).

The Bypass Valve (C) functions differentially because there is supplied oil (under pressure) at both sides of the valve - One side is supplied from the outside of the filter material and the other side is supplied pressure from the oil that has passed thru the filter material (being at the outlet of the filter). This means IF the filter material flows well (being new and/or clean with warmed up oil viscosity) then both sides of the material will be close to the same pressure level, with the material presenting little resistance. BUT, if the filter is very restrictive (clogged or oil is cold & thick) the flow from passing THRU the filter will be present a significantly less pressure on the Bypass Valve output side, thereby calling for the Bypass
Valve (C) to open.

To be clear, the Bypass Valve (C) doesn't care if there is 5psi on each side or 20psi on each side, it will not open until there is a difference between the incoming side of the filter & the outgoing side of the filter. If rated at 12psi, the difference must be 12psi before it opens (17psi in vs 5psi out - or - 32psi in vs 20psi out). If so rated, the difference must be 12psi. This can/will occur when the oil is cold & thick or when the filter is sufficiently clogged to minimize oil flow thru it.

In contrast, there is no pressure on the output side of the Relief Valve (H). It only has pressure on the input side, which, when it reaches 30psi, will open to allow some volume to bleed off, thereby reducing the pressure in the line. Since there is no pressure on the output side of the Relief Valve (H), dumping into the gearcase or crankcase, the differential pressure is always perceived as XX (inside) psi to 0 (cam/crank) psi.

It should also be noted that in normal operation, the bypassing of the oil filter for brief periods (like thick viscosity) will have little affect on the longevity of the engine. However, a clogged oil filter that is continuously bypassing oil around the filter material, will eventually sufficiently contaminate the engine oiling system to cause damage. Oil filter replacement on the recommended schedule (or sooner) is a precautionary chore to keep the engine supplied with clean oil.

These two references are a good read:
http://www.mgnoc.com/article_oil_filters_revisited.html
http://xlforum.net/forums/showthread.php?t=2071942

Oil Filter Mount

Sub Documents

- 86-90 Oil Filter Mount Parts, Specs and Dims

--- 1986-1990 Models ---
--- 1991-later Models ---

The oil filter adapter is the threaded part that the filter screws onto.
The threads on the adapter for the filter are 3/4"-16.

See also Oil Filter Fitment in the REF section of the Sportsterpedia.

**Engine Oil Pressure and Testing**

On Evo engines, 20% of oil pressure is sent to the bottom end and 80% is sent to the top end.  

The oil pump is non-regulatory and delivers its entire volume of oil under pressure to the oil filter mount. When an engine is cold, the engine oil will be more viscous (ie., thicker). During start-up of a cold engine, oil pressure will be higher than normal and oil circulation will be somewhat restricted within the oiling system. As the engine wams to normal operating temperature, the engine oil will warm up also and become less viscous - oil pressure will decrease.

When an engine is operated at high speeds; The volume of oil circulated through the oiling system increases, resulting in higher oil pressure. As engine speed is reduced, the volume of oil pumped is also reduced, resulting in lower oil pressure.

**On 86-91 engines:**

Oil pressure was measured with a pressure gauge at the plug hole on the engine case between the tappets. The 1/8" NPT allen head plug between the tappets has to be removed for the gauge to be installed. **Note:** On 86-90 models, oil pressure (when checked at the oil filter pad) will be 6-10 psi higher than
when checked at the tappet plug on the case at idle.

**On 92 and up engines:**

Oil pressure was measure with a pressure gauge at the oil pressure switch location at oil filter pad. The oil pressure switch has to be removed for the gauge to be installed. (idle speed varies from 950-1050 rpm between the different FSMs)

**2013 XR1200X:**

Includes an oil cooler with a thermostat that starts to open at 190°F (88°C). The oil pump and the head breathers are a new design.
The oil pump rotors are driven by the cams, the feed rotor is driven off the front intake cam and the scavenge rotor is driven by the rear exhaust cam.

Oil pressure relief (50 psi)

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**Oil Tank Pressure**

See the full article, *Oil Tank Pressure*, in the REF section of the Sportsterpedia.

