

Figure 9-1. Typical dry-sump oil system.

## OIL TANKS

Oil tanks are generally associated with a dry sump lubrication system, while a wet sump system uses the crankcase of the engine to store the oil. Oil tanks are usually constructed of aluminum alloy and must withstand any vibration, inertia, and fluid loads expected in operation.

Each oil tank used with a reciprocating engine must have expansion space of not less than the greater of 10 percent of the tank capacity or 0.5 gallons. Each filler cap of an oil tank that is used with an engine must provide an oil-tight seal. The oil tank usually is placed close to the engine and high enough above the oil pump inlet to ensure gravity feed.

Oil tank capacity varies with the different types of aircraft, but it is usually sufficient to ensure an adequate supply of oil for the total fuel supply. The tank filler neck is positioned to provide sufficient room for oil expansion and for foam to collect.

The oil filler cap or cover is marked with the word "OIL." A drain in the filler cap well disposes of any overflow or spillage caused by the filling operation. Oil tank vent lines are provided to ensure proper tank ventilation in all attitudes of flight. These lines are usually connected to the engine crankcase to prevent the loss of oil through the vents. This indirectly vents the tanks to the atmosphere through the crankcase breather.

Large radial engines have many gallons of oil in their tanks. To help with engine warm up, some oil tanks had a built in hopper or temperature accelerating well. (*Figure 9-2*) This well extended from the oil return fitting on top of the oil tank to the outlet fitting in the sump in the bottom of the tank. In some systems, the hopper tank is open to the main oil supply at the lower end. Other systems have flapper-type valves that separate the main oil supply from the oil in the hopper. The opening at the bottom of the hopper in one type and the flapper valve-controlled openings in the other allow oil from the main tank to enter the hopper and replace the oil consumed by the engine. Whenever the hopper tank includes the flapper controlled openings, the valves

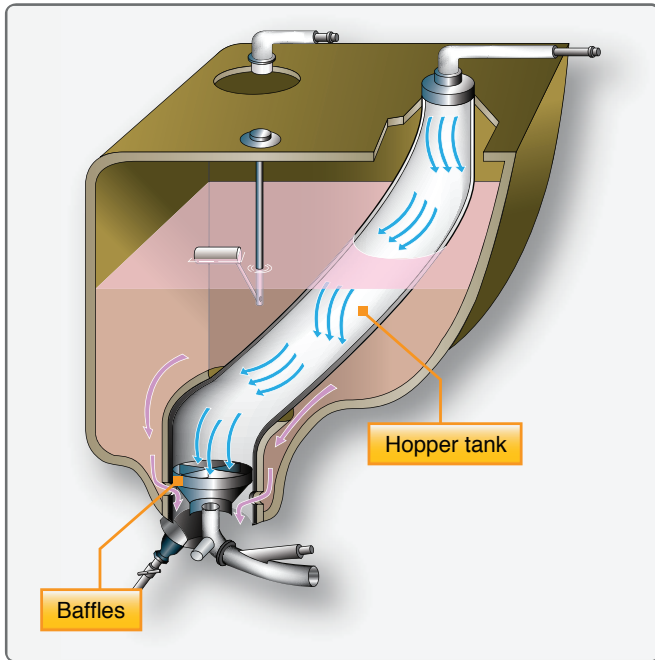


Figure 9-2. Hopper tank within oil tank used to expedite oil warm-up.

are operated by differential oil pressure. By separating the circulating oil from the surrounding oil in the tank, less oil is circulated. This hastens the warming of the oil when the engine was started. Very few of these types of tanks are still in use and most are associated with radial engine installations.

Generally, the return line in the top of the tank is positioned to discharge the returned oil against the wall of the tank in a swirling motion. This method considerably reduces foaming that occurs when oil mixes with air. Baffles in the bottom of the oil tank break up this swirling action to prevent air from being drawn into the inlet line of the oil pressure pump. Foaming oil increases in volume and reduces its ability to provide proper lubrication. In the case of oil-controlled propellers, the main outlet from the tank may be in the form of a standpipe so that there is always a reserve supply of oil for propeller feathering in case of engine failure. An oil tank sump, attached to the undersurface of the tank, acts as a trap for moisture and sediment. The water and sludge can be drained by manually opening the drain valve in the bottom of the sump as shown in *Figure 9-3*.

