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(11) **EP 1 199 448 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
24.04.2002 Bulletin 2002/17

(51) Int Cl.7: **F01M 13/04**

(21) Application number: **01124657.6**

(22) Date of filing: **16.10.2001**

(84) Designated Contracting States:
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU
MC NL PT SE TR**
Designated Extension States:
AL LT LV MK RO SI

(72) Inventor: **Bianchi, Pietro**
10153 Torino (IT)

(74) Representative: **Franzolin, Luigi et al**
STUDIO TORTA S.r.l.,
Via Viotti, 9
10121 Torino (IT)

(30) Priority: **17.10.2000 IT TO000973**

(71) Applicant: **IVECO FIAT S.p.A.**
10156 Torino (IT)

(54) **Internal-combustion engine provided with a purifying device for the separation of particles of lubricating oil from the crankcase blow-by gases**

(57) An internal-combustion engine (1) provided with a cylinder head (2), a crankcase (4), a plurality of cylinders (3) and breather means (6) for gases which have escaped into the crankcase (4) through the cylinders (3) and containing in suspension particles of lubricating oil; the breather means (6) are provided with a purifying device (8) adapted to separate the particles of oil from the gases and formed by a column-type integrated unit accommodated in a vertical cavity (10) of the crankcase (4) and comprising a hollow outer casing (15) through which the gases to be purified pass, deflector means (16) of generally helical configuration accommodated inside the casing (15) and adapted to divert the gases to be purified along an ascending helical conveying path for separating under centrifugal action the particles of oil from these gases, and a substantially tubular intermediate element (17) accommodated inside the casing (15) downwardly with respect to the deflector means (16), through which the gases to be purified flow internally and upwardly towards the deflector means (16), and which delimits externally with the casing (15) a separate chamber (18) for conveying under gravity the oil particles projected under centrifugal action against an internal surface (19) of the casing (15) adjacent to the deflector means (16).