There should not be any noticeable pressure in the oil tank although it does transfer pressure. The oil tank vent line to the cam chest allows the pump to send the oil to the tank without pressurizing the inside of it and blowing the cap off. 

It is not there to vent the cam chest, the breathers do that.

**During normal operation**;

With the tank cap / dipstick removed, tank pressure is vented to atmosphere from the top of the tank.

With the tank cap / dipstick installed, tank pressure is vented to the cam chest.

**During shutdown**;

The oil tank vent is connected to the cam chest and the cam chest is vented out the breather valve in the cam cover.

So if you have pressure in your oil tank and the vent to the cam chest is not blocked then the cam chest is also pressurized.

If the cam chest is holding pressure, then your breather valve can not be venting properly.

Bottom line is that if the vent system is working properly, you shouldn't have excessive pressure build up in the oil tank.

---

**Checking oil pressure**

See also *Installing an Oil Pressure Gauge* in the REF section of the Sportsterpedia.

When checking oil pressure, it's important to note that you are not testing pressure at a dead stop standpoint.

The oil is flowing into the engine at the same time you are testing from a still test site. Likewise, the resulting pressure reading is a reflection of residual pressure while that pressure is being manipulated.
(by oil flow as well as the current viscosity)

- Remove the oil pressure switch or tappet hole plug (respectively) and insert the appropriate gauge and fitting(s).
- Run the engine until oil reaches normal operating temperature (motorcycle should be driven at least 20 miles at or above 50mph).
  ○ For an accurate reading, engine oil should be at normal operating temperature: 230°F (110°C).  
- Check pressure against the figures in the FSM as in below:

**Expected (hot) oil pump pressure per the FSM's:**

<table>
<thead>
<tr>
<th>Year Model</th>
<th>Minimum PSI (Idle Speed)</th>
<th>Normal Riding Conditions (2500 rpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1986-1990</td>
<td>1-7 psi</td>
<td>5-30 psi (2500 rpm)</td>
</tr>
<tr>
<td>1991</td>
<td>7-12 psi</td>
<td>12-17 psi (2500 rpm)</td>
</tr>
</tbody>
</table>

**With pressure gauge mounted at oil filter pad**

<table>
<thead>
<tr>
<th>Year Model</th>
<th>Minimum PSI (Idle Speed)</th>
<th>Normal Riding Conditions (2500 rpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1986-1990</td>
<td>7-17 psi (see above)</td>
<td>not specified</td>
</tr>
<tr>
<td>1992-2004</td>
<td>7-12 psi</td>
<td>10-17 psi (2500 rpm)</td>
</tr>
<tr>
<td>2013 XR1200X</td>
<td>16-20 psi</td>
<td>40-44 psi</td>
</tr>
</tbody>
</table>

**Rocker box pressure**

- Residual working pressure from the lifters resides in the rocker boxes as well as crankcase pressure.
  ○ On a cold startup, the pressure is higher due to the thicker oil present.
  ○ As the engine warms up, the oil thins out and the pressure is reduced in the rocker boxes.
- Excess crankcase pressure (air and oil mist) is vented differently between (86-90) and (91 and up) models.
  ○ So, it is possible to notice different pressures from them with a pressure gauge testing from the rocker box.
  ○ However, a gauge tapped into any rocker box will most likely measure air pressure instead of oil pressure.
  ○ Air will compress and oil will not, therefore the readings should be lower than if you were testing at the oil pressure switch.
86-90 engines

- Crankcase pressure is vented through the cam cover.

91 and up engines

- Crankcase pressure is routed up the pushrod tubes and exit a hole in each head on the intake valve side.

Cam Cover Pressure

Oil pump pressure is always present in the cam cover with the engine running. That is also a deceiving statement. Pump pressure runs through internal cavities in the cover to get from the top to the bottom of the cover and to the pinion shaft. However, oil pump pressure does not dump directly into the cam chest from the cover normally. On 86-91 engines with the oil pressure regulator, the regulator dumps excess oil pressure into the gearcase until the high pressure condition subsides. 92 and Up engines do not have this spring actuating pressure regulator but they still have a pressure bleed off passage in the main feed galley. This tiny hole from the feed galley bleeds off excess feed pressure into the gearcase and onto the #2 cam gear.