Most aircraft oil systems are equipped with the dipstick-type quantity gauge, often called a bayonet gauge. Some larger aircraft systems also have an oil quantity indicating system that shows the quantity of oil during flight. One type system consists essentially of an arm



Figure 9-3. Oil Tank sump and drain valve.

and float mechanism that rides the level of the oil and actuates an electric transmitter on top of the tank. The transmitter is connected to a cockpit gauge that indicates the quantity of oil.

## OIL PUMP

Oil entering the engine is pressurized, filtered, and regulated by units within the engine. They are discussed along with the external oil system to provide a concept of the complete oil system.

As oil enters the engine, it is pressurized by a gear-type pump. (*Figure 9-4*) This pump is a positive displacement pump that consists of two meshed gears that revolve inside the housing. The clearance between the teeth and housing is small. The pump inlet is located on the left and the discharge port is connected to the engine's system pressure line. One gear is attached to a splined drive shaft that extends from the pump housing to the crankshaft or an accessory drive shaft on the engine. Seals are used to prevent leakage around the drive shaft. As the lower gear is rotated counterclockwise, the driven idler gear turns clockwise.

As oil enters the gear chamber, it is picked up by the gear teeth, trapped between them and the sides of the gear chamber, is carried around the outside of the gears, and discharged from the pressure port into the oil screen passage. The pressurized oil flows to the oil filter, where any solid particles suspended in the oil are separated from it, preventing possible damage to moving parts of the engine.

