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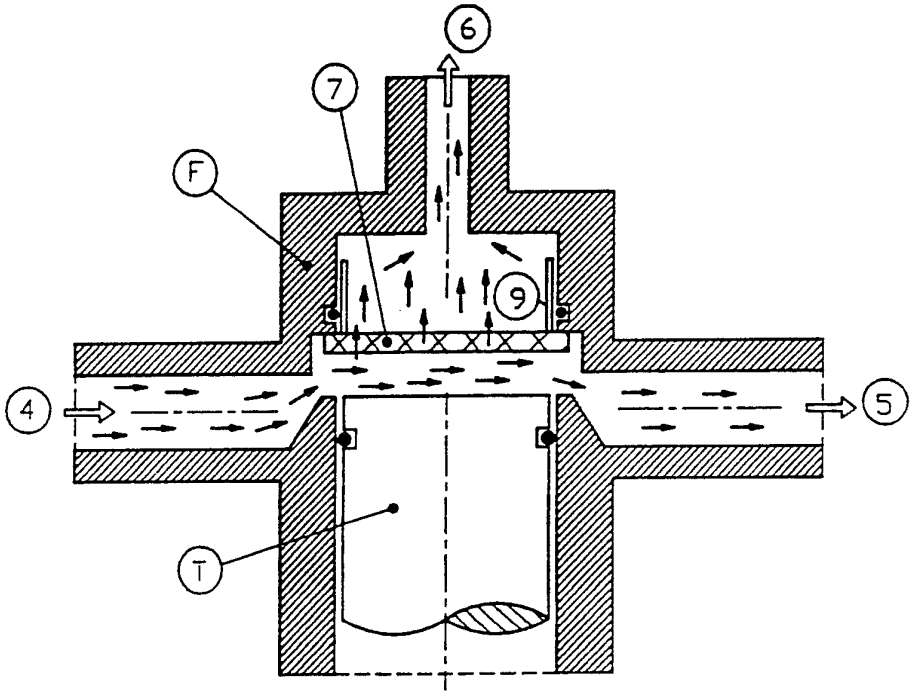
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(57) Abstract

The specification describes a method and a liquid-filtration apparatus (F) where in a relatively flat and broad chamber a liquid circulating in a primary circulation flows over a plane filter element (7), and a fraction of the liquid is pressed through the filter element. Arranged opposite to the filter element (7) an ultrasound transducer (T) is working at least when the filter element is cleaned by reflushing liquid from the secondary side to the primary side. During the reflushing, the distance between the filter element (7) and the transducer (T) is reduced or eliminated. The life of the filter element (7) is thereby extended.

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A METHOD OF FILTER-CLEANING AND AN APPARATUS FOR CARRYING OUT THE METHOD.

The present invention relates to a method of filter-cleaning, and a liquid-filtering apparatus where in a relatively flat and broad chamber a liquid circulating in a primary circulation flows in a so-called cross flow over a substantially plane filter element, and a fraction of the liquid amount is pressed through the filter element, whereby an ultrasonic transducer arranged with its vibration surface situated parallel to and opposite one of the surfaces of the filter element is active at least during a periodic filter-cleaning reflushing of liquid through the filter element.

The method and apparatus according to the invention are further developments of methods and filters used for filtration of fuel oil for motors, where the filter is cleaned periodically by establishing a pressure drop in the primary oil circulation and hence a reflux of the oil through the filter element which at the same time is exposed to ultrasound, thereby causing impurities deposited in the filter to loosen and be washed away by the oil in the primary circulation.

However, the ultrasonic waves counter-acting the formation of a filter pulp on the surface of the filter element, i.a. owing to cavitations in the oil, have appeared to wear the filter element to such an extent that it is spoiled very quickly if the cleaning of the filter is to be fairly effective. The wear is particularly heavy during the reflushing process which requires a strong transducer to allow the impurities to be "shaken out" of the filter cloth and be carried away with the oil in the primary circulation.

It is the object of the invention to indicate a method of filter-cleaning and an apparatus for carrying out the method, which make it possible to obtain a far more considerate cleaning of a filter element by reflushing than has hitherto been possible, so that the life of the filter element may be extended considerably.

According to the invention this is obtained in that

the distance between the vibration surface of the ultrasound transducer and the surface of the filter element is reduced or eliminated during the reflushing when the transducer is active.

By carrying the transducer and the filter element close together during the reflushing process it is obtained that during the reflushing the oil will flow away very fast from the primary side of the filter and effectively carry away impurities loosened by the transducer which is located quite close to the filter. A relatively weak ultrasound-transducer having a brief effect on the filter may be used. The life of the filter has appeared to become much longer than has hitherto been possible to obtain.

