



(51) International Patent Classification:
B01D 27/10 (2006.01) *G01N 27/04* (2006.01)
B01D 35/14 (2006.01)

(21) International Application Number:
PCT/SE2012/050039

(22) International Filing Date:
19 January 2012 (19.01.2012)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
1150054-3 26 January 2011 (26.01.2011) SE

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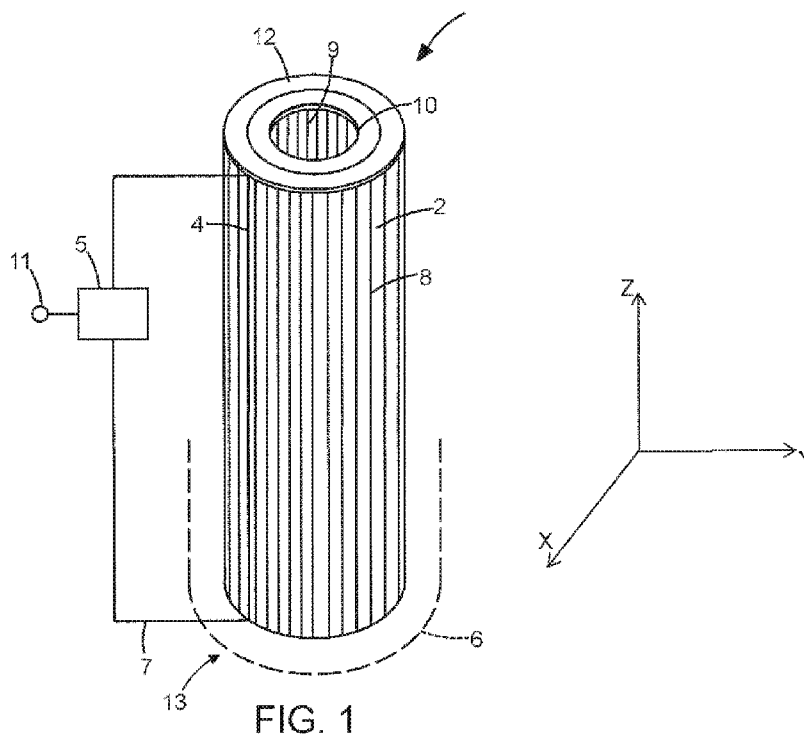
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(81) Designated States (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ,
CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO,
DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN,
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MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ,
OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD,
SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR,
TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every
kind of regional protection available): ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ,
UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU,
TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE,
DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU,
LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK,

[Continued on next page]

(54) Title: OIL FILTER ELEMENT



[Continued on next page]



SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(57) Abstract: The present invention relates to an oil filter element 1 which comprises a filter medium 2 with at least one sensor in the form of an electrical conductor 4, any rupture of said filter medium (2) being intended to be detected by monitoring means 5. The invention relates also to an oil filter unit 13 and a vehicle 40 which is provided with such an oil filter element 1. The invention relates also to a method for detecting the filter medium failure in an oil filter element 1.

OIL FILTER ELEMENT

TECHNICAL FIELD

- 5 This invention relates to oil filter elements comprising a filter medium with sensors for monitoring of oil filter failure, an oil filter unit comprising an oil filter element, a vehicle comprising an oil filter element or an oil filter unit and a method for detecting filter medium failure of an oil filter element.

10 BACKGROUND

- The fact that a torn oil filter may cause engine failure makes it very important that oil filters are changed regularly. Oil filters are currently changed at intervals based more on statistics than on their actual status. Oil filters fail from time to time but there is currently no way for drivers to check their status
- 15 while the vehicle is in motion. Oil filter failure involves rupture of the filter medium which is intended to remove particles from the oil. The cleaning function of the filter medium thus ceases.

- There are various causes of oil filter failure. One is the filter medium
- 20 becoming obstructed, e.g. by particles, potentially causing a large oil pressure difference which may result in the filter medium rupturing, e.g. in the filter's inner folds.

- Oil filters may also fail because the filter medium has become brittle. It may
- 25 then crack in directions which are independent of the folds. Cellulose-based filter media may be rendered brittle by too high temperatures or by acid and aggressive oil. The fibres disintegrate and the material becomes brittle.

- KR20080058753 describes a warning system which indicates when an oil
- 30 filter paper is damaged. A main filter paper for filtering of oil is surrounded by an auxiliary metal mesh filter. The auxiliary filter serves as a temporary filter if the main filter fails. Valves are provided in the bottom of the casing which

surrounds the filter paper, and the warning system signals if oil makes it way out through the valve as a result of damage to the filter paper.

