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(54) Internal-combustion engine provided with a device for purifying the crankcase breather gases

(57) An internal-combustion engine (1) provided with a purifying device (7) having an inlet communicating with the interior of the crankcase (4) of the engine (1) so as to receive the breather gases containing oil in suspension, an outlet (9) for the purified breather gases, a filter element (22) interposed between the inlet and the outlet, an oil- collecting chamber (28) communicating with the interior of the crankcase (4) via a drain valve (33) designed to allow the passage of the oil accumulated in the chamber (28) towards the crankcase (4) but to prevent the reflux of gases in the opposite direction; said valve (33) comprises a sealing element (38) sensitive to fluctuations in pressure in the crankcase (4) during operation of the engine (1) and designed to allow a quantity of oil to escape when the pressure in the crankcase (4) falls below a predetermined threshold value.

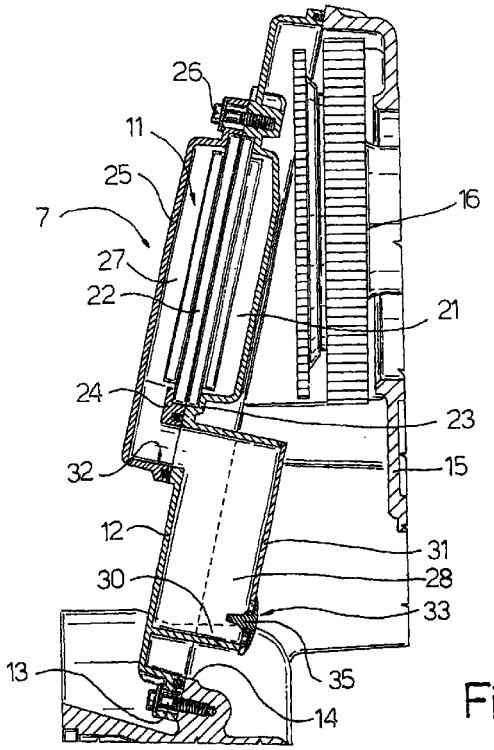

Fig. 3

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Description

[0001] The present invention relates to an internal-combustion engine provided with a device for purifying the breather gases in the crankcase of said engine.

[0002] It is known that engines are provided with a crankcase breather circuit designed to discharge to the outside of said crankcase the so-called breather or blow-by gases, i.e. gases which escape from the cylinders into the crankcase via the piston rings. This breathing is necessary both to prevent an increase in pressure inside the crankcase and to compensate for the variations in volume caused by the movement of the pistons.

[0003] The blow-by gases contain particles of finely atomised oil, as well as particles of unburnt matter of carbon type (particulates) having dimensions or the order of several μm, typically between 5 and 8 μm.

[0004] In some cases the breather circuit is of the open type, i.e. it discharges the blow-by gases into the atmosphere; in this case, the oil and particulates have to be separated from the gases for obvious reasons relating to environmental and health protection (the particulates have carcinogenic effects).

[0005] In other cases, the breather circuit is of the closed type and recirculates the blow-by gases to the engine intake system so as to ensure the complete combustion of the particulates. However, in this case too, the problem arises of removing oil and particulates from these gases; in fact, the oil and particulates tend to form resinous sediments on the components through which the gases pass before reaching the cylinders (particularly, on the valves and, for forced-induction engines, in the compressor and intercooler, where they greatly reduce the heat exchange), thus compromising the satisfactory operation of said components. Moreover, in vehicles with a catalytic converter the combustion of any engine oil recirculated to the intake system has harmful effects on the catalytic converter and on the Lambda sensor.

[0006] Therefore, purifiers of various types have been proposed comprising, for example, impact separators, filter elements or a combination of the two.

[0007] In particular, devices are known for purifying the crankcase breather gases, which comprise an inlet communicating with the interior of engine crankcase so as to receive the breather gases containing oil In suspension, an outlet for the purified breather gases, a filter element interposed between the inlet and the outlet, and an oil- collecting chamber communicating with the interior of the crankcase via a drain valve designed to allow the passage of the oil accumulated in the chamber towards the crankcase but to prevent the reflux of gases in the opposite direction.

[0008] The object of the present invention is to devise an internal-combustion engine with a device for purifying the crankcase breather gases, provided with a drain valve of improved type, which is designed to operate efficiently, reliably and fully automatically so as to prevent any undesirable accumulations of oil.

