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METHOD AND APPARATUS FOR TESTING OILS

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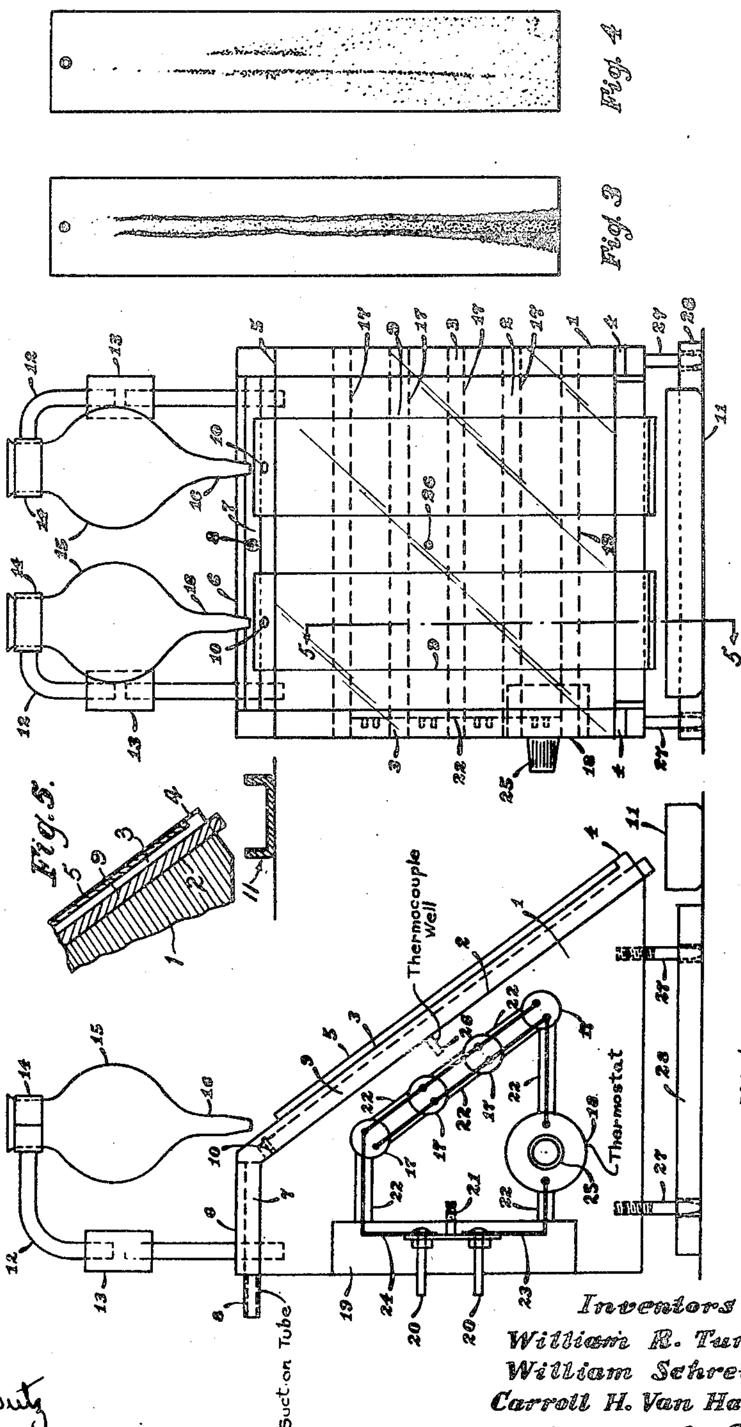

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METHOD AND APPARATUS FOR TESTING OILS

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The present invention relates to a method and apparatus for determining the detergent properties of lubricating oils, and more particularly internal combustion engine lubricating oils containing sludge.

An object of this invention is to determine the quantity and state of dispersion of sludge in lubricating oil and to correlate this information with engine condition in order to effect change of oil at the proper time.

A further object of this invention is to provide a method for comparing the detergent or sludge-dispersing effect of various additives upon sludge contained in or added to either new or used lubricating oils.

