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OIL CHANGE MONITORING SYSTEM

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Oil Change Monitoring System
Bob Kauffman

The invention is an oil change monitoring system for cars and trucks that contains a sensor system designed to monitor both the quality of the performed oil change and the condition of the drained oil to identify specific engine problems. The quality of the oil change is determined from the quantity and temperature of the drained oil. The specific engine problems identified by the sensor system are coolant intrusion, fuel dilution (viscosity decrease), severe oxidation (viscosity increase) and possibly hot spots/over heating (high conductivity readings).

The oil change monitoring system consists of two basic components: oil measurement compartment and oil condition sensors. The oil measurement compartments shown in Figures 1 and 2 are designed to measure the temperature and quantity of the drained oil. The oil is drained into the left side of the measurement compartment which is molded/manufactured from a chemically resistant, non-stick, non-conductive material such as high density polyethylene, Teflon, glass, machinable ceramic, etc with an outer insulating layer to maintain the oil temperature during the oil condition analyses. Any coolant/dirt/other insoluble contaminant that have pooled/accumulated in the engine's oil pan during use will concentrate on the left side of the compartment above the left flow valve in Figure 1 and away from the overflow cup in Figure 2. The thermistors in Figures 1 and 2 are used to confirm that the engine was operated just prior to the oil drain (drained oil above room temperature/warm) to ensure that the temperature of the drained oil was sufficient for rapid oil flow from the engine and that any contamination of the in-service oil was suspended prior to the oil change process to ensure its removal from the engine.

The oil measurement compartments in Figures 1 and 2 contain two sets of parallel metal wires (stainless steel, nickel, nichrome, gold plated copper, or any other non-corrodible metal or conductive plastic) for determining the level/quantity of the oil drained from the engine which is in turn compared to the known engine oil capacity to evaluate the completeness of the oil change. Both sets of parallel wires measure the conductivity of the used oil covering their surfaces. Since the horizontal wire pair is always submerged in the oil until the compartment is drained completely, its output is constant as the container fills/empties, and thus, is used as the reference conductivity value for the drained oil. In contrast to the horizontal parallel wires, the output of the vertical parallel wires increases as the oil level covering its surfaces increases. Consequently, the ratio of the vertical wire output/horizontal wire output is directly related to the oil level, and after calibration in the manufactured compartment, is directly related to the oil quantity. Although Figures 1 and 2 use parallel metal wires to determine the quantity of the drained oil, other level sensing systems (optical, acoustic, mechanical float, etc.) could be used but are not well-suited for monitoring the opaque, viscous used oil.

Additionally, metal traces (gold, nickel, gold plated copper, or any other non-corrodible metal) on non-conductive polymeric substrates could also be used in place of the horizontal or vertical wires. Once the engine oil drainage is complete and the drained oil temperature and quantity recorded, the flow valves on the bottom of the oil measurement compartments in Figures 1 and 2 are electronically or manually opened to allow the used oil to flow out of the compartments onto the coolant sensors positioned on the below funnel's (or any similarly angled structure) inner wall then down into the used oil storage reservoir. In Figure 1, the left flow valve allows the coolant/dirt/other insoluble contaminants that had pooled/accumulated in the engine's oil pan during use to flow first out of the compartment onto the left coolant sensor in Figure 1 or onto the lower coolant sensor in Figure 2. The right flow valve in Figure 1 will allow only drained oil representative of the bulk of the engine's in-service oil to drain onto the right coolant sensor in

Figure 1. In Figure 2, the coolant sensor positioned in the overflow cup (when oil level rises above cup wall, cup fills) will only be exposed to a set quantity of drained oil representative of the bulk of the engine's in-service oil.

The coolant sensor consists of two parts: a permanent surface and a hydrophilic, oil repellant material. Examples of the permanent surface are: two spaced, parallel wires or rods; two spaced, metal wires molded into a nonconductive rod so that only the wires' tips (flush with rod surface) are visible; and two spaced, metal traces on a non-conductive surface. The metals are the same as listed above for the conductivity sensors (stainless steel, nickel, nichrome, gold plated copper, or any other non-corrodible metal). The non-conductive, hydrophilic material (paper, nylon, sodium polyacrylate, molecular sieves, glass wool, etc.) can be in the form of a film, liner, filter, coating, honeycomb, etc. The water adsorbent material is positioned on the permanent surface so as to make contact with both metal wires/traces. When the absorbent material is brought into contact with oil, it becomes saturated with oil but remains non-conductive. However, when the adsorbent material is brought into contact with oil containing suspended/dispersed water, the water is extracted from the oil and accumulates in the adsorbent material.