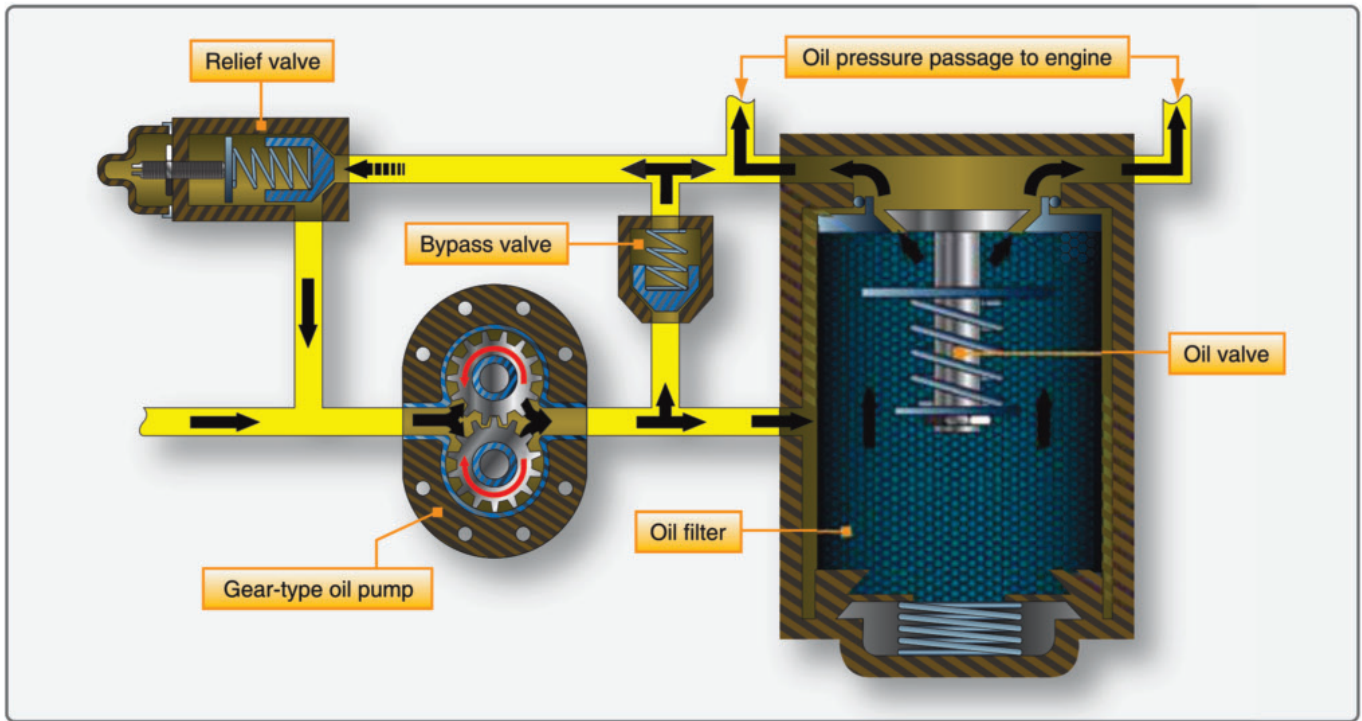


Figure 9-4. Oil pump and associated components.

Oil under pressure then opens the oil filter check valve mounted in the top of the filter. This valve is used mostly with dry sump radial engines and is closed by a light spring loading of 1 to 3 pounds per square inch (psi) when the engine is not operating to prevent gravity-fed oil from entering the engine and settling in the lower cylinders or sump area of the engine. If oil were allowed to gradually seep by the rings of the piston and fill the combustion chamber, it could cause a liquid lock, also known as a hydraulic cylinder lock. This could happen if the valves on the cylinder were both closed and the engine was cranked for start. Damage could occur to the engine.

The oil filter bypass valve, located between the pressure side of the oil pump and the oil filter, permits unfiltered oil to bypass the filter and enter the engine if the oil filter is clogged or during cold weather if congealed oil is blocking the filter during engine start. The spring loading on the bypass valve allows the valve to open before the oil pressure collapses the filter; in the case of cold, congealed oil, it provides a low-resistance path around the filter. Dirty oil in an engine is better than no lubrication.

## OIL FILTERS

The oil filter used on an aircraft engine is usually one of four types: screen, Cuno, canister, or spin-on. A screen-type filter with its double-walled construction provides a large filtering area in a compact unit. (*Figure 9-4*) As oil passes through the fine-mesh screen, dirt, sediment, and other foreign matter are removed and settle to the bottom of the housing. At regular intervals, the cover is removed and the screen and housing cleaned with a solvent. Oil screen filters are used mostly as suction filters on the inlet of the oil pump.

The Cuno oil filter has a cartridge made of disks and spacers. A cleaner blade fits between each pair of disks. The cleaner blades are stationary, but the disks rotate when the shaft is turned. Oil from the pump enters the cartridge well that surrounds the cartridge and passes through the spaces between the closely spaced disks of the cartridge, then through the hollow center, and on to the engine. Any foreign particles in the oil are deposited on the outer surface of the cartridge. When the cartridge is rotated, the cleaner blades comb the foreign matter from the disks. The cartridge of the manually operated Cuno filter is turned by an external handle. Automatic Cuno filters have a hydraulic motor built into the filter head. This motor, operated by engine oil pressure, rotates the cartridge whenever the engine is running. There is a

manual turning nut on the automatic Cuno filter for rotating the cartridge manually during inspections. This filter is not often used on modern aircraft.

A canister housing filter has a replaceable filter element that is replaced with rest of the components other than seals and gaskets being reused. (Figure 9-5) The filter element is designed with a corrugated, strong steel center tube supporting each convoluted pleat of the filter media, resulting in a higher collapse pressure rating. The filter provides excellent filtration, because the oil flows through many layers of locked-in-fibers.