Sensors for monitoring high pressures and temperatures in oil filters are
5 described in, for example, CN 101526020. These sensors do not monitor oil filter failures.

Systems which monitor whether the oil filter medium is obstructed and then release the oil via a bypass valve are also known. There are also systems
10 which warn of oil passing through the bypass valve, since this indicates that the filter is overloaded.

The invention proposes to solve oil filter failure detection problems.

15 SUMMARY OF THE INVENTION

The present invention relates to an oil filter element comprising a filter medium with at least one sensor in the form of an electrical conductor, any rupture of said filter medium being intended to be detected by monitoring means.

20

The invention relates also to an oil filter unit comprising an oil filter element and a filter housing which surrounds the oil filter element.

The invention relates also to a vehicle comprising at least one oil filter
25 element or oil filter unit.

The present invention relates also to a method for detecting filter medium failure in an oil filter element as above, comprising the steps of measuring the resistance of the conductor by a monitoring means,
30 evaluating whether the resistance exceeds a predetermined value R_0 , signalling if the resistance exceeds the predetermined value R_0 , as an indication that a filter medium failure has occurred.

The invention is described below with reference to the drawings listed below.

DESCRIPTION OF DRAWINGS

- 5 Figure 1 depicts an oil filter element in perspective view according to the invention.

Figure 2 is a cross-section of part of an oil filter element according to the invention.

- Figure 3 depicts a sheet of filter medium material before it is formed to
10 become an oil filter element.

Figure 4 depicts a vehicle provided with an oil filter element.

Figure 5 is a block diagram for a method according to the invention.

DETAILED DESCRIPTION

- 15 The invention relates to an oil filter element comprising a filter medium with at least one sensor in the form of an electrical conductor for monitoring whether the oil filter element ruptures. An oil filter element 1 is depicted in Figure 1.

- The oil filter element 1 comprises a filter medium 2 with at least one sensor in
20 the form of at least one electrical conductor 4, and any rupture of said filter medium 2 is intended to be detected by the monitoring means 5. The monitoring means 5 then signals and the driver of the vehicle can have the filter changed.

- 25 The oil filter element 1 is provided with said conductor 4 in such a way that the conductor breaks if the filter medium 2 ruptures. The monitoring means 5 then detects the breaking of the conductor.

- Said conductor 4 is connected to the monitoring means 5 via known contact
30 devices (not depicted) and signal cables 7. When the vehicle is in motion, oil is pumped round in the engine or, when measurement is desired, a current will be passed through the conductor to allow suitable technology and

apparatus to measure the resistance through it. It is also possible to apply voltage to the conductor in order to be able to measure the resistance. Figure 1 depicts a cover 12 which may be placed in the top of the oil filter element 1.

5

At its ends, the conductor 4 has contacts connected to signal cables 7 which lead to the monitoring means 5. The monitoring means 5 may be connected to a signal system in which an indicator 11, e.g. in the form of a lamp, lights up when the monitoring means 5 indicates that the filter medium 2 has ruptured. The monitoring means 5 may take the form of a control system. The monitoring means 5 is adapted to monitoring the resistance of said conductor 4. If the oil filter element 1 disintegrates and said conductor 4 breaks, the resistance will become infinite, which will be detected by the monitoring means 5. The resistance becoming infinite means that it increases, since it increases from a previous value when the conductor carries current. The monitoring means 5 then conveys the result to warn the driver.

The filter medium 2 may comprise cellulose fibres and/or synthetic fibres. Cellulose fibres may be derived from wood, cotton or other plant material. The filter medium may comprise synthetic fibres or a mixture of cellulose fibres and synthetic fibres. The synthetic fibres may for example be polymer fibres, glass fibres or carbon fibres. The fibres are usually bonded together by a phenol resin. Cellulose fibres are sensitive to high temperatures and aggressive oil. Oil used in engines may absorb combustion residues, e.g. sulphuric acid, potentially rendering the oil acid and corrosive. To prevent the oil becoming acid, it is provided with various additives to serve as buffers. The additives are consumed over time, reducing the buffer effect and thereby allowing the oil to become acid and corrosive. The fibres may become brittle, rendering the filter medium also brittle, if exposed for a time to high temperatures or aggressive oil. If the filter medium becomes brittle, it may

well rupture. Filter failure may also occur if the filter medium becomes obstructed and consequently subject to high pressure.

5 The conductor 4 may be situated in or on the filter medium 2. In cases where it is in the filter medium, the conductor is placed there at the time of manufacture. In cases where it is on the filter medium, the conductor may for example be bonded to it adhesively.