[0009] This object is achieved by the present invention in that it relates to an internal-combustion engine comprising a device for purifying the crankcase breather gases of said engine, said device comprising an inlet communicating with the interior of the engine crankcase so as to receive the breather gases containing oil and particulates in suspension, an outlet for the purified breather gases, a filter interposed between the inlet and the outlet, a chamber for collecting the oil separated by said filter, and a drain valve interposed between said chamber and the inside of the crankcase so as to allow the passage of the oil accumulated in the chamber towards the crankcase and prevent the reflux of unpurified gas in the opposite direction, characterised in that said valve comprises at least one opening for the passage of oil from said chamber to said crankcase and a sealing element co-operating fluidtightly with said opening under the action of the pressure of the gases in said crankcase, said sealing element being sensitive to fluctuations in pressure inside the crankcase so as to allow oil to escape through said opening when the pressure in the crankcase falls below a predetermined threshold value.

[0010] With a view to a better understanding of the present invention a preferred embodiment will be described non-restrictively by way of example below and with reference to the accompanying drawings, in which:

Figure 1 is a view in elevation, partly in section, of an internal-combustion engine in accordance with the invention;

Figure 2 is a view in front section of a purifying device for the engine in Figure 1;

Figure 3 is a section along the line III-III in Figure 2;

Figures 4 and 5 are schematic sections, on an enlarged scale, illustrating two different operative positions of a valve for the device in Figure 2.

[0011] Referring now to Figure 1, the reference numeral 1 denotes an internal-combustion engine comprising a cylinder head 2, a plurality of cylinders 3, a crankcase 4 and a sump 5 designed to contain lubricating oil.

[0012] The engine 1 is further provided with a circuit 8 for recirculating the so-called blow-by gases, i.e. the gases which flow into the crankcase 4 by passing between the cylinders 3 and the associated pistons 6.

[0013] These gases contain in suspension finely atomised particles of oil, as well as solid particles (particulates), predominantly of carbon type, which are partly formed by partially unburnt products of combustion and partly by solid impurities normally present in the oil.

[0014] The recirculation circuit, which is not illustrated in detail as it is known, comprises a purifying device 7 (Figure 2) having an inlet opening (not shown)

communicating with the interior of the crankcase 4 and an outlet connection 9 designed to be connected to the intake system (not shown) of the engine.

[0015] The purifying device 7 comprises, in known manner, an impact separator 10 for capturing the coarsest particles and a filter 11 for separating the residual particles, preferably of the coalescent type, disposed in series between one another and forming an integrated unit provided with a common casing 12. The casing 12 is secured to the engine 1 by means of a plurality of screws 13 in alignment with an opening of a protecting case 15 for the timing gear 16 and flywheel 17 of the engine 1, for which it substantially defines a closure cover.

[0016] The casing 12 has a box-type inlet portion 18 provided with a plurality of internal baffles 20 defining the impact separator 10 and designed to provide a tortuous path for the gases; the geometry of the various ducts delimiting the path of the gases will not be described in detail since it does not form part of the present invention.

[0017] The casing 12 also defines an inlet chamber 21 (Figure 3) for the filter 11, of substantially rectangular shape, into which the gases flow upon leaving the impact separator 10.

[0018] The filter 11 comprises a filter element 22, in the form of a rectangular cartridge, which is mounted between a peripheral flange 23 of the inlet chamber 21 and a corresponding flange 24 of a detachable cover 25 secured to the casing 12 by means of a plurality of screws 26.

[0019] Advantageously, the filter element 22 is formed by a cartridge of non-woven fabric consisting of fibre with variable porosity along its thickness; the fabric is crimped so as to increase the filtering surface area for the same dimensions.

[0020] Preferably, the retention capacity of the filter element 19 is such that it allows to pass, per se, the particulates and has a coalescent action.

[0021] The cover 25 defines an outlet chamber 27 for the filter 11 and forms integrally the outlet connector 9 of the device 7.

[0022] The cover 25 further defines integrally a drain duct 32 (Figures 2 and 3) extending from the bottom of the outlet chamber 27 of the filter 11 and communicating with an oil-collecting chamber 28, the casing 12 of which forms integrally a front wall and the side walls. In particular, the chamber 28 is bounded downwardly by a pair of side walls 29 which are downwardly inclined and which are mutually convergent in alignment with a bottom portion 30 of the chamber itself. The chamber 28 is closed rearwardly by a substantially flat wall 32 suitably welded to the side walls.