A further object of this invention is to provide a method for testing used lubricating oils for the presence of sludge, varnish-forming constituents, water, or gasoline, and thereafter making the necessary adjustments to the engine or changing the oil in order to reduce or eliminate the trouble, in accordance with the test information obtained.

Briefly, the method of the present invention comprises flowing the oil sample containing sludge, at a rate of from 2 to 60 drops per minute for a period of ½ to 30 minutes, downwardly over a surface inclined at an angle of from 5° to 75° to the horizontal and heated at a temperature between 300° F. and 550° F., and noting the quantity and state of dispersion of the sludge deposited upon the surface. Under the preferred conditions, the oil containing the sludge is dripped, at a rate of about 6 drops per minute for a period of 5 minutes, and caused to flow downwardly over a surface inclined at an angle of about 50° to the horizontal and heated to about 460° F., and the quantity and state of dispersion of the sludge deposited upon the surface is noted. If it is desired to make a permanent record of the condition of the surface, the oil is drained off and the sludge is transferred, without change in quantity or state of dispersion, to an absorbent surface such as a paper or blotter, by bringing the two surfaces into contact under pressure.

The present invention may be further understood with reference to the accompanying drawing, in which

Figure 1 is a side elevation of our apparatus;

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Figure 2 is a front elevation of the apparatus; and

Figures 3 and 4 are front elevations of test strips after use.

Figure 5 is a sectional view of a portion of the apparatus taken along the line 5—5 of Figure 2.

Referring to the drawing, particularly Figures 1 and 2, 1 is a truncated, wedge-shaped body member of metal, preferably aluminum, having a surface 2 inclined at an angle of about 50° to the horizontal. Affixed along the outer edges of the inclined surface 2 are relatively narrow strips or ribs of heat-resistant insulating material such as "Masonite" or asbestos board 3 provided at their lower extremities with shoulders 4 which function to maintain the cover plate 5 of glass or other translucent material in position on the strips 3. Topping the truncated body member 1 is a horizontal section of asbestos board 6 recessed at 7 to form a flat, funnel-shaped opening tapering toward the rear of the body member 1 and connecting with a small diameter tube 8 adapted for attachment to a vacuum pump or other pressure-reducing device (not shown). Removably disposed longitudinally of the inclined surface 2 of body member 1 are metal test strips 9, preferably of aluminum, which strips are held in place on surface 2 by means of pins 10 extending through holes provided adjacent the upper ends of the strips. These strips are preferably about 8¼ inches long, 1½ inches wide, and ¼ inch thick, the surface being sand-blasted. The lower ends of the strips project over the lower edge of the inclined surface 2 of body member 1, in order that oil flowing downwardly over the strips may drain into the rectangular receiving vessel 11 disposed under the ends of the strips. Pivotally affixed in the upper, truncated end of body member 1 are a pair of inverted L-shaped arms 12 provided with cylindrical handles 13 of fiber or other heating-insulating material, such arms carrying collars 14 supporting the oil reservoirs 15. By means of these arms, the reservoirs may be swung into position over test strips 9 to deliver oil thereto at a regulated rate during the test, and then swung outwardly at right angles when the test is completed, thereby preventing oil from dripping upon the inclined surface 2 of body member 1 when strips 9 are not in place. The oil reservoirs 15 may be made of glass and may be provided with capillary nipples 16 to give approximately the same rate of flow from each reservoir. If desired, the capillary nipples may be replaced with conventional stopcocks, although these are less satisfactory due to expansion and leakage under the influence of the heat rising from the body member 1.