10 The oil filter element 1 may be of cylindrical configuration as depicted in Figure 1. An arrow Z denotes the cylinder's axial direction, an arrow Y a direction perpendicular to the cylinder's axial direction, and an arrow X a direction perpendicular to the cylinder's axial direction.

15 The filter medium 2 may rupture in various different ways and in different directions, so the conductor needs to be so arranged that it breaks when the filter medium 2 ruptures irrespective of the direction in which the rupture takes place. This means that the conductor may be arranged in various different ways.

20 The conductor 24 is situated in or on the filter medium 22 and is preferably in contact with the constituent material of the filter medium 22 which is of cylindrical shape. Figure 2 depicts a section of part of an oil filter element. The conductor or conductors are situated in or on the filter medium 22 and extend in a helical shape or form part of a helical shape in the cylindrical oil
25 filter element. The filter medium 22 may be provided with at least one conductor 24 running at an angle α relative to the cylinder's axial direction Z. The angle α may be between 0 and 90°. If there are two or more conductors, they may be connected separately to connecting elements which may themselves be connected to means for monitoring whether the conductor 24
30 or conductors break. The conductors may also be connected together and form part of a single circuit and be connectable via electrical contacts and thence by signal cables to a monitoring means.

The filter medium 22 may also be provided with a further conductor 29 running at an angle β relative to the cylinder's axial direction Z. Angle β may be between 0 and 90°. The conductor 29 may extend in a helical shape or
5 part of a helical shape in or on the filter medium 22 in a similar way to the conductor 24.

The sensors will be able to monitor ruptures of the filter medium in different directions if angles α and β are not equal. There needs to be a difference of
10 at least about 20-30° between angles α and β for the sensors to be able to monitor ruptures in different directions. In an embodiment, angle α may for example be 0° and angle β 90°.

The filter medium 22 may be provided with two or more substantially parallel
15 conductors 24 running at an angle α in the cylinder's axial direction Z and two or more substantially parallel conductors 29 running at an angle β relative to the cylinder's axial direction Z. The conductors may run near or adjacent to one another in order to monitor whether the filter medium 22 ruptures. This rules out the possibility that the filter might rupture without the conductors
20 breaking, in which case there would be no filter failure signal.

The oil filter element 1 according to the invention may comprise a folded filter medium with folds 8 arranged in the cylinder's axial direction Z. Figure 1 shows outer folds 8 running parallel with the cylinder's axial direction Z.
25 Inner folds 9 are visible through an upper aperture 10 in the oil filter element 1. This is a usual configuration for oil filter elements, resulting in a large surface to filter the oil.

If the oil filter element comprises a folded filter medium with folds 8, 9
30 arranged in the cylinder's axial direction Z, at least one conductor may be arranged in that direction in a fold, i.e. the conductor or conductors are arranged at an angle α of 0°. Conductors at approximately every second fold

are needed to monitor filter medium failures. It is also conceivable for a conductor to be provided in every fold, but this might affect the cost of making the oil filter element. There may also be fewer conductors than every second fold. The filter medium may also have at least one conductor running
5 at an angle β relative to the cylinder's axial direction Z.

The conductors may be situated in the inner folds and/or the outer folds. They may also run in the cylinder's axial direction Z in the filter medium between folds.

10

The oil filter element 1 comprises a filter medium 2, 22 which may take the form of a rectangular filter medium sheet 30, see Figure 3, before it is formed to a cylindrical configuration. The two short sides 31, 32 are then joined together to form the cylindrical configuration of the oil filter medium 2, 22.

15 The conductor is situated in or on this filter medium sheet 30. The conductor may be integrated in the filter medium at the time of manufacture. It may also be placed on the filter and, for example, be bonded adhesively to it. It is possible for the conductor or conductors to be placed on the oil filter element before it is joined together to form the cylindrical configuration. The direction
20 of the short sides will be parallel with the cylinder's axial direction Z.

The filter medium may be provided with at least one conductor running in a zigzag pattern. To illustrate how the conductor might be arranged, Figure 3 depicts a filter medium sheet 30 with a conductor 34 arranged in a zigzag
25 shape extending from one short side to the other. The conductor 34 extends to and fro between the long sides of the rectangular filter medium sheet 30. The zigzag pattern may run in any desired direction of the sheet and the cylindrical oil filter element. Conductors may also be arranged to run zigzag from one long side to the other. These conductors may individually be
30 connected to monitoring means via electrical contacts, or be connected together and form part of a single circuit and be connectable to a monitoring means via electrical contacts. The connections may run to already existing

electrical systems which serve as monitoring means. Arranging the conductor zigzag fashion makes it possible for ruptures in several different directions of the filter medium to be monitored.