[0023] The chamber 28 communicates with the interior of the crankcase 4 through a drain valve 33 designed to allow the passage of oil from the chamber itself towards the crankcase but not the reflux of blow-by gases in the opposite direction.

[0024] The valve 33 is formed by a plurality of openings 34 provided in the rear wall 31 in alignment with the bottom portion 30, for example six holes disposed in a circle and equidistant from one another, and by a shut-off member 35 mounted in the wall 31 and designed to close fluidtightly the openings 34 under the pressure of the blow-by gases.

[0025] More precisely, the shut-off member 35 is made of elastomeric material and is substantially umbrella-shaped; it comprises integrally a spigot 36 force-fitted in a hole 37 in the wall 31 provided at the centre of the circle defined by the openings 34, in which it is retained axially by an integral annular retaining projection 41, and a flexible sealing element 38 formed by an annular flange extending from one axial end 39 of the spigot 36 and disposed on the side of the wall 31 facing towards the outside of the chamber 28, i.e. towards the interior of the crankcase 4.

[0026] The sealing element 38 has a peripheral lip 40 designed to co-operate with the wall 31 under the pressure of the blow-by gases, in an annular zone surrounding the openings 34.

[0027] The mode of operation of the purifying device 7 is as follows.

[0028] The blow-by gases with the oil and particulates in suspension flow into the impact separator 10, in which the coarsest particles of oil are separated from the flow by inertia and they collide with the baffles 20; the oil thus purified runs into the crankcase 4. The flow of gas from which the coarsest oil particles have been removed thus enters the chamber 21 and the filter element 22.

[0029] The particles of oil pass into the interior of the filter element 22, where they agglomerate by coalescence so as to form drops of sufficient size to prevent them from being entrained downstream; therefore, the oil runs from the outlet chamber 27 of the filter 11 into the collecting chamber 28 via the drain duct 32.

[0030] The particulates, which in the absence of oil would tend to pass through the filter element 22, are immersed in the drops of oil which agglomerate in the element itself.

[0031] The gases, from which oil and particulates have been removed, flow from the outlet chamber 27 of the filter 11 to the outlet connector 9 and from here they are recirculated in known manner to the intake system of the engine 1.

[0032] The oil which collects in the chamber 28 tends to flow into the crankcase 4 through the openings 24 of the wall 31 of the chamber. If an overpressure prevails in the crankcase 4 in relation to the chamber 28, the sealing element 38 closes the openings 34, thereby preventing the reflux of contaminated blow-by gases (Figure 5). The dimensions of the sealing element 38 are such that the seal is broken whenever the value of the pressure inside the crankcase falls below a predetermined threshold value; under the action of the cyclical variations in pressure inside the crankcase when the

engine is running, the sealing element 38 allows small amounts of oil to escape into the crankcase even when the engine is operative.

[0033] When the engine is inoperative, there is no overpressure in the crankcase 4 and, therefore, the chamber 28 is completely emptied.

[0034] The advantages which can be achieved with the present invention are evident from a study of the features of the engine 1 and, in particular, of the purifying device 7.

[0035] The use of a valve 33 with a sealing element 35 [sic] which is sensitive to the variations in pressure inside the crankcase makes it possible to discharge the oil from the chamber 28 in an efficient, simple and reliable manner, thus preventing any undesirable accumulations and without any need for control.

[0036] The valve 33 of the type described is particularly simple and inexpensive to produce and assemble.

[0037] Finally, it is evident that the engine 1 and the device 7 can be subject to modifications and variations without departing from the scope of protection defined by the claims.

[0038] For example, the valve 33 can be replaced by a lamella-type valve, a diaphragm valve or a valve with a movable closure means, provided that it is sufficiently sensitive to fluctuations in pressure.