The amount of water that needs to be extracted from the oil to make the adsorbent material conductive is dependent on the amount of material in contact with the metal surfaces, the affinity of the material for the water, the presence of water soluble salts/water adsorbing particles, spacing of the metal surfaces, etc. Consequently, the coolant sensor can be made to be sensitive to as little as 10 micrograms of water (small amount of material, closely spaced metal surfaces, salts present) or insensitive to water quantities below 1 gram (large amount of material, widely spaced metal surfaces, water adsorbent particles that must become saturated prior to total material becoming conductive). The quantity of oil that the coolant sensor is exposed to is also important since the amount of water in 1 mL of used oil with 2500 ppm (severe coolant leak) contamination is equal to the water in 10 mL of used oil with 250 ppm (normal operation) contamination.

Also. the way in which the adsorbent material comes into contact with the oil is important. Flat adsorbent films are used by the coolant sensors in Figure 1 since all of the oil makes contact with the adsorbent material as it flows across the sensor surface. In contrast, the absorbent material of the coolant sensor in the overflow cup must designed to increase the oil:material interactions (e.g., a honeycomb filling the cup or line the interior surfaces of the cup). Increasing the surface area of the adsorbent material in the cup, increases the oil: adsorbent interactions making the water extraction from the isolated oil more efficient with shorter residence times. Although metal traces spaced less than 75 microns on non-conductive surfaces have been shown to be sensitive to 2500 ppm contamination levels. The response is sporadic and requires that the suspended coolant droplets accumulate on the polymeric surface to form a conductive bridge between the metal traces.

Once the oil measurement compartment is empty (oil no longer in contact with the horizontal wire pair), the following oil condition evaluations can be performed based on the individual/combined sensor readings to identify specific engine problems:

- Coolant Intrusion - if the coolant sensor on the left in Figure 1 or on the bottom in Figure 2 shorts out then coolant/water has pooled in the oil pan of the engine since the last oil change – however, the severity of the coolant leak is unknown since the length of time required to produce the coolant pool is unknown (affected by oil dispersancy, engine temperature. leak rate. etc.). Therefore, the second coolant sensor (right in Figure 2 or in overflow cup in Figure 2) .is used to assess the severity of the coolant leak. Since the quantity of oil coming into contact with the sensor is known (quantity drained from engine known) and the sensitivity of the coolant sensor has been established with known standards, then the coolant/water concentration of the drained oil can be determined. and consequently, the severity of the coolant leak. For instance. the right coolant sensor in Figure 1 can be set to short out at coolant concentrations above 2500 ppm (condemnation level used by US Army for diesel engines of ground equipment) since it is indicative of an active coolant leak. So based on the outputs of both coolant sensors in Figure 1 or 2:

  - If both sensors short out = leak is active, severe (overcame dispersancy of oil)
  - If only the left/bottom coolant sensor shorted out =accumulation in pan probably due to low engine temperature, leak if any, minor/just initiating
  - If only the right/overflow cup coolant sensor shorted out =leak is active. but most likely, recent and oil dispersancy is still effective

- Severe Fuel Dilution and Oxidation - since the oil temperature and quantity in the oil measurement compartment are known and the rate at which the oil drains from the compartment (rate at which the vertical wire output changes)/time for entire compartment to empty (horizontal wire output goes to zero) is directly proportional to the thickness of the drained oil. the oil temperature and drainage rate/time to empty can be used to calculate the oil's viscosity (once compartment calibrated with oils of known viscosities and temperatures). If the calculated viscosity/drainage rate is less than 50°A> of the expected value, then the drained engine is experiencing severe fuel dilution. Conversely. if the calculated viscosity/drainage rate is greater than 150% of the expected value, then the drained engine is experiencing severe oxidation. Obviously. the viscosity of the drained oil being out-of-spec could also be the result of an out-of-spec new oil being used in the drained engine which is also of value to the engine user.

- Hot spot/overheating - excessive heat will cause the anti-wear additives to breakdown producing highly conductive species. If the conductivity sensor is greater than 200% of the new oil value and the coolant sensors do not detect suspended coolant present, then the engine is experiencing hot spots/overheating.