- 5 As mentioned above, the filter medium may be provided with at least one conductor running at angle α relative to the cylinder's axial direction Z. It may also be provided with a conductor in a zigzag pattern. The two conductors may be connected to one another to form a single circuit. Further conductors at angle α may also be connected to further zigzag conductors.
- 10 Every second conductor may run at angle α and the intermediate ones may zigzag. The oil filter element may also be provided with a conductor at angle β relative to the cylinder's axial direction Z.

The conductor may for example take the form of a wire or of rolled material
15 such as a thin foil, in which case the thin and elongate foil will, like a wire, be laid in or on the filter medium.

The conductor material has to be able to carry current and may be chosen from among metals, conductive polymers and conductive adhesives. The
20 metal might be aluminium, silver, iron, gold, copper or alloys thereof. It is also possible to use rolled metal material, e.g. rolled aluminium, silver, iron, gold, copper or alloys thereof. Examples of polymers which might be used in the conductor material are polyaniline or PEDOT-PPS, i.e. poly(3,4-ethylenedioxythiophene) poly(styrenesulphonate). Conductive adhesives
25 might also be used. They often contain conductive fillers, e.g. silver (Ag), gold (Au), copper (Cu), palladium/silver (Pd/Ag), carbon or graphite. An example of a conductive adhesive might be epoxy adhesive containing silver.

The nature of the conductor material is such that it breaks when the oil filter
30 element ruptures. Its brittleness, toughness and size are such as to give way when the oil filter element ruptures.

The material used needs to be quite resistant to aggressive oil so that the wire is not too affected by the oil.

If the conductor is a wire it may have a diameter of about 0.1 mm. The
5 diameter may be within a range of 0.02 to 2.0 mm. The thickness of the conductor affects its ability to give way, which also depends on what material the conductor is made of. If the conductor is not a wire and no diameter is measurable, its cross-sectional area might be about 0.008 mm². The cross-sectional area may be within a range of 0.0003 to 4.0 mm². The length of the
10 conductor may vary greatly. It may for example depend on whether two or more conductors are used or just one conductor through the whole of the filter medium.

The oil filter element 1 may be of the insert type, in which case it will be
15 situated in a filter housing 6. When the oil filter element 1 disintegrates, it has to be changed and a new one be put into the filter housing. An insert filter is thus an oil filter element in the form of an insert which is put into a filter housing.

20 The invention relates also to an oil filter unit 13 comprising an oil filter element 1 according to the invention and a filter housing 6 which surrounds the oil filter element. This makes it possible for the whole oil filter unit to be changed when the filter medium fails, which is an advantage of using this type of oil filter. The oil filter unit 13 can be removed to allow the change and
25 then be replaced by a new oil filter unit. The oil filter element 1 contained in the oil filter unit 13 is configured according to the invention.

The conductor 4 is connected to a monitoring means 5 via electrical contacts and signal cables 7. Contact has to be effected between the conductor 4 of
30 the oil filter element and contact devices which are themselves connected to electrical signal cables 7 connected to the monitoring means 5. The contact device may take the form of spring-loaded sheetmetal contacts pressed

mechanically against the oil filter element. The conductor in the oil filter element is connected to sheetmetal contacts, or a larger conductor is provided in the area where the contact is to be effected. Part of the filter housing 6 is depicted in Figure 1 by a broken line. The filter housing 6 will surround the whole oil filter element 1. If the oil filter element is of the screw-on type with integrated filter housing, the conductor 4 will be so arranged that there is also contact with the filter housing, which is thus connected to the monitoring means 5 at the time of fitting oil filters in the vehicle. If the oil filter element 1 is of the insert type, the conductor 4 or conductors have to be connected to the filter housing 6 at the time of fitting the oil filter element. These connections are arranged in conventional ways and as described above.

The filter housing 6 has both inlets and outlets for the oil, although they do not appear in the diagram.

The present invention relates also to a vehicle 40 provided with at least one oil filter element 41 according to the invention or oil filter unit according to the invention. A vehicle 40 is depicted in Figure 4. The oil filter element 41 may be situated on or close to the combustion engine or at some other suitable location in the vehicle 40.