86-90 engines

- Oil pressure to the cam cover is fed from the bottom.
  - The cover gets it's oil from the oil pump via intersecting holes between the bottom of the case and the cover.
  - (the gearcase gets no oil from this passage in the cover, outside of spill from the pinion shaft bushing)
- The cover supplies oil to the feed galley for the lifters.
  - A hole is internally routed from the top to the bottom of the cover with a hole exiting in each corresponding hole in the case.
  - The hole in the middle of the case at the top intersects into the internal oil feed galley.
- It also supplies oil to the pinion shaft and bushing.
  - An internal cross drilled hole runs to the back of the pinion shaft bushing.
  - This oils the pinion bushing and at the same time sends pressurized oil through the hole in the pinion shaft for the rod bearings.

91 and up engines

- Oil pressure to the cam cover is fed from the top.
  - Oil is sent through a cross drilled hole from the case feed cavity into the top of the cam cover
to the rear of the pinion shaft bushing.
(thegearcase gets no oil from this passage in the cover, outside of spill from the pinion shaft bushing)
• The cam cover supplies oil to the pinion shaft and bushing.
  ◦ An internal cross drilled hole runs to the back of the pinion shaft bushing from the slotted cavity in the top of the cover.
  ◦ This oils the pinion bushing and at the same time sends pressurized oil through the hole in the pinion shaft for the rod bearings.

Oil System Controls

Oil Pressure Regulator - 1986-1991 Models ONLY

--- 1986-1990 Models ---

See pics and installation of the plunger and spring for 86-90 models in the Sportsterpedia. Also 86-90 Oil Filter Mount Mods for modifications to the pressure regulator system.

Pressurized oil comes into the gearcase from the hole at the arrow on the right. 52)
With the new Evolution engine in 1986, an oil pressure regulator (relief valve) was implemented to bleed off some of the oil when the pressure thru the filter became too high. The spring loaded pressure valve was built into the oil filter mounting pad. There is a passage from the filter pad relief valve into the cam gearcase. The discharge from the relief valve drains down into the gearcase. Then that 'extra' oil and is routed to the crankcase sump through a hole in the case wall and gets pumped back to the tank.

The spring-loaded pressure regulator opens at about 30 psi. However, it is usually only regulating when the engine oil is cold. When the engine is warm, the valve is typically shut, since pressure is usually below 30 psi even at high rpms. 53)

The pressure relief parts for 1986-1990 are:

<table>
<thead>
<tr>
<th>HD Part#</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>737</td>
<td>PLUG</td>
</tr>
<tr>
<td>6037</td>
<td>WASHER</td>
</tr>
<tr>
<td>26001-86</td>
<td>PLUNGER</td>
</tr>
<tr>
<td>26002-86</td>
<td>SPRING</td>
</tr>
</tbody>
</table>

The plug installation torque is 15-20 ft-lbs.

--- 1991 Model ---

In 1991, the entire oil filter mount was incorporated into the right crankcase half. It still used a supply & return hose to flow oil thru the filter. The implementation of the pressure regulator in this version used the same spring & plunger as before. It was mounted into a hole from the gearcase side of the mount. Then, a new plug, with a hole drilled in the center of the hex head, held the spring & plunger in place. This allowed oil to escape from the incoming side of the filter, thru the plug hole and into the gearcase, where it eventually made it to the crankcase.
sump & was returned to the oil tank.

As in the previous implementation, this allowed the relief valve to bypass oil thru the plunger when activated instead of pumping it thru the filter. The relief pressure was the same, being about 30psi.

Since the new plug is already in the gearcase, the washer (6037) was eliminated.