Even in cases where the ultrasound-transducer is working continuously at a maximum distance from the filter element during normal filtration (i.e. is not only activated during reflushing) this extension of lifetime may be obtained when the maximum distance and the effect of the transducer are adapted to each other with a view to sparing the filter element as much as possible.

The method may be carried out in a relatively simple liquid-filtration apparatus having a relatively flat and broad flow chamber, one side of which is formed by a substantially plane surface of a flat filter element, and an ultrasound-transducer the vibration surface of which is parallel to and arranged opposite one of the surfaces of the filter element, said apparatus being characteristic in that the ultrasound-transducer and/or the filter element are/is mounted to be displaceable in a way so that the distance between the vibration surface of the transducer and the surface of the filter element may be varied, and that control members producing the displacement are so adjusted that said distance is reduced to a minimum or zero during reflushing of liquid through the filter element in the direction towards the flow chamber at the same time while the ultrasound-transducer is working, and so that the

maximum distance is reset when the reflushing ceases.

In the following the invention is described in details in connection with the drawing in which

Figure 1 shows a simplified diagram of a part of a fuel system of a motor, wherein the liquid-filtration apparatus according to the invention can be used,

Figure 2 a section through an embodiment of the filter according to the invention, shown in normal position,

Figure 3 the filter of Figure 2 shown during reflushing for cleaning of the filter element, and

Figure 4 a diagram illustrating the dependence of the cleaning effect on the distance between filter cloth and ultrasound-transducer during reflushing.

In the diagram of Figure 1 a pump P is shown, which draws oil from a storage tank (not shown) through a suction pipe 10 and sends it on through a heat exchanger H to a filtration apparatus F. In a primary circulation, the greater part of the oil flows in cross flow over a filter element 7 - i.e. in a flat flow parallel to the filter cloth - and out through a primary outlet 5 and back to the pump P. A small part of the oil flows through the filter element 7 to a secondary outlet 6 and further through a buffer tank B to the motor (not shown).

The filter element of the apparatus F is cleaned periodically by reflushing, a valve 1 at regular time intervals - or controlled by the pressure drop over the filter element - opening a pump by-pass 11 so that the pressure in the primary circulation drops, and impurities deposited in the filter loosen and are washed away by the oil in the primary circulation when the valve 1 is closed again. An ultrasound-transducer (not shown in Figure 1), the vibration surface of which forms a limitation surface for the flat cross flow of oil along the filter element 7, cooperates in preventing formation of a filter pulp at the surface of the filter element 7. When the amount of impurities in the primary circulation causes the intervals

between necessary reflushings to be undesirably small, a draining valve 2 in the primary circulation is opened, and oil is either carried back to the buffer tank or is drained out to be cleaned. Oil may also be drained out during reflushing, the valves 1 and 2 in that case being open at the same time. If the pump P draws oil (e.g. diesel oil) which is so clean that no filtration is necessary, a valve 3 in a filter by-pass pipe 8 is kept open. The filter may then be examined or replaced, it being possible to cut it off from the rest of the fuel system by means of closing valves not shown. Frequently, several filters connected in parallel are used.

A difficulty of the described method consists in that the filter element used is spoiled rather quickly which is especially presumed to be owing to cavitation formations at that side of the filter element which faces the ultrasound-transducer, and to protracted actions to loosen the impurities in the filter.

It has now appeared that by means of the liquid-filtration apparatus according to the invention, e.g. the embodiment shown in Figures 2 and 3, it has become possible to obtain an effective cleaning and a considerable extension of the life of the filter element 7 thereby, that during the periodic reflushings, when the liquid pressure at the primary side of the element is lower than that at the secondary side, the distance between the surface of the filter element 7 and the ultrasound transducer T is reduced or quite eliminated while the transducer is working.

For this purpose, the filter element 7 in the housing 8 is mounted by means of guidings 9 in a way so as to be displaceable between the positions shown in Figures 2 and 3. In Figure 2, the filter is in its normal working position where - as indicated by arrows - oil in the primary circulation flows in a cross flow over the filter element 7 from the inlet 4 to the outlet 5. Also as indicated by arrows, a fraction of the oil flows through the filter

element 7 to the secondary outlet 6.

Figure 3 shows the filtration apparatus during cleaning of the filter element 7 by reflushing provoked by a pressure drop in the primary circulation or a pressure rise at the secondary side of the filter element 7. As shown by arrows, oil now flows back through the filter element 7 from the secondary side to the primary side thereof and in a direction towards the inlets 4 and the outlets 5. It will be seen that by means of the guidings 9 the filter element 7 is moved closed up to the vibration surface of the ultrasound-transducer T so that the flow velocity away from the primary side of the filter element 7 is high and, at the same time, the vibrations from the transducer T to the filter element 7 are very effective.