The invention further relates to a method illustrated in Figure 5 for detecting filter medium failure in an oil filter element as described above, comprising steps s110 of measuring the resistance of the conductor with a monitoring means, s120 of evaluating whether the resistance exceeds a predetermined value R_0 and s130 of signalling when the resistance exceeds the predetermined value R_0 , as an indication that a filter medium failure has occurred. As mentioned above, the resistance may for example be measured by applying a voltage to the conductor and measuring the current or by passing a current through the conductor. The resistance is measured by appropriate technology and apparatus.

Figure 5 is a block diagram for the method according to the invention, comprising comprises the steps

- s110 of measuring the resistance of the conductor with a monitoring means,
5 s120 of measuring whether the resistance is greater than a predetermined value R_0 .

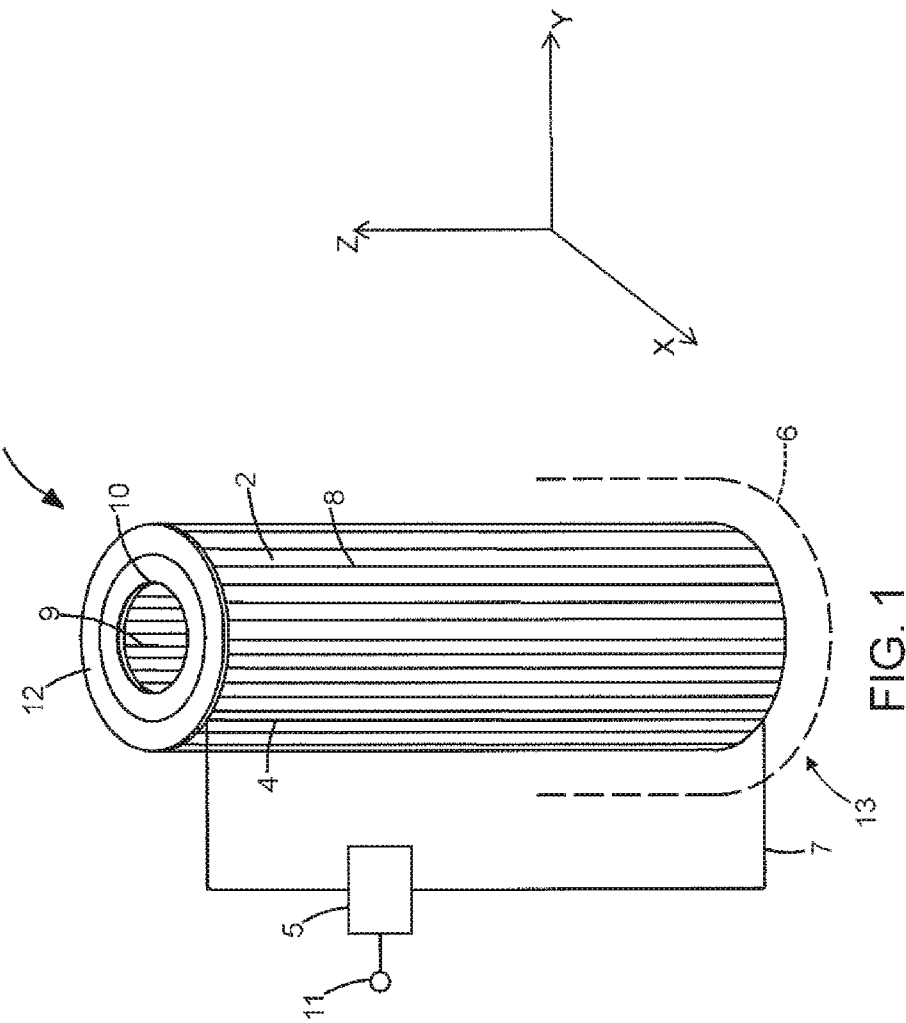
Resistance greater than a predetermined value R_0 will indicate a filter medium failure, s130. If the conductor gives way, the resistance will become infinite and therefore be greater than R_0 , but if it is not greater than a
10 predetermined value R_0 the system will continue to measure the resistance as at step s110. The value R_0 will depend on what material is used in the conductor, the thickness and other characteristics of the conductor which determine the value needed for indication of filter medium failure.