The pressure relief parts for 1991 are:

<table>
<thead>
<tr>
<th>HD Part#</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>742</td>
<td>PLUG</td>
</tr>
<tr>
<td>26001-86</td>
<td>PLUNGER</td>
</tr>
<tr>
<td>26002-86</td>
<td>SPRING</td>
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(It should be noted that the 1991 & 1992 parts catalogs list these pressure relief parts for all models, although they are not illustrated for either year. However, I have only been able to visually verify the
existence of these parts on the 1991 model engine. Harley Tech Tips #26 & #27 seem to support this, but there might have been some early 1992 models with the 1991 implementation. Research continuing.\(^\text{55}\)

**XLFORUM Discussion Threads on the Pressure Regulator**

**Oil Pump Upgrade '86-'90**

**Oil Pressure Regulator - 92 and Up Models**

The oil pressure regulating unit was discontinued for 92 and up engines (and 91 replacement cases). Excess oil pressure is relieved by a passage drilled in the top of the right case. It is a double duty (hole) drilled from the center open feed galley down toward #2 cam gear. This passage is on the oil filter side of both the lifters and the crankpin and relieves high pressure to both. It sprays (or possibly drips) oil onto #2 cam gear until the pressure gets high in the feed galley.

- When pressure is normal, most of the oil goes to the normal engine routes.
- When pressure is high, the excess pressure is bled off to #2 cam leaving normal pressure to the rest of the path.

**Oil Pressure Switch**

See also **Testing the Oil Pressure Switch** in the Ref section of the Sportsterpedia.

The oil pressure switch (for the oil light) is a pressure actuated diaphragm type on / off switch basically. The diaphragm is spring loaded and held against its contact point when the engine is not running or the when the oil pressure is too low while running. With the switch contacts touching, this closes the circuit to the oil pressure light and causes it to light up (with the key on, of course).
When the engine is fired up, oil pressure builds in the filter pad, activates the oil light switch and opens the oil pump check valve (or check ball respectively) allowing oil to enter the engine. Oil pressure is sensed by the oil pressure switch. By the time the engine reaches over 1000 to 1200 rpms, the oil pressure is sufficient to move the oil pressure switch diaphragm completely off it's seat. This opens its contact point, breaking the circuit to the oil pressure light and it goes off.

Cold cranking oil pressure can reach between 30 PSI and upwards of 60-100+ PSI. Oil pressure will vary under normal riding conditions. See above for expected oil pressures. However, idle (hot) oil pressure will vary from 7-17 PSI on most models. So, at idle, the oil check valve (or ball) may only be opened just past it's cracking pressure (not to it's end of travel).

**In the Case of a Defective Oil Pressure Switch:**

This switch opens and closes the contacts to the oil pressure light. The oil light is important to have since if it is not working, it can be assumed that you have little to none oil flow to the engine. If the pressure switch doesn't operate the light it should be checked for proper operation or replaced. For the $30 or whatever you save by not buying the switch, it's just not worth it to not have the low engine pressure idiot light working. If your motor is ready to run and you need to test it then you can connect a piece of clear hose so you can see oil in it. Don't plug the end till you've primed the pump (if applicable). Replace a defective switch as soon as possible.

Part # (26554-77)
Torque:
Pressure switch: 5-7 ft/lbs.
Wire nut: 4-10 in/lbs.
Installation

Caution: DO NOT tighten the oil pressure switch too tight. It will either strip the threads in the filter housing or crack the filter housing. If you don't have access to a torque wrench or can't get one to fit in there, use a “hand tight plus a little” approach when tightening the switch.
You can also clamp a nut in a vise if needed, install a bolt and tighten it to 5-7 ft/lbs. Then use a open/box end wrench to feel the point where it turns. Then you have a bench mark 'feel' for how tight to turn the pressure switch with the same type wrench. This one got tightened too much and cracked the filter housing.

Don't over tighten to try and stop a leak. It doesn't take much oomph to seal the pressure switch. Don't use silicone on the threads. Thread tape may break off and enter the filter or the engine. In theory, you should be able to stop a leak from the switch threads without any thread sealer because of the tapered threads.
But thread sealer of some type (Loctite, plumbing pipe dope or other) is suggested. Keep in mind that any thread dressing applied will pre-load the torque needed. So be sure to back down on final torque when using thread sealants.