Full flow spin-on filters are the most widely used oil filters for reciprocating engines. These filters are similar to those used in automotive engines. (Figure 9-6) Full flow means that all the oil is normally passed through the filter. In a full flow system, the filter is positioned between the oil pump and the engine bearings, which filters the oil of any contaminants before they pass through the engine bearing surfaces. The filter also contains an anti-drain back valve and a pressure relief valve, all sealed in a disposable housing. The relief valve

is used in case the filter becomes clogged. It would open to allow the oil to bypass, preventing the engine components from oil starvation. A cutaway of the micronic filter element shows the resin-impregnated cellulosic full-pleat media that is used to trap harmful particles, keeping them from entering the engine. (Figure 9-7)

### OIL PRESSURE REGULATING VALVE

An oil pressure regulating valve limits oil pressure to a predetermined value, depending on the installation. (Figure 9-4)



Figure 9-6. Spin-on oil filter.

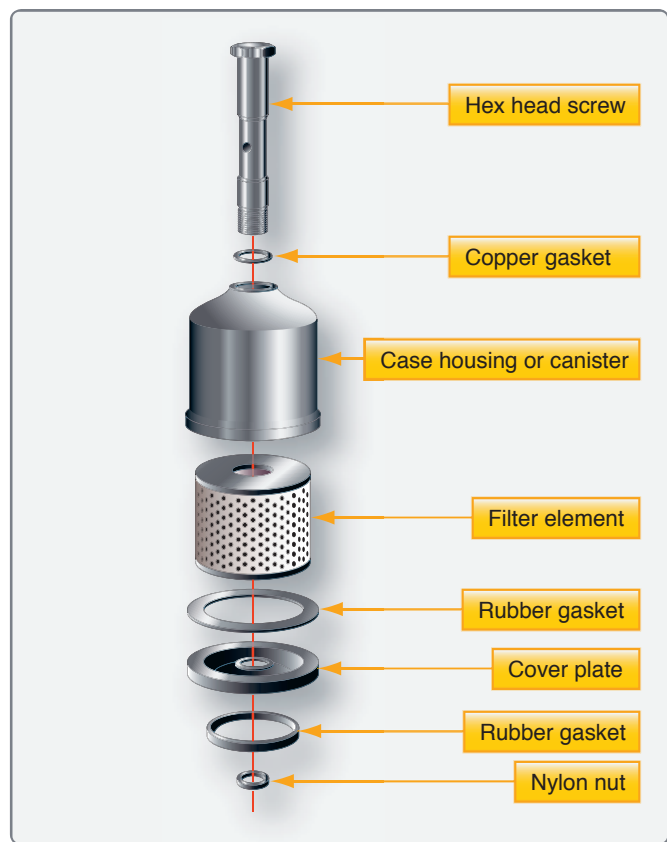


Figure 9-5. Exploded view of housing, filter element, and associated parts of canister filter.

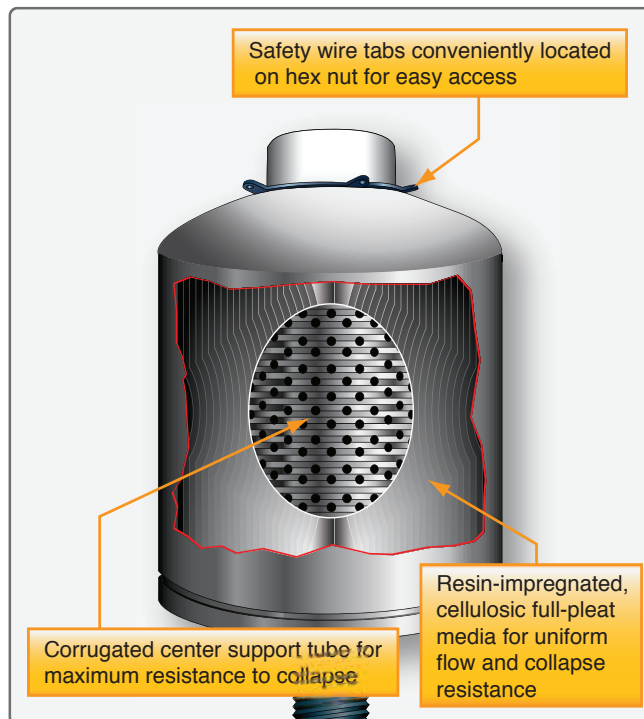


Figure 9-7. Spin-on filter cutaway.