CLAIMS

1. An oil filter element (1), **characterised** in that it comprises a filter
5 medium (2) with at least one sensor in the form of at least one
electrical conductor (4), any rupture of said filter medium (2) being
intended to be detected by monitoring means (5).
2. An oil filter element (1) according to claim 1, **characterised** in that the
10 filter medium (2) is provided with said conductor (4) in such a way that
the conductor (4) will break if the filter medium (2) ruptures.
3. An oil filter element (1) according to claim 2, **characterised** in that the
15 monitoring means (5) are adapted to monitoring the resistance of said
conductor (4).
4. An oil filter element (1) according to any one of the foregoing claims,
characterised in that the oil filter element (1) is of cylindrical
20 configuration.
5. An oil filter element (1) according to claim 4, **characterised** in that the
filter medium (22) is provided with at least one conductor (24) running
at an angle α relative to the cylinder's axial direction (Z).
- 25 6. An oil filter element (1) according to claim 5, **characterised** in that the
filter medium (22) is provided with at least one further conductor (29)
running at an angle β relative to the cylinder's axial direction (Z).
7. An oil filter element (1) according to any one of the foregoing claims,
30 **characterised** in that the filter medium (3) is provided with at least
one conductor (34) arranged zigzag fashion.

8. An oil filter element (1) according to any one of the foregoing claims,
characterised in that said conductor comprises a material chosen
from among metals, conductive polymers and conductive adhesives.
- 5
9. An oil filter element (1) according to any one of the foregoing claims,
characterised in that the filter medium (2, 22) comprises cellulose
fibres and/or synthetic fibres.
- 10
10. An oil filter element (1) according to any one of the foregoing claims,
characterised in that the oil filter element (1) is of the insert filter
element type.
- 15
11. An oil filter unit (13) **characterised** in that it comprises an oil filter
element (1) according to any one of claims 1 to 9 and a filter housing
(6) which surrounds the oil filter element (1).
- 20
12. A vehicle (40) **characterised** in that it is provided with at least one oil
filter element (41) according to any one of claims 1-10 or oil filter unit
according to claim 11.
- 25
13. A method for detecting filter medium failure in an oil filter element (1)
according to any one of claims 1-10, comprising the steps
of measuring the resistance of the conductor with a monitoring means
(s110),
of evaluating whether the resistance exceeds a predetermined value
 R_0 (s120),
of signalling when the resistance exceeds the predetermined value R_0 ,
as an indication that a filter medium failure has occurred (s130).

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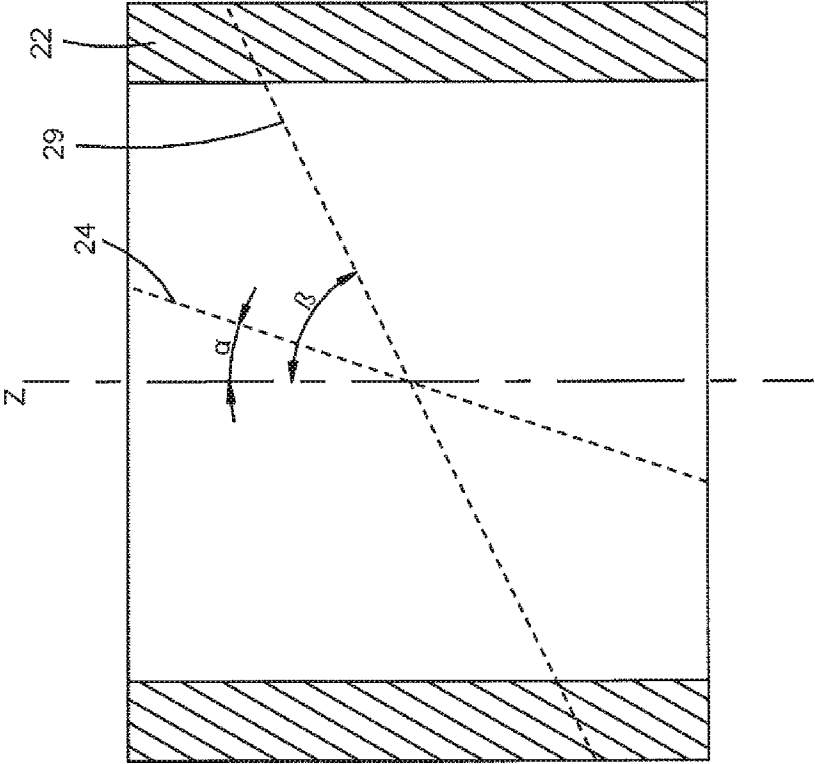


