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APPARATUS FOR TESTING LIQUIDS, AND ESPECIALLY LUBRICANTS

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Fig. 1.

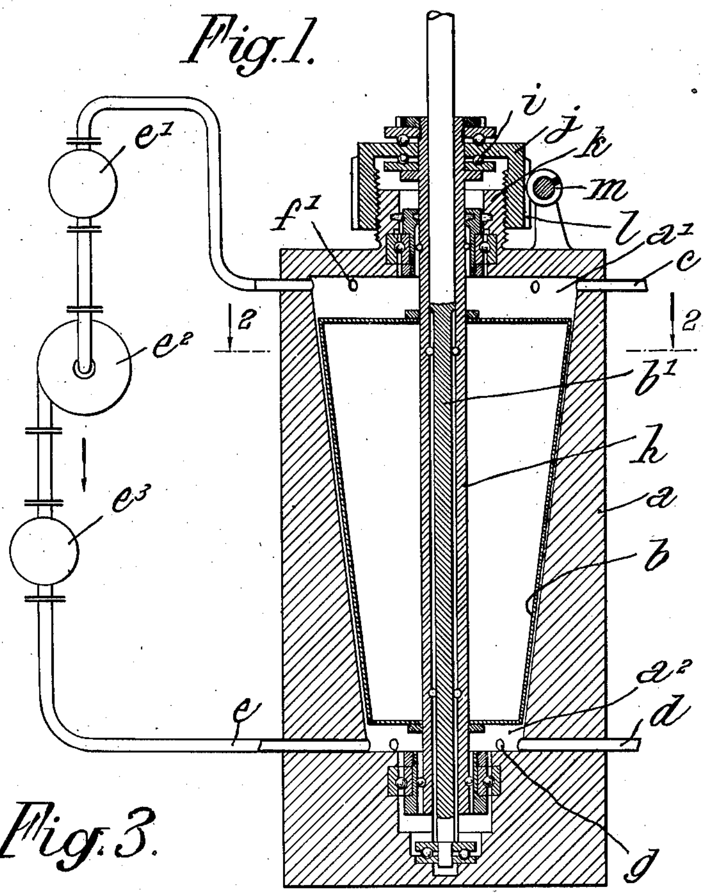


Fig. 3.

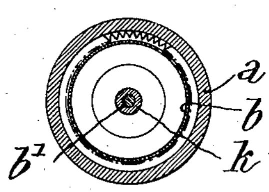


Fig. 2.

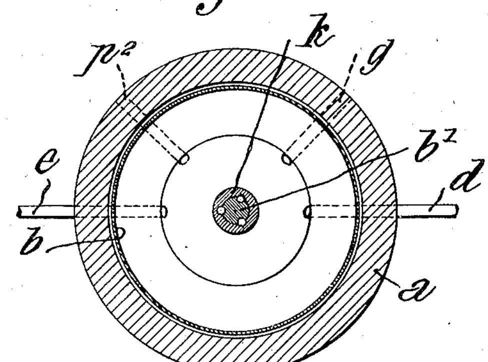
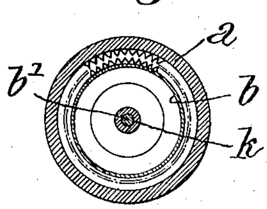


Fig. 4.



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APPARATUS FOR TESTING LIQUIDS, AND ESPECIALLY LUBRICANTS

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6 Claims. (Cl. 73—51)

The present invention relates to apparatus for subjecting a liquid, and especially a lubricant, to a determined treatment, and more particularly to mechanical shearing stresses between two surfaces disposed at a relatively small distance from each other and moving with respect to each other, this being the kind of stresses to which a lubricant is generally subjected by the organs of a machine.

The object of my invention is to provide an apparatus through which it is possible, after treatment of the lubricant, to examine it with a view to determining the transformations it has undergone, from different points of view, especially concerning the following properties: viscosity, adhesion, heating, capillarity, alteration, decomposition, polymerization, darkening, oxidation, etc.

As for the apparatus according to my invention it comprises esentially at least two surfaces disposed close to each other and moving with respect to each other so as to maintain a thin film of liquid between them, the space between these surfaces being included in a closed circuit in which a relatively small amount of liquid is caused to flow continuously, this closed circuit containing a certain amount of a gas or of a mixture of gases so that the lubricant, or other liquid, is caused to work in the presence of this gas or mixture of gases.

According to my invention, these cooperating surfaces may be either smooth or grooved, the latter arrangement being utilized when it is desired to examine the lubricant from the point of view of its intermolecular friction. In this case, either one or both of the cooperating surfaces may be grooved.

The cooperating surfaces are given any suitable shape, for instance the shape of a surface of revolution, or eventually a plane shape (in which case said cooperating surfaces are given either rotary relative movements, or rectilinear reciprocating relative movements).