Claims

1. An internal-combustion engine (1) provided with a device (7) for purifying the breather gases in the crankcase of said engine (1), said device comprising an inlet communicating with the interior of the crankcase (4) of the engine (1) so as to receive the breather gases containing oil and particulates in suspension, an outlet (9) for the purified breather gases, a filter (11) interposed between the inlet and the outlet, a chamber (28) for collecting the oil separated by said filter (11), and a drain valve (33) interposed between said chamber (28) and the inside of the crankcase (4) so as to allow the passage of the oil accumulated in the chamber (28) towards the crankcase (4) and prevent the reflux of unpurified gases in the opposite direction, characterised in that said valve (33) comprises at least one opening (34) for the passage of oil from said chamber (28) to said crankcase (4) and a sealing element (38) co-operating fluidtightly with said opening (34) under the action of the pressure of the gases in said crankcase (4), said sealing element (38) being sensitive to fluctuations in pressure inside the crankcase (4) so as to allow oil to escape through said opening (34) when the pressure in the crankcase (4) falls below a predetermined threshold value.

2. An engine according to claim 1, characterised in that said opening (34) is formed in a wall (31) of said chamber (28), and in that said valve (33) comprises a shut-off member (35) made of elastomeric material and defines integrally a portion (36) for fastening to said wall (31) and said sealing element (38).

3. An engine according to claim 2, characterised in that said fastening portion is a spigot (36) force-fitted in a hole (37) in said wall (31), and in that said sealing element (38) is a flexible annular flange extending integrally from one end (39) of said spigot (36) and having a peripheral lip (40) designed to cooperate fluidtightly with a zone of said wall (31) extending around said at least one opening (34) on one side of said outer wall (31) of said chamber (28).

4. An engine according to claim 3, characterised in that said valve (33) comprises a plurality of openings (34) disposed equidistantly around said hole (37) in said wall (31).

5. An engine according to any one of the preceding claims, characterised by comprising an impact separator (10) disposed upstream of said filter (11).

6. An engine according to claim 5, characterised in that said impact separator (10) and said filter (11) form an integrated unit provided with a common casing (12).

7. An engine according to claim 6, characterised by comprising a protecting case (15) for the timing gear (16) and a flywheel (17), said casing (12) of said purifying device (7) being secured to said engine (1) in alignment with an opening (14) in said case (15), for which it substantially defines a closure cover.

8. An engine according to any one of the preceding claims, characterised in that said filter (11) comprises a coalescent-type filter element (22).

9. An engine according to claim 8, characterised in that said filter element (22) has a retention capacity such that it allows to pass the particulates contained in said breather gases.

10. An engine according to claim 8 or 9, characterised in that said casing (12) defines integrally an inlet chamber (21) for said filter, said filter element (22) being fitted between said inlet chamber (21) and a cover (25) detachably secured to the casing (12) and defining an outlet chamber (27) of said filter (11) and a drain duct (32) connecting said outlet chamber (27) of said filter (11) to said chamber (28).

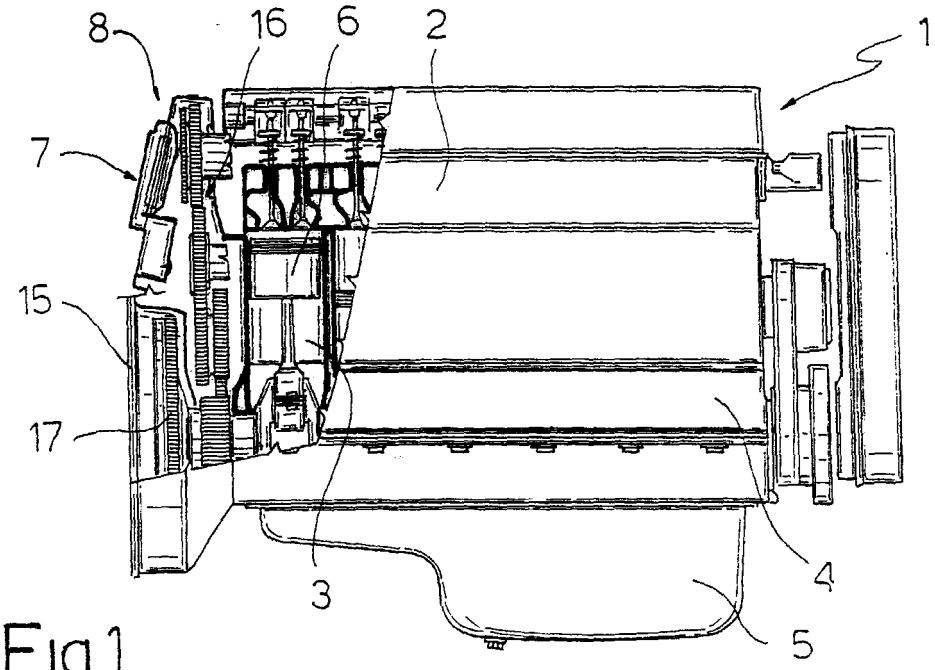
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Fig.1