Surprisingly it has appeared that the filter element 7 stands up excellently to the strong vibration influence thereby produced, which in connection with the increased flow velocity at the primary side of the filter has the effect that it is possible to obtain an effective cleaning in a very short time. The dependence of the cleaning effect on the distance between the filter element and the ultrasound-transducer is illustrated in the diagram of Figure 4 which is based on a series of experiments employing varying distance and ultrasound-effect.

Even though the embodiments of the filtration apparatus according to the invention schematically shown in Figures 2 and 3 comprise a stationary ultrasound transducer T at the primary side of the filter element, it will be understood that the transducer may also be arranged at the secondary side (discharge side) of the filter. Further, the relative displacement between the filter element 7 and the transducer T may also be established by the transducer T being moved up to and away from the filter element 7 or by the transducer T as well as the filter element 7 being movable. The displacement may be produced by control signals from the control circuit for the pump P or the transducer T

or possibly just mechanically as a result of the pressure drop in the primary circulation.

Patent Claims.

1. A method of filter-cleaning where in a relatively flat and broad chamber a liquid circulating in a primary circulation flows in a so-called cross flow over a substantially plane filter element, and a fraction of the liquid amount is pressed through the filter element, whereby an ultrasonic transducer arranged with its vibration surface situated parallel to and opposite one of the surfaces of the filter element is active at least during a periodic filter-cleaning reflushing of liquid through the filter element, characterized in that the distance between the vibration surface of the ultrasound transducer and the surface of the filter element is reduced or eliminated during the reflushing when the transducer is active.

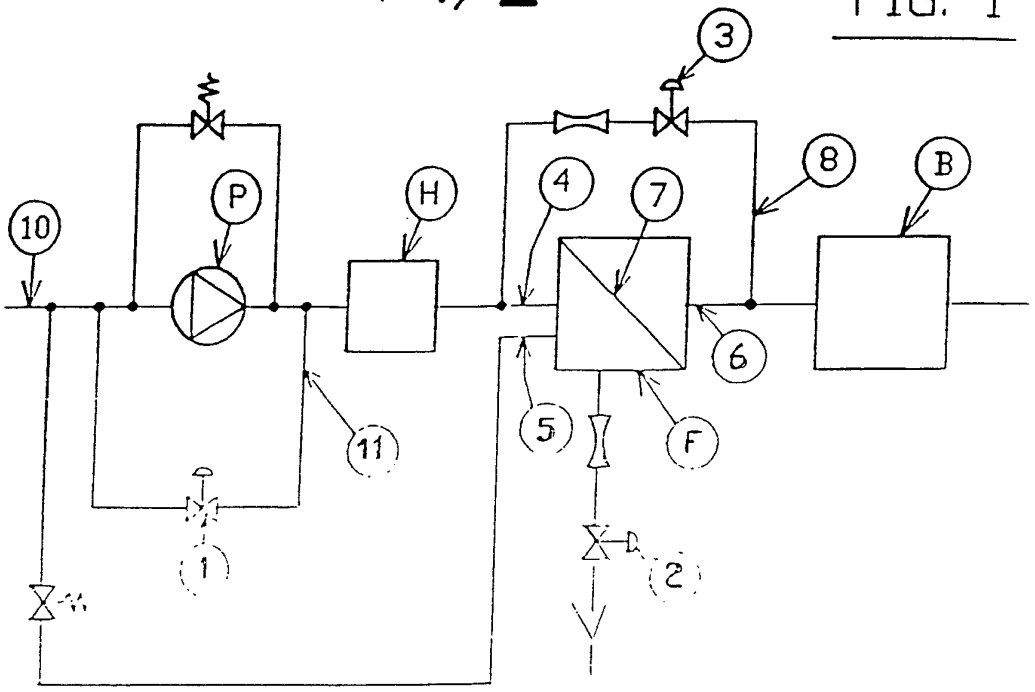
2. A liquid-filtration apparatus comprising a relatively flat and broad flow chamber, one side of which is formed by a substantially plane surface of a flat filter element, and an ultrasound-transducer the vibration surface of which is parallel to and arranged opposite one of the surfaces of the filter element, characterized in that the ultrasound-transducer (T) and/or the filter element (7) are/is mounted to be displaceable in a way so that the distance between the vibration surface of the transducer (T) and the surface of the filter element (7) may be varied, and that control members producing the displacement are so adjusted that said distance is reduced to a minimum or zero during reflushing of liquid through the filter element (7) in the direction towards the flow chamber at the same time while the ultrasound-transducer (T) is working, and so that the maximum distance is reset when the reflushing ceases.