So the invention is an oil change monitoring system that combines an oil measurement compartment and a sensor system to monitor both the quality of the performed oil change and the condition of the drained oil to identify specific engine problems.

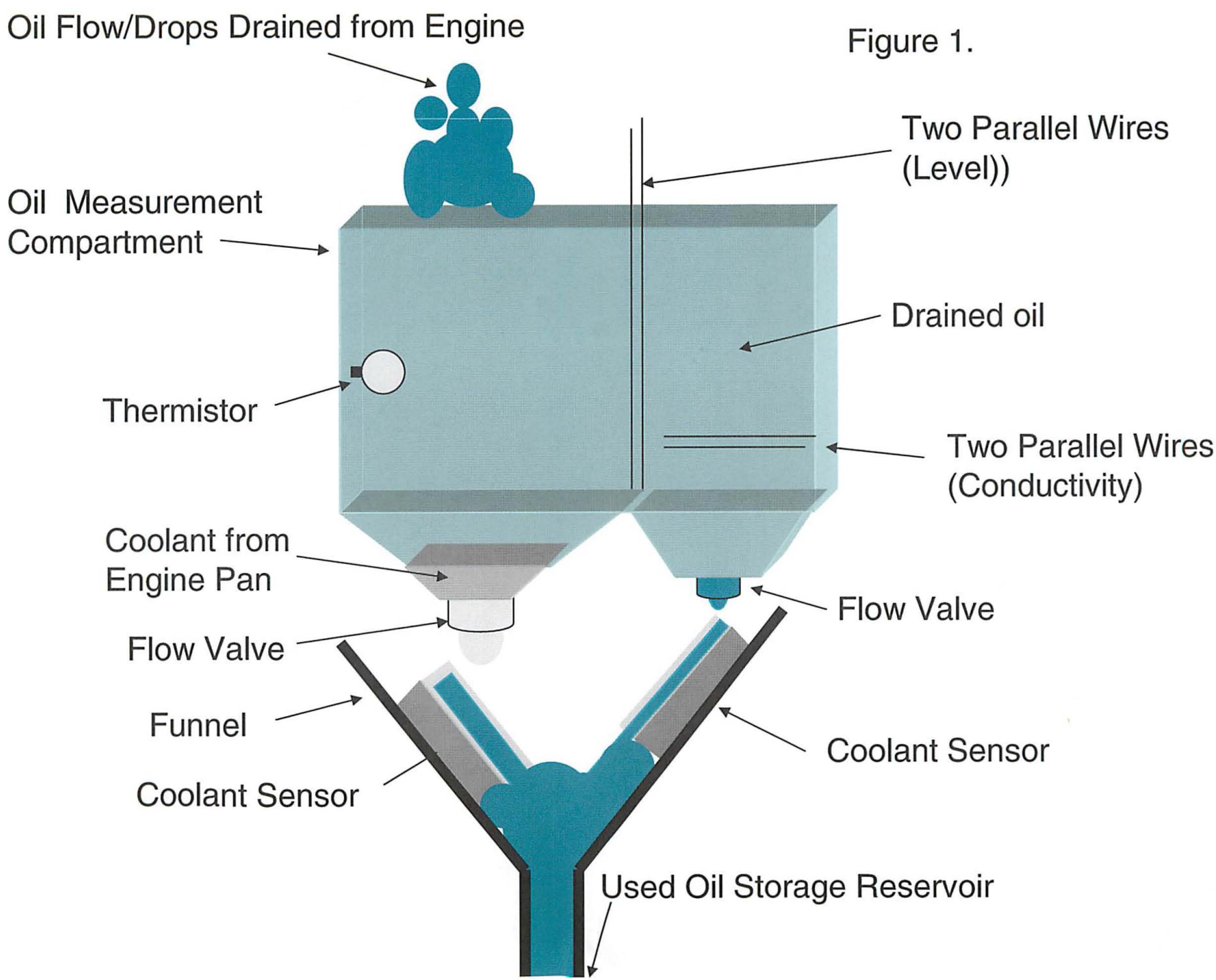
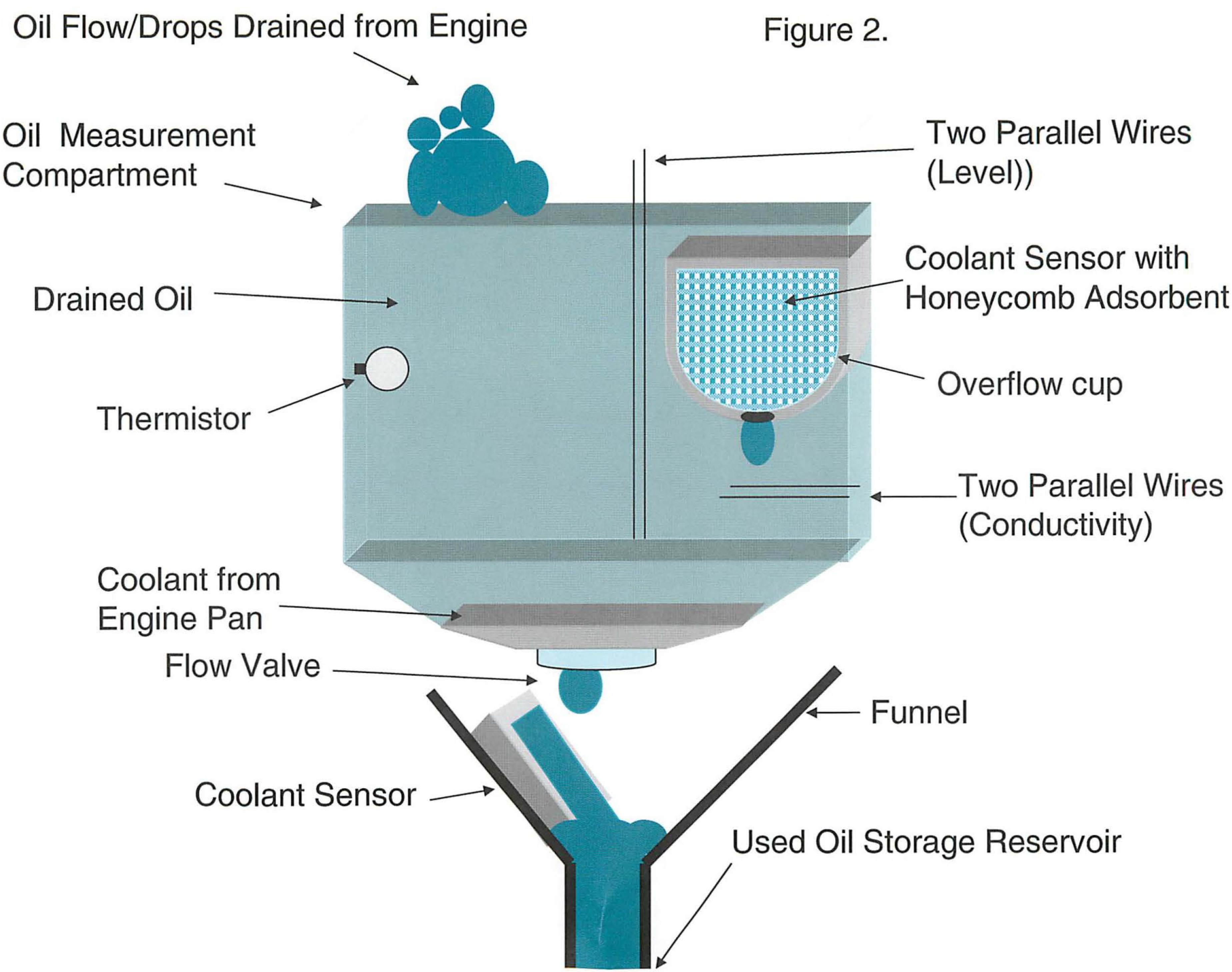

Oil Flow/Drops Drained from Engine
Two Parallel Wires (Level))
Oil Measurement Compartment
Drained oil
Thermistor
Two Parallel Wires (Conductivity)
Coolant from Engine Pan
Flow Valve
Flow Valve
Funnel
Coolant Sensor
Coolant Sensor
Used Oil Storage Reservoir

Figure 1.


Oil Flow/Drops Drained from Engine
Figure 2.
Oil Measurement
Compartment
Two Parallel Wires
(Level))
Coolant Sensor with
Honeycomb Adsorbent
Drained Oil
Overflow cup
Thermistor
Two Parallel Wires
(Conductivity)
Coolant from
Engine Pan
Flow Valve
Funnel
Coolant Sensor
Used Oil Storage Reservoir