FIG. 2

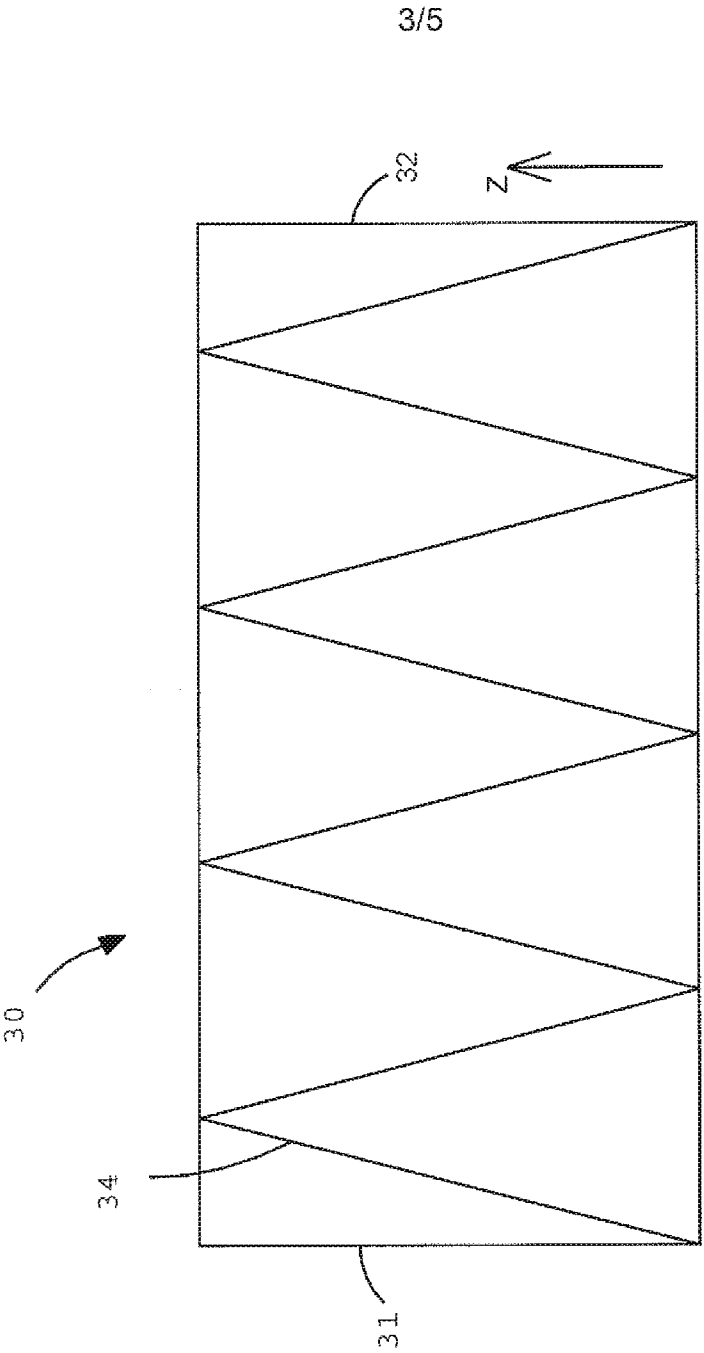


FIG. 3

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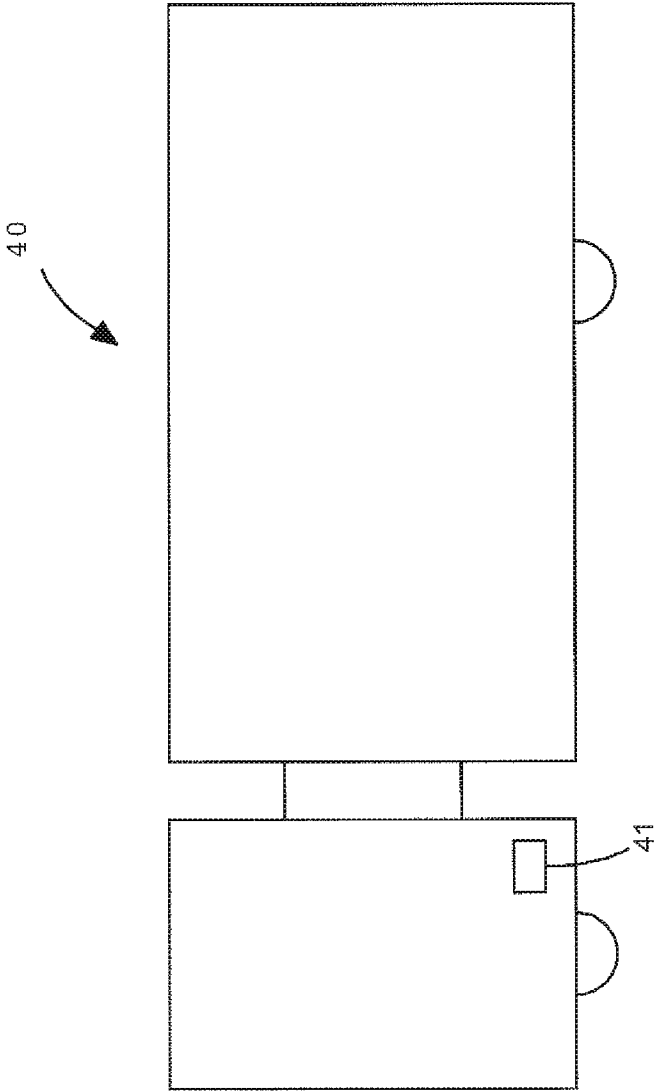