According to a preferred embodiment of my invention these cooperating surfaces are located inside a fluid tight vessel connected through suitable pipes with means for causing the liquid to be examined to flow therethrough, for instance a pump. The whole is so arranged as to leave at least one free space inside said vessel, which free space can be filled, at the beginning of the treatment, with any desired gas or mixture of gases.

Another important feature of my invention consists in providing means for varying at will the interval existing between the two cooperating surfaces. This last mentioned feature permits of effecting, with my apparatus, the following tests:

(a) A plurality of different lubricants are successively treated in the apparatus, all at the same temperature, by suitably adjusting the interval between the two cooperating surfaces according to the viscosity of the lubricant that is to be treated, so that the temperature resulting from the shearing stresses to which the thin film of lubricant is subjected is substantially the same for all the tests.

(b) Different samples of the same lubricant are successively treated with different intervals between the cooperating surfaces, in order to study the corresponding temperatures.

For reasons that will be hereinafter explained it is preferable to give the cooperating surfaces the shape of frustums of cones.

Preferred embodiments of my invention will be hereinafter described with reference to the accompanying drawing, given merely by way of example, and in which:

Fig. 1 is a vertical axial sectional view showing, in a diagrammatic manner, an apparatus according to the present invention;

Fig. 2 is a horizontal sectional view, on the line 2—2 of Fig. 1;

Fig. 3 is a view similar to Fig. 2 showing a modification;

Fig. 4 is a view similar to Fig. 2 showing still another modification.

In the embodiment shown in Figs. 1 and 2, the apparatus comprises a vessel *a* the inner surface of which is in the shape of a frustum of a cone, preferably having a vertical axis, and a rotor *b*, of corresponding shape, coaxially disposed inside said vessel and driven by a shaft b^1, preferably vertical. The angle of the cone of said rotor is equal to that of the conical surface of vessel *a*.

The vessel and the rotor are made either of the same metal or of different metals, the rotor being preferably mounted in an easily removable and interchangeable manner.

With such an arrangement, I obtain a structure including: an upper chamber a^1, a lower chamber a^2 and a very narrow clearance space between the inner wall of the vessel and the lateral walls of the rotor.

These upper and lower chambers are connected to a pump e^2 through a system of pipes, which may further include the following elements:

(a) On the one hand a reservoir e^1 having a certain head;

(b) On the other hand another tank e^3.

Conduits c and d for the inflow and outflow of gas open into chambers a^1 and a^2 respectively. The apparatus may be further provided with other conduits, such as f^1 and f^2, for fitting thermometers and manometers, and also a conduit g at the lower part of chambers a^2 for drawing off samples of the lubricant, all these conduits being, of course, provided with stoppers, cocks, valves, or the equivalent, as may be useful.

When it is desired that the interval between the cooperating surfaces of the vessel and of the rotor should be varied, the means for varying this interval are very simply devised, in the case of the cooperating surfaces being of conical shape, in the following manner:

Rotor b is rigidly fixed to a sleeve h slidably keyed on shaft b^1 so as to be able to slide longitudinally with respect thereto, while being angularly driven by it. This sleeve h is preferably carried, through a ball bearing i, by a support j adapted to be moved in a vertical direction. For instance this support j is screwed on a shoulder k provided at the upper part of vessel a. The screwing and unscrewing movement of this support j can be obtained by means of a screw wheel and screw l, m.

The above described structure constitutes a testing apparatus which makes it possible to have the lubricants working in different atmospheres. It will be easily understood how these different treatments are interesting in order to find out what are the true causes of the transformations of the lubricants. It will be possible, for instance, to subject a given lubricant successively to a mechanical treatment in the presence of air and to the same treatment in the presence of nitrogen. This will make it possible to determine, through a comparison of the results obtained, the importance of the phonemena due to the oxidation by air.

Supposing, for instance, that it is desired to perform the mechanical treatment of a lubricant as above explained in an atmosphere of nitrogen, I first create, inside the apparatus an atmosphere of nitrogen in the pure state. For this purpose, I feed this gas, in the pure state, into vessel a through conduit c (the gas would be fed through conduit d if its density were higher than that of air) and I cause the nitrogen thus fed to vessel a to flow through all the chambers of the apparatus, for any length of time as it may be desirable, the gases being evacuated through conduit d. When it is absolutely certain that the atmosphere created inside the apparatus does not contain any substantial amount of another gas, (which may be ascertained for instance by means of suitable chemical reagents), the flow of gas is interrupted by closing conduits c and d, the pressure in the apparatus being substantially equal to one atmosphere.

All the chambers of the apparatus are then filled with lubricant, by pouring thereinto a portion of the lubricant present in reservoir e^1, the pressure in the apparatus remaining to a value close to one atmosphere.

Rotor b is then rotated about its axis b^1, at the desired speed of revolution, for a certain time, for instance for five hours, with a speed of revolution of 5,000 revolutions per minute. At the same time pump e^2 is brought into action, also at the desired speed, according to the nature of the lubricant, to the duration of the treatment, to the result to be obtained, to the pressure to be established, and so on. This causes the lubricant to flow through the circuit consisting of reservoir e^3, chamber a^2, the clearance space between the rotor and the inner wall of vessel a, chamber a^1, reservoir e^1 and pump e^2.