In order to raise and maintain the temperature of the body member 1 and test strips 9 at the desired level, for example, 460° F., the body member 1 is provided with a plurality of resistance heaters 17 (cartridge type), one being inserted in each of the four holes drilled horizontally through body member 1 in a plane parallel to the inclined surface 2 of the body member 1. A largeer or smaller number of heaters may be employed, depending upon their capacity and their position with respect to surface 2. Very satisfactory results have been obtained with 4 heaters of 250 watts each at 110 volts, connected in parallel, with a thermo-regulator or thermostat 18 in series. As shown in Figure 1, the rear face of body member 1 is recessed across its width to provide a chamber 19 accommodating the insulated terminal prongs 20 affixed to body member 1 by screw 21. In order to permit connection of the terminal prongs 20 with the heater units in parallel and the thermostat in series, the side-face of body member 1 is channeled at 22 to accommodate the insulated wires 23 and 24. If desired, the side-faces and the rear face of body member 1 may be provided with removable side-plates and rear plate of insulated metal or asbestos board (not shown) in order to enclose the connections. The resistance heaters are of conventional design, with both terminals of the heater resistance being brought through the same end of the cartridge. The thermo-regulator or thermostat is likewise of conventional design and functions simply to make or break the heater circuit as required, the thermostat being set or adjusted by means of rotatable knob 25. The body member 1 is provided in approximately the center of its inclined surface 2 with a thermocouple well 26, into which may be inserted, from time to time, a thermocouple or thermometer for checking the temperature of the body member.

The body member 1 is supported upon a plurality of legs 27 threaded into the bottom of the body, and adjustable as to length by rotating, if desired. The lower ends of legs 27 project loosely through holes provided in insulating block 28, which functions to insulate the heated body member 1 from the surface upon which it may be supported. While the apparatus herein described includes two test strips, it is obvious that for some purposes one strip will suffice, whereas in other cases where a plurality of comparative tests are to be made, it may be desirable to use more than two strips, in which case the apparatus may be modified to include more than two strips.

The operation of the apparatus in connection with the testing of the effectiveness of a lubricating oil detergent will now be described.

Internal combustion engine lubricating oil sludge, obtained in a relatively dry state by scraping the crankcase, or valve chamber, or oil filter of a dismantled engine is diluted with about 5% by volume of lubricating oil and the mixture is forced through a 200 mesh screen, whereby there is produced a viscous paste of finely divided sludge and oil. Oil test samples are then prepared by uniformly incorporating 2% by volume of the sludge paste in a new lubricating oil containing no detergent or additive, and 2% by volume of the sludge paste in new lubricating oil containing 7% by volume of a detergent, for example, an additive comprising 28.57% of oil-soluble calcium petroleum sulfonate, 14.29% of a zinc salt of dicyclohexyl acid thiophosphate, and 57.14% lubricating oil. The oil samples so prepared are then introduced into the oil reservoirs 15, respectively, which prior to beginning the test, are swung outwardly of the testing apparatus.

Two sand-blasted aluminum test strips 9 are hung in place on the inclined surface 2 of the body member 1 by means of pegs 10, respectively, and cover glass 5 is disposed on asbestos board strips 3, thus partially covering but out of contact with aluminum strips 9. Electric current is then applied from a source (not shown) to terminals 20, the four cartridge-type heaters 17 supply heat to the body member 1, the temperature being controlled by thermo-regulator 18 and maintained at 460° F., which temperature may be checked by inserting a thermocouple or thermometer in the well 26. Once equilibrium is reached, it is usually unnecessary to change the thermo-regulator setting or to take further temperature readings. The aluminum test strips 9, having come to equilibrium temperature, are then ready for carrying out the test. To this end, the oil reservoirs 15 are swung inwardly to bring the capillary nipples 16 in line with the center of the strips and the oil samples are permitted to drip from the reservoirs 15 upon the upper ends of the strips below pins 10. The preferred rate of dripping is 6 drops per minute for a period of 5 minutes. In order to remove oil fumes generated by contact of the oil with the hot test strips, suction is applied to tube 8, and the fumes are drawn upwardly off the strips into the funnel-shaped opening 7 of plate 6 and thence into suction tube 8. The oil flowing downwardly over the inclined strips 9 drains from the lower ends thereof into receiving vessel 11, and upon completion of the test, may be disposed of as desired. At the end of the test period, the oil reservoirs 15 are swung outwardly, the glass cover plate 5 is removed, and the quantity and state of dispersion of the sludge deposited upon the strips 9 is noted. The strips are removed from the apparatus and cleaned for reuse, or if it is desired to make a permanent record of the detergency test, the strips are completely drained of oil and then contacted with an absorbent surface, such as paper or blotter, whereby the residue from the strips is transferred, without alteration, to the absorbent surface. This may be readily accomplished by placing the test strips upon blotting paper and running them between rolls under pressure, or subjecting them to hydraulic or other mechanical pressure. The sludge is thus transferred from the metal test strip to the blotter without alteration in the quantity or state of dispersion, and gives an exact picture of the test results. In Figures 3 and 4 are reproduced the results of the tests described above. Figure 3 represents the test strip using the new oil with no detergent added, while Figure 4 represents the test strip using new oil containing 7% of the detergent, both oils containing 2% of added sludge. In Figure 3, it will be noted that a heavy deposition of sludge occurred in the path followed by the oil in flowing downwardly over the strip, with little or no dispersion. In Figure 4, on the contrary, relatively little sludge deposited in the path of the oil, and a high degree of dispersion is shown by the fanning-out of the oil over the lower half of the test strip.