FIG. 4

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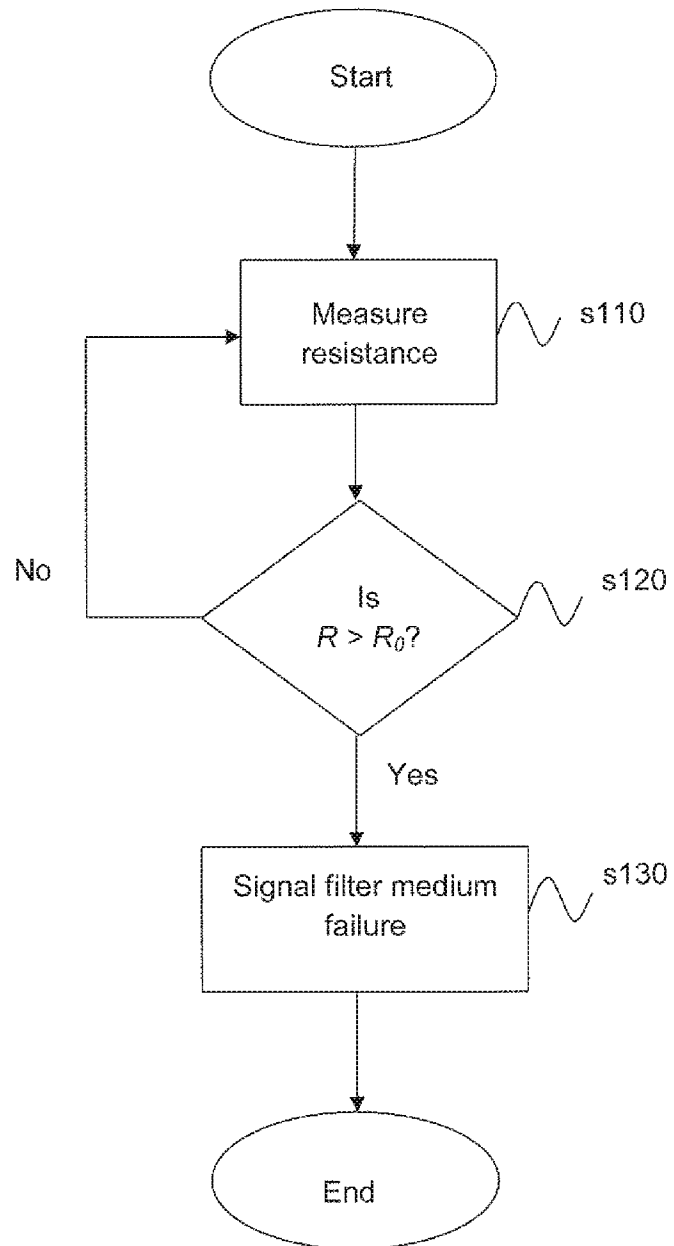


Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2012/050039

A. CLASSIFICATION OF SUBJECT MATTER IPC: see extra sheet According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) IPC: B01D, G01N Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched SE, DK, FI, NO classes as above Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal, PAJ, WPI data, COMPENDEX, INSPEC		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 20080072666 A1 (SHATTUCK JARED S ET AL), 27 March 2008 (2008-03-27); abstract; claim 1 --	1-13
A	KR 20080058753 A (DOOSAN INFRACORE CO LTD), 26 June 2008 (2008-06-26); (abstract) Retrieved from: Epodoc database; Original document: Figures 2 and 3.; Cited in the application. --	1-13
A	CN 101526020 A (UNIV ZHEJIANG), 9 September 2009 (2009-09-09); (abstract) Retrieved from: Epodoc database.; Cited in the application. --	1-13
☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
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Date of the actual completion of the international search 24-04-2012		Date of mailing of the international search report 07-05-2012
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2012/050039

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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International Patent Classification (IPC)

B01D 27/10 (2006.01)

B01D 35/14 (2006.01)

G01N 27/04 (2006.01)

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/SE2012/050039

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