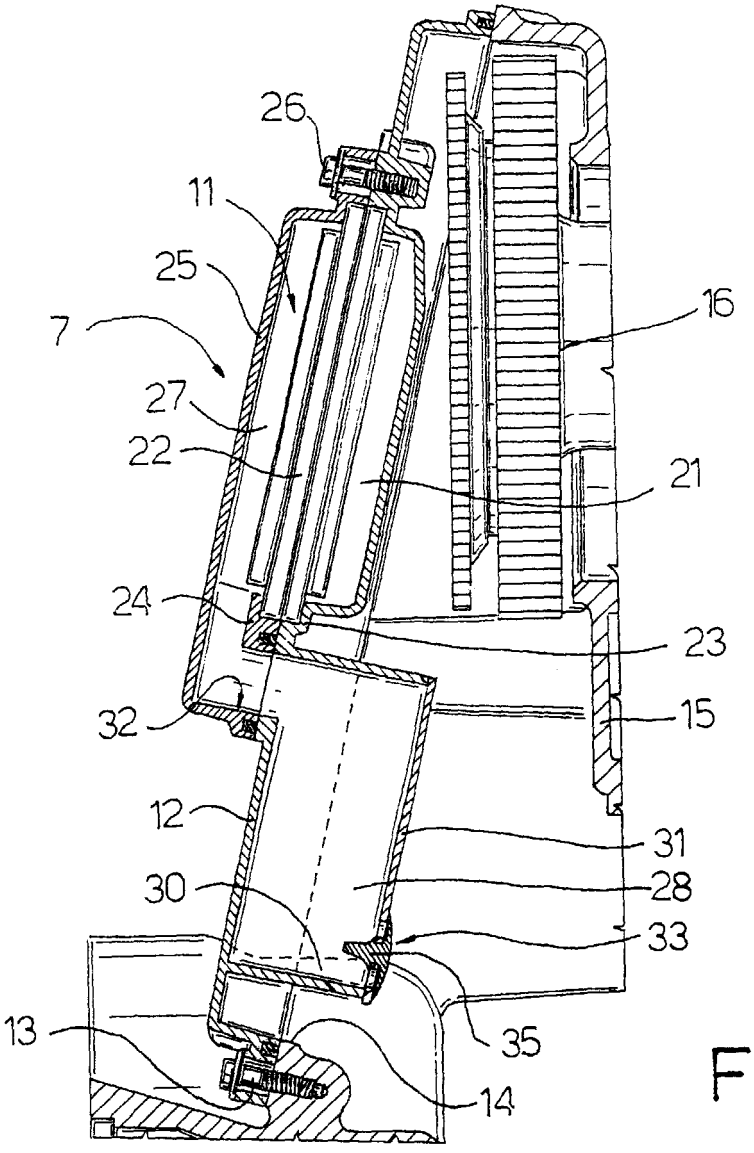
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Fig.3