If you used the proper torque and it still leaks oil, you may need to pull the switch and filter and look for a crack in the housing.
Pull the switch and the filter so you can see both the housing and the hole threads. It only takes a little more than needed to crack the housing.
The switch threads are tapered. Turned too far in, the taper widens the hole and expands the aluminum around the hole.
The hole is near the end of the filter pad. With little surface area between the hole and the end of the housing, that is the weakest part and where
cracks will appear. If yours has cracked, it'll need to be welded. The crack will only get worse with vibration. The thing about welding is it causes warp-age. Once it's welded, the threads for the switch will probably need to be reconditioned as the hole may warp. If so, you can try and chase the threads with a tap. You may have to go with a threaded bushing (bigger threads into the housing with smaller threads on the other end) to add the switch back. Also the main purpose for the filter pad is the machined flat surface for the filter. It will need to be checked for flatness after welding so the filter don't leak.

Also check the threads in the hole. Too much torque will damage aluminum threads pretty fast and to different degrees. Clean the filter mount surface and verify there is no crack and then inspect the threads for the switch. The thread pitch in the housing is 1/8” NPS (non tapered). You can run a tap into the threads and try to straighten them if needed.

**Cracked:** This filter housing was cracked due to too much torque being applied while tightening the oil pressure switch.
Oil Pressure Light

If the oil pressure light stays on at speeds above idling, always check the oil supply first. Then if the oil supply is normal, look inside the oil tank to determine if oil is returning to the tank from the return hose with the engine running. If oil is returning to the tank, there is some circulation and the engine may be run a short distance if necessary. If no oil is returning, shut the engine off until the trouble is located and fixed.

Conditions causing the oil light to stay on;
Low or diluted oil supply,
Or a plugged lifter screen (86-91) under the plug between the tappets,
A grounded oil signal switch wire,
Faulty oil switch,
Faulty or weak oil pump,
Clogged feed hose (in freezing weather from ice and sludge preventing the circulation of oil).

Oil Check Valve (77-E87)

See Oil Check Valve (86-E87) in the Sportsterpedia.
The Oil Check Valve is located behind the threaded filter adapter in the center of the oil filter mount. The filter adapter I.D. was enlarged on the filter end to accept the check valve. The check valve operation is dependent on receiving filtered oil (through the filter media) to lift the check valve cup and allow oil to pass. Therefore, a stopped up oil filter media condition (not allowing flow or enough flow) may not produce enough oil pressure to open the check valve before the filter bypass opens.

The oil pump check valve plays a role in the operation of the oil pressure switch.

The check valve is not a pass through but instead a cartridge type one way check valve operated by a spring loaded cup against a seat pressing at 4-6 PSI. Oil pressure enters the center of the check valve, lifts the cup against its spring and exits the check valve
by pushing around and past the cup and into the engine.
At a point, the cup will float off it's seat up against the spring towards the end of it's travel.

According to the FSM, the check valve has two main functions;
It prevents gravity oil drainage from the tank to the engine when not in operation.
It also acts as a restriction to activate the oil pressure switch.

Without the check valve, the pressure would not build up as much in the oil 'pocket' in the filter housing.
It would free flow into the crankcase and disperse.
With the check valve installed and the oil having to find it's way around the cup, pressure builds behind it in the pocket.
This back pressure builds inside the pump and pushes the pressure switch contacts open, shutting off the oil light.

The check valve spring does not control the amount of oil that enters the engine (unless it's stuck closed).
The flow goes past the check no matter what. The spring pressure is very light.
It regulates (creates and manages) the oil pressure in the pocket next to the switch before it enters the engine.
That pocket is protected for one reason (to operate the oil switch, therefore the oil light).
If you are not running an oil light, there is no reason to be concerned with the check valve (in regards to a running engine).
You could remove the light and the check and it would not affect the oil flow thru the engine.
The positive displacement oil pump will still deliver oil.

The check/switch/light is a safety precaution to let you see the light and warn you that the pressure in the pocket is low.
In theory and design, if the pressure in the pocket is low, oil flow would also be low.
In practice, there are too many variables on a worn engine, pump, check, switch etc. to keep theory and design true all the time.