3. A liquid-filtration apparatus according to claim 2, characterized in that the vibration surface of the transducer (T) has an area of the same size as the surface of the filter element (7), which is situated opposite

to said vibration surface.

1/2

FIG. 1


3
P
H
4
7
8
B
10
6
11
5
F
1
2

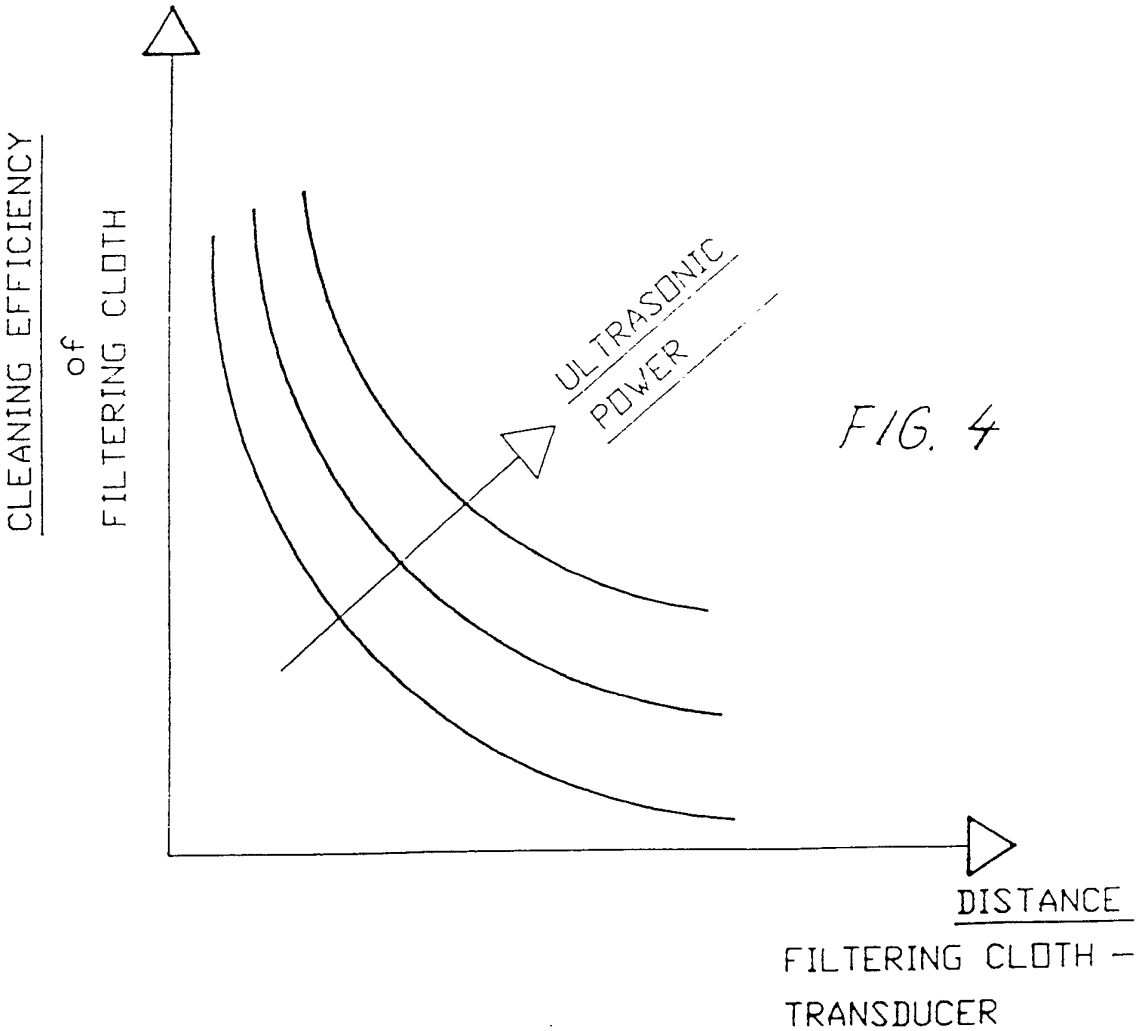

CLEANING EFFICIENCY
of
FILTERING CLOTH
ULTRASONIC
POWER
DISTANCE
FILTERING CLOTH –
TRANSDUCER

FIG. 4

2/2

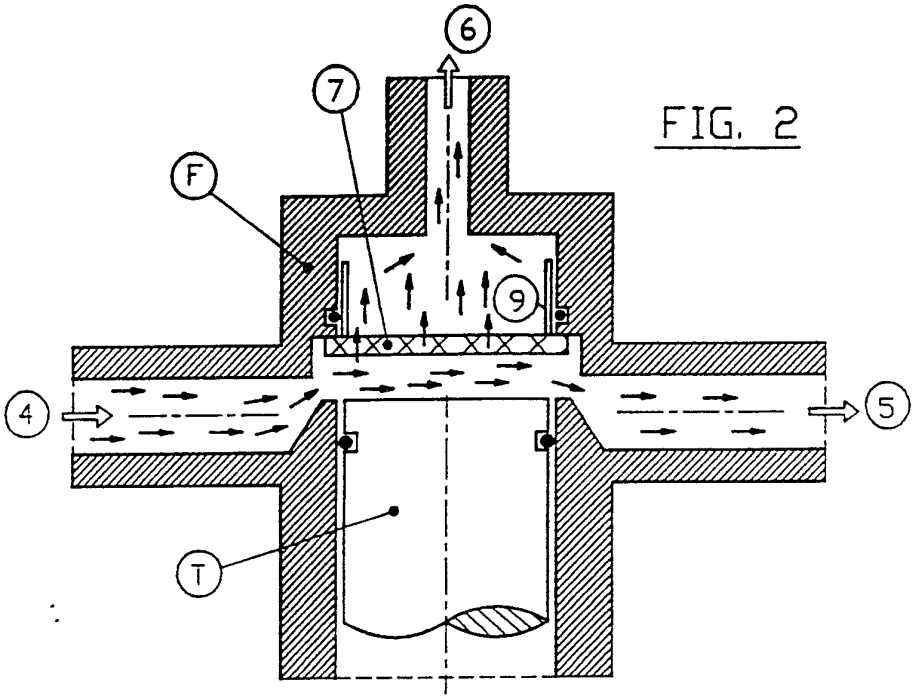


FIG. 2

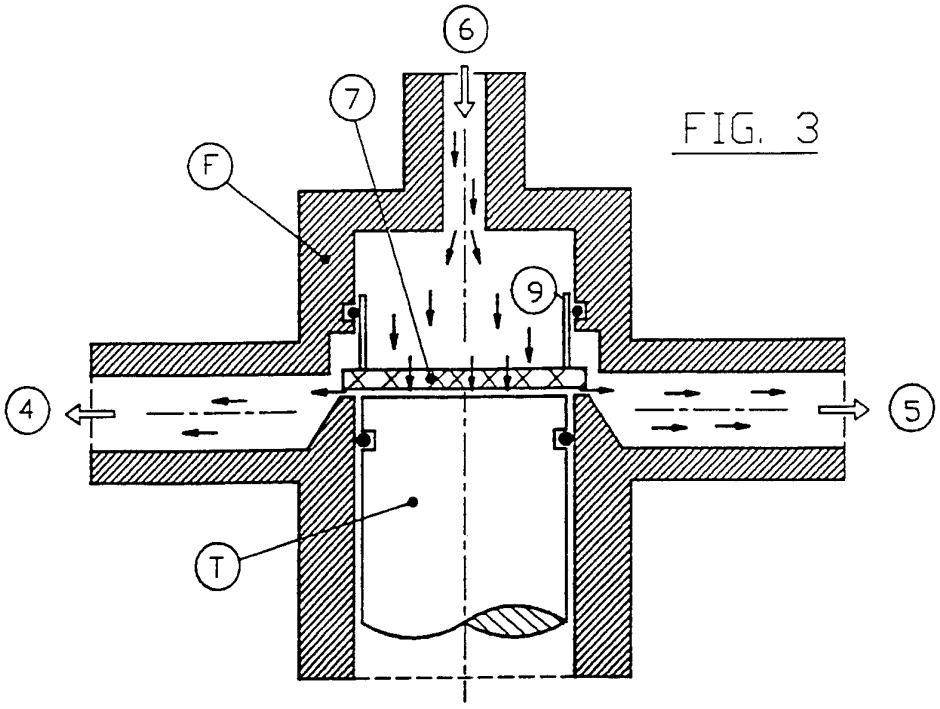


FIG. 3

INTERNATIONAL SEARCH REPORT

International Application No PCT/DK89/00081

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC 4

B 01 D 35/20

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC 4	B 01 D 29/28, 35/20
US Cl	210: 785, 407

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
Y	GB, B, 1 210 942 (EASTMAN KODAK COMPANY) 4 November 1970 & FR, 1556005 BE, 711247	1-3
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IV. CERTIFICATION

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