For purposes of comparing the effectiveness of various detergents or additives, or for routine examination of used oils, we have found that very satisfactory results may be obtained using oil charged at a rate of 6 drops per minute over a test period of 5 minutes, the temperature being held at 460° F. and the test strips being inclined at about 50° to the horizontal. The actual volume per drop varies only slightly with the viscosity of the oil. For example, 1 drop of oil within the SAE range of 10 to 50 occupies from 0.04 to 0.05 cc. at 75° F. While the body member 1 and test strips 9 are preferably made of aluminum, other metals may be employed such as iron, steel, or metals which will not react with the oil or oil components. The strips may also be made of glass, porcelain, or Alundum.

While the above test conditions are preferred, we have found that they are susceptible of considerable modification without seriously affecting the results. For example, the strips may be inclined at an angle of from 5° to 75° to the horizontal. The temperature may be held between 300° F. and 550° F. The rate of charge of oil may range from 2 to 60 drops per minute. The test period may range from ½ to 30 minutes, depending largely upon the amount of sludge present in the oil, and the effectiveness of the detergent, if present. For comparative purposes, we have found that sludge should not be added in amounts greater than 3% by volume of the oil, since the most effective detergents when used in commercially significant or economic amounts (up to 10% of the oil) are incapable of dispersing more than about 3% of sludge in the oil. With small amounts of sludge, a longer test period is required than in the case of large amounts of sludge. For example, a successful test may be made with oil containing ½% of sludge in a period of 20 to 30 minutes, whereas with 3% of sludge, the test may be completed in ½ to 2 minutes. Various detergents or additive materials may be incorporated in the oil, including the alkaline earth metal salts of oil-soluble sulfonic acids, particularly petroleum sulfonic acids; metal salts of carboxylic acids such as naphthenic acids; alkaline earth metal salts of acid esters of the acids of phosphorus, and particularly the barium salt of dialkyl or dicycloalkyl thiophosphates; and other agents known and described in the prior art. Also, while motor oil sludge is the sludge preferred for test purposes, other finely divided solid materials may be employed, including carbon, carbon black, graphite, fine clay, and the like.

In the lubrication of internal combustion engines, the chief value of a detergent-containing oil over a non-detergent oil is its ability to hold in suspension sludge and varnish contaminants which come down from the combustion chambers, and in extreme cases, from the breakdown of the oil itself. When these contaminants are not held in suspension in the oil, they deposit throughout the engine, and particularly on hot surfaces such as in the ring belt or on piston skirts. Additional deposits settle in the crankcase where they ultimately plug up the oil pump inlet screens, and when these deposits bypass the inlet screens they block oil passages and fill bearing clearances. The method and apparatus of the present invention fulfills a long felt need for an inspection test which will measure the tendency of a used oil to leave engine deposits. The present invention is particularly adapted to the routine testing of motor oils for the determination of the proper time to change such oils. The method of the present invention not only shows the quantity and

state of dispersion of the sludge in the used oil, but also gives dependable indications of the presence of water in the used oil, gasoline dilution, and the presence of varnish or varnish-forming components in the used oil. The present invention is equally well adapted for determining the comparative effectiveness of various detergents or additives insofar as their ability to disperse sludge or water is concerned.