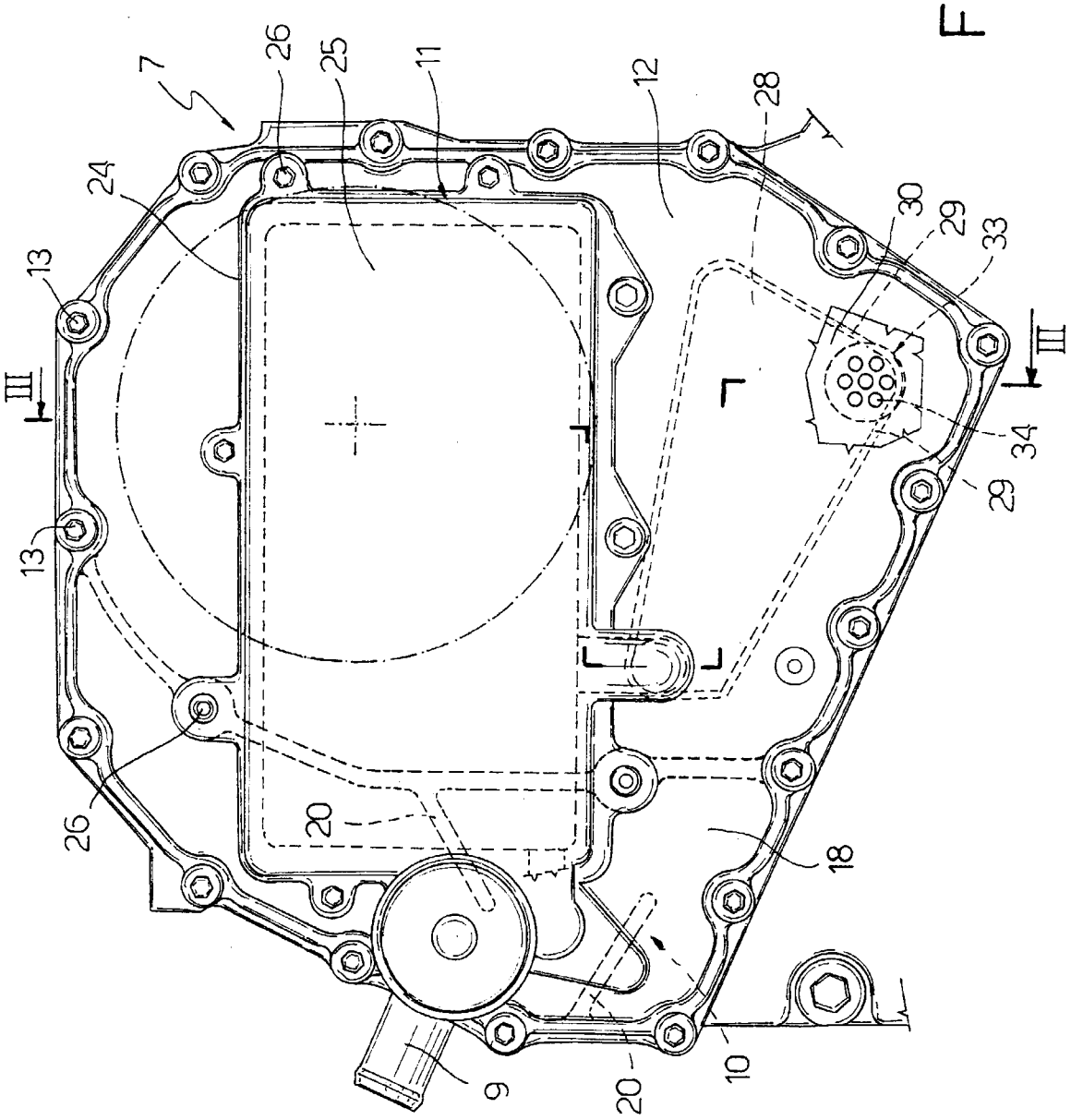

Fig.2

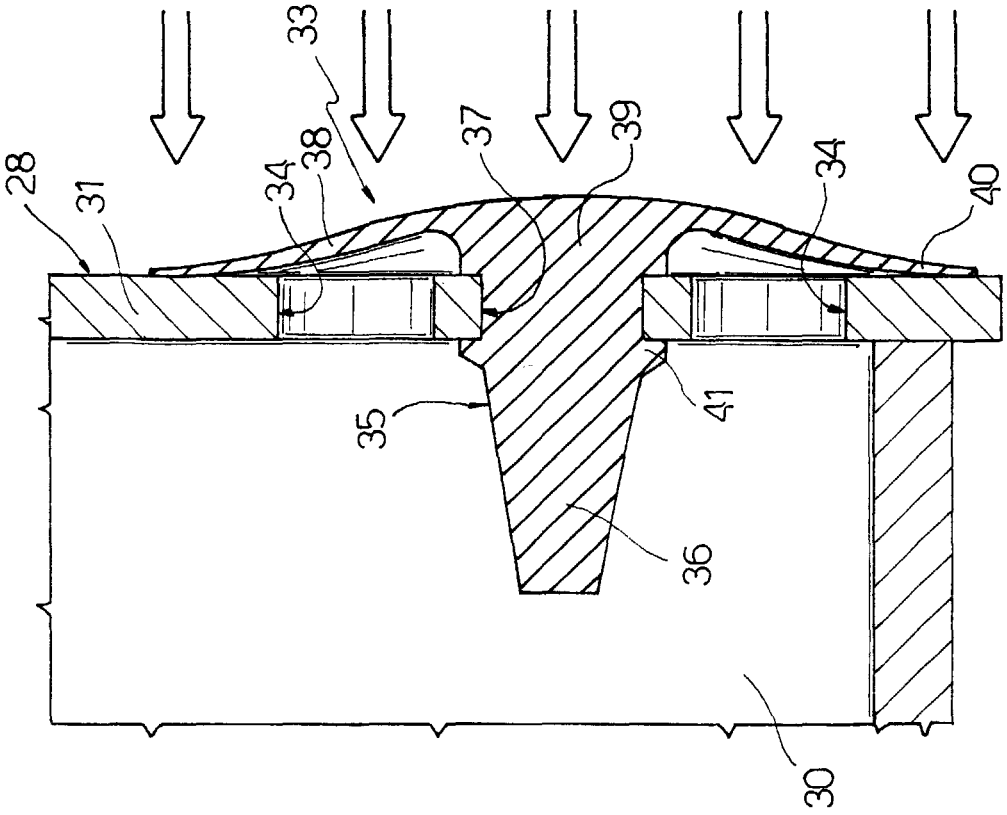
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Fig.5