In the clearance space between the rotor and the inner wall of the vessel a, the lubricant assumes the shape of a thin film and it is then subjected, due to its adhesion on the one hand to the surface of the rotor through which it is driven and on the other hand to the inner wall of the vessel a, to an intensive mechanical frictional action, involving shearing stresses in the thickness of the film, of the same kind as those to which a lubricant is generally subjected in machines.

Of course, such a friction involves an elevation of temperature, which may be regulated at will by eventually varying the interval existing between the rotor and the inner wall of vessel a. The variations of temperature and pressure can be easily observed by means of the various thermometers and manometers with which the apparatus is equipped.

The lubricant, after being treated, is removed through conduit g is examined (either in itself or by comparison with one or several other lubricants, of the same nature or of a divergent nature, previously treated, either in the same manner or in a different manner, and then examined) concerning any of its properties, such as viscosity, capillarity, adhesion, heating, alteration, decomposition, polymerization, darkening, etc.; also oxidation, calamining action, etc., if the treatment has taken place in an atmosphere of air, an oxidizing atmosphere, etc.

When it is more especially desired to study the effects of intermolecular friction in the film of lubricant, I make use of either of the two modifications shown in Figs. 3 and 4 respectively. In the embodiment of Fig. 3 the inner lateral wall of the vessel a is provided with longitudinal grooves running along generatrices of the cone so that there is practically no relative angular movement of the film of lubricant and of vessel a. In the embodiment of Fig. 4, both the outer lateral wall of the rotor and the inner wall of the vessel are provided with such grooves so that there is practically no relative angular movement of the inner layer of oil and of the rotor on the one hand and of the outer layer of oil and of the vessel on the other hand. With such arrangements, and especially in the latter case, the shearing stresses in the mass of the film of lubricant are very important.

Of course my invention is not limited to the case in which the vessel is stationary and the rotor is angularly moved therein. The only essential condition, according to my invention, is that these elements should be given a relative angular displacement.

It should also be well understood that I can, according to my invention, vary the pressure, the composition and the pressure of the gaseous atmosphere within the vessel, in the course of a single treatment. In a likewise manner, the speed of revolution of the rotor and the velocity of flow of the lubricant might be varied in the course of the treatment.

I may also, through any refrigerating or heating means, acting on the whole or on a portion of the elements of the apparatus, and brought into play at a given time of the treatment, for any desired time, modify the evolution of the phenomena. In particular, I may fix in advance a temperature and a pressure of the lubricant and maintain constantly these factors to these values by suitably varying the speed of revolution of the pump, on the one hand, and the temperature of the refrigerating or heating device, on the other hand, which would finally give, for different treatments, comparable results.

While I have described what I deem to be practical and efficient embodiments of my invention, it should be well understood that I do not wish to be limited thereto as there might be changes made in the arrangement, disposition and form of the parts, without departing from the principle of my invention as comprehended within the scope of the appended claims.

What I claim is:

1. An aparatus for testing liquids, and especially lubricants, which comprises in combination, a closed vessel the innel surface of which is of the shape of a frustum of a cone, a closed rotor of the same shape coaxially disposed in said vessel so as to leave a very small clearance space between the lateral walls of said rotor and the inner surface of said vessel, said vessel being formed with two chambers at either end of said rotor, means for rotating said rotor and said vessel relatively to each other, two pipes opening at their respective ends into these chambers respectively, a pump connected to the other ends of said pipes for circulating liquid through said vessel from one chamber to the other, and means for moving said vessel and said rotor relatively to each other in the direction of their common axis, so that it is possible to vary the interval between their lateral cooperating walls.

2. An apparatus according to claim 1 further comprising means for feeding gases into these chambers and removing them therefrom.

3. An apparatus according to claim 1 in which the cooperating surfaces of the rotor and of the vessel are both smooth.

4. An apparatus according to claim 1 in which one of the cooperating surfaces of the rotor and of the vessel is provided with grooves running in the direction of the generatrices of the cone.

5. An apparatus according to claim 1 in which both of the cooperating surfaces of the rotor and of the vessel are provided with grooves running in the direction of the generatrices of their conical surfaces.

6. An apparatus for testing liquids, and especially lubricants, which comprises, in combination, a closed vessel the inner surface of which is of the shape of a frustum of a cone, a closed rotor of the same shape coaxially disposed in said vessel so as to leave a very small clearance space between the lateral outer surface of said rotor and the inner surrface of said vessel, said vessel being formed with two chambers at both ends of said vessel respectively, means for rotating said rotor and said vessel relatively to each other, a closed circulation system for said liquid, including said two chambers and said clearance space, means for causing liquid to flow continuously through said circulation system, and means for moving said vessel and said rotor relatively to each other in the direction of their common axis, so that it is possible to vary the interval between their lateral cooperating walls.

JEAN GEORGES DINTILHAC.