The cup will stay off it's seat and open as long as there is sufficient oil pressure pushing against its spring.
This spring actuates the 4-6 PSI pressure that the pump must overcome.
If there is not enough oil pressure coming from the pump to keep the check valve cup completely or partially off it's seat;
The back pressure from the spring will push the cup toward it's seat, or closed position, equal to the amount of minimum pressure loss from the pump.
Thinner (hotter) oil flows faster and builds less pressure.

When the oil thins out, the oil will still push past the cup.
At a point, the pressure from the pump may not be sufficient to completely float the cup off it's seat.
So, the cup will turn sideways a bit only allowing oil to pass it on one side.
This reduction in pressure is also sensed by the oil pressure switch. When the pressure drops, the diaphragm eases back toward the closed position. If the pressure is low enough, the contacts will close or partially make contact while closing or intermittently opening and closing. The oil light will come on or flicker depending on the action of the contacts.

The pressure switch requires no back pressure from the engine to stay open. It opens solely from the pressure generated from the oil pump with the assistance of the check valve to hold some of that pressure in the pump. So, it is possible but not likely to have a stuck closed check valve with no oil light on.

**Oil Check Ball (L87 and Up)**

See also [L87-90 Oil Check Ball Pics](http://sportsterpedia.com/) in the Sportsterpedia. The Oil Check Ball is located behind the threaded filter adapter in the center of the oil filter mount.

**The oil pump check ball plays a role in the operation of the oil pressure switch.**
The check ball replaced the check valve in L87 and up models.

**L87 check ball addition at the oil filter mount.**

L87 models were fitted with a (light brown) check ball and spring instead of a cartridge type check valve as in previous year models. The original check ball was redesigned to a smaller version due to the bore size for it in the filter mount. The new smaller size ball (26437-86A) was black and usable on 86-90 model Sportsters.
Some Sportster oil filter mounts with the original oil check ball may have had an undersized oil passageway. The original check ball could stick causing reduced oil pressure and lifter noise. The solution was to remove the original light brown check ball and either; Install the new black check ball (26437-86A) and spring (26436-86). Or, install the old style check valve (26435-76A) and it's O-ring (26433-77). Affected crankcase numbers:

- 883 models: 1787063001-1787159608
- 1100 models: 1887062035-1887160608

The oil enters the oil filter at full pressure from the pump.
After the oil exits the oil filter, it pushes against and opens the check ball that's located behind the oil filter mount.
The spring behind the check ball keeps pressure (4 to 6 psi) against the ball. It's purpose is to prevent the oil tank from draining into the motor while the bike is shut off. It also keeps enough oil pressure upstream of the motor to turn off the oil pressure light. It does nothing to actually regulate the oil pressure in the motor though.

The check ball operation is dependent on receiving filtered oil (through the filter media) to push the ball off it's seat and allow oil to pass. Therefore, a stopped up oil filter media condition (not allowing flow or enough flow) may not produce enough oil pressure to open the check ball path before the filter bypass opens.
Removal
Installation

two cable tie wraps make it easier to remove the ball

1998 1200S Oil Filter Mount

install spring, then check ball

1998 1200S Oil Filter Mount

oil system check ball

blue Loctite added to a couple threads of the oil filter adapter before installing it

1998 1200S Oil Filter Mount

Sportsterpedia - http://sportsterpedia.com/
Wet Sumping

See article on **Wet Sumping** in the REF section of the Sportsterpedia
shanneba of the XLFORUM http://xlforum.net/forums/showthread.php?t=2073175&page=3

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2000 MMI Documents

shanneba from the XLFORUM- 2013 Factory Service Manual

cbjurr of the XLFORUM

http://xlforum.net/forums/showthread.php?t=59421&highlight=piston+oiler&page=68
Deimus of the XLFORUM http://xlforum.net/forums/showthread.php?t=87313

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1986 HD FSM pgs 3-2
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1991-1992 HD Sportster FSM pgs 3-2, 3-32
1993-1994 HD Sportster FSM pgs 3-3, 3-40
1995-1996 HD Sportster FSM pgs 3-3, 3-38
1998 HD Sportster FSM pgs 3-3, 3-38
1999 HD Sportster FSM pgs 3-3, 3-40
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2004 HD Sportster FSM pgs 3-3, 3-14

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