In applying our method as a control for the routine operation of passenger cars, trucks, buses, and the like, it is, of course, necessary to correlate the results of the strip test with actual performance of the oil in the engines. To this end, a new or overhauled engine is supplied with fresh oil and samples of the oil are removed from the engine and tested by our method at periodic intervals, for example, after 250, 500, 750, 1000, 1250, 1500, and 2000 miles' operation. The engine is inspected at each interval to determine engine cleanliness, i. e., degree of sludge deposition in valve chambers, pistons, crankcase, etc., and the condition of the engine may thus be correlated with the results of strip tests for each interval of operation. As a result of this correlation, it may be found that with a given oil, the strip test may indicate that the engine oil should be changed after 1000 miles' use, otherwise sludge deposition may become serious enough to interfere with proper engine lubrication. Since various factors affecting engine operation are reflected in the results of the strip test, i. e., the presence of excessive gasoline dilution, or water dilution, or of varnish in the oil, it is possible to determine by an examination of the test strip which condition is present and thereafter to take steps to remedy the trouble. Gasoline dilution, water dilution, and varnish each give characteristic patterns in the strip test, and are readily discernible from one another.

When gasoline is present in a used oil, the deposit on the test strip is darker and tends to spread over the whole strip. The presence of water in used oil indicates that the engine has been run cold or that crankcase ventilation is insufficient, and in extreme cases would indicate a cracked engine block or a faulty head gasket. In the case of used base oils containing no detergent, the presence of water produces a characteristic spattering of oil and sludge at the top of the test strip. When detergents are present, the water is emulsified or dispersed in such a manner that spattering is considerably reduced. The presence of varnish-like components in used oil is generally indicated by a yellow or orange colored deposit surrounding the sludge deposit on the test strip.

We claim:

1. Apparatus for determining the detergent properties of lubricating oil containing sludge, comprising a truncated solid body member having a surface inclined at an angle to the horizontal, a plurality of heating elements disposed within said body member in a plane parallel to said inclined surface, temperature regulating means associated with said heating elements, a strip member disposed longitudinally upon said inclined surface of said body member, a cover plate disposed in close proximity to but out of contact with said strip member, and means for supplying oil to said strip member at a predetermined rate.

2. Apparatus for determining the detergent properties of lubricating oil containing sludge, comprising a truncated, wedge-shaped solid body

member saving a surface inclined at an angle to the horizontal, a plurality of electrical heating elements disposed within said body member in a plane parallel to the inclined surface of said body member, temperature regulating means associated with said heating elements, a strip member disposed longitudinally upon the inclined surface of said body member, narrow ribs of heat-resistant material affixed adjacent the outer edges of the inclined surface of said body member, a transparent cover plate disposed upon said narrow ribs of heat-resistant material out of contact with said strip member, means for supplying oil to said strip member at a predetermined rate, and means disposed upon the truncated surface of said body member for removing oil vapors arising from the surface of said strip member.

3. A method for determining the detergent properties of lubricating oil, which comprises incorporating a small quantity of finely divided sludge in said oil, flowing said oil containing said sludge downwardly over an inclined, heated surface, and noting the quantity and state of dispersion of the sludge deposited upon said surface.

4. A method for determining the detergent properties of a lubricating oil, which comprises incorporating a detergent and a small quantity of

finely divided sludge in said oil, flowing said oil containing said detergent and sludge downwardly over an inclined, heated surface, and noting the quantity and state of dispersion of the sludge deposited upon said surface.

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