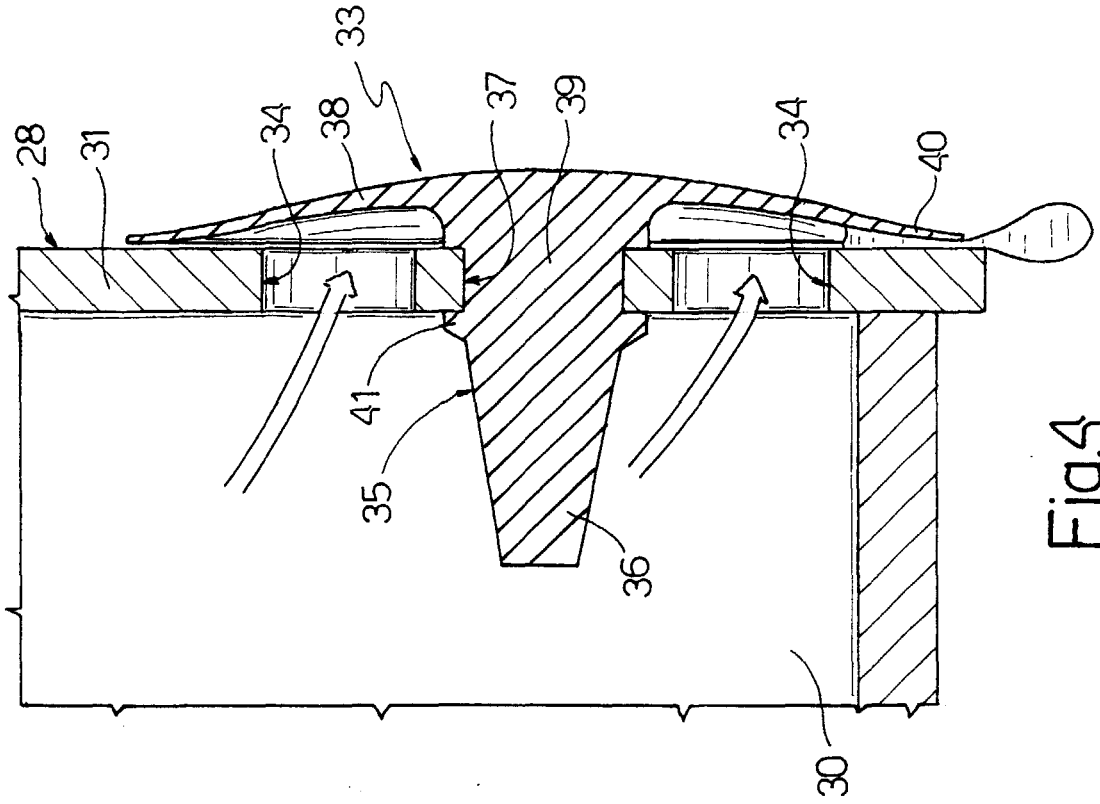
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Fig.4

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 00 11 4664

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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A	EP 0 563 565 A (TECUMSEH PRODUCTS CO) 6 October 1993 (1993-10-06) * column 4, line 4 - column 6, line 2; figures *	1	TECHNICAL FIELDS SEARCHED (Int.Cl.7) F01M
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	2 October 2000	Mouton, J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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