Figure 9-8. Oil pressure relief valve adjustment.

This valve is sometimes referred to as a pressure relief valve but its real function is to regulate the oil pressure at a present pressure level. The oil pressure must be sufficiently high to ensure adequate lubrication of the engine and its accessories at high speeds and powers. This pressure helps ensure that the oil film between the crankshaft journal and bearing is maintained. However, the pressure must not be too high, as leakage and damage to the oil system may result. The oil pressure is generally adjusted by loosening the locknut and turning the adjusting screw. (*Figure 9-8*) On most aircraft engines, turning the screw clockwise increases the tension of the spring that holds the relief valve on its seat and increases the oil pressure; turning the adjusting screw counterclockwise decreases the spring tension and lowers the pressure. Some engines use common flat washers under the spring that are either removed or added to adjust the regulating valve and pressure. The oil pressure should be adjusted only after the engine's oil is at operating temperature and the correct viscosity is verified. The exact procedure for adjusting the oil pressure and the factors that vary an oil pressure setting are included in applicable manufacturer's instructions.

## OIL COOLER

The cooler commonly used with radial engines, either cylindrical or elliptical shaped, consists of a core enclosed in a double-walled shell. The core is built of copper or aluminum tubes with the tube ends formed to a hexagonal shape and joined together in the honeycomb effect. (*Figure 9-9*)

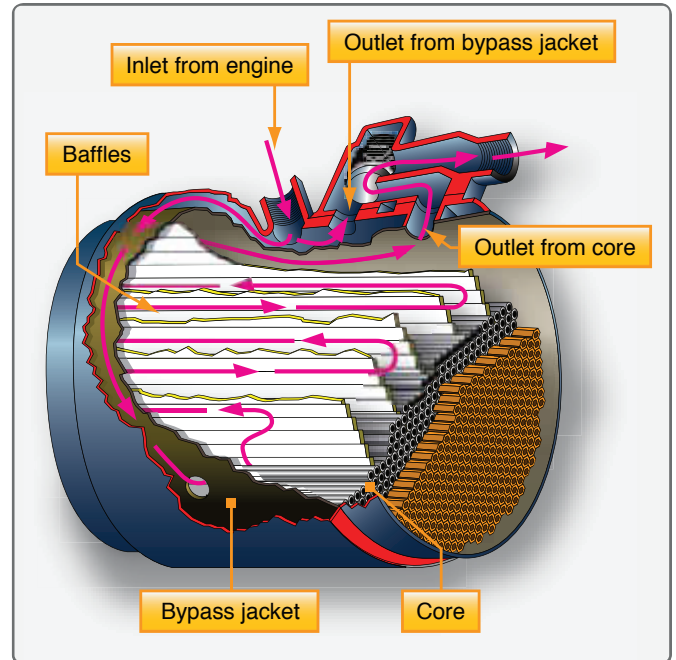


Figure 9-9. Typical radial engine oil cooler.

The ends of the copper tubes of the core are soldered, whereas aluminum tubes are brazed or mechanically joined. The tubes touch only at the ends so that a space exists between them along most of their lengths. This allows oil to flow through the spaces between the tubes while the cooling air passes through the tubes.

The space between the inner and outer shells is known as the annular or bypass jacket. Two paths are open to the flow of oil through a cooler. From the inlet, it can flow halfway around the bypass jacket, enter the core from the bottom, and then pass through the spaces between the tubes and out to the oil tank. This is the path the oil follows when it is hot enough to require cooling. As the oil flows through the core, it is guided by baffles that force the oil to travel back and forth several times before it reaches the core outlet. The oil can also pass from the inlet completely around the bypass jacket to the outlet without passing through the core. Oil follows this bypass route when the oil is cold or when the core is blocked with thick, congealed oil.

Oil coolers found on opposed engines have similar features. They are normally smaller and rectangular in shape. Items, such as oil temperature control and surge protection may be included in the engine or accessory case rather than in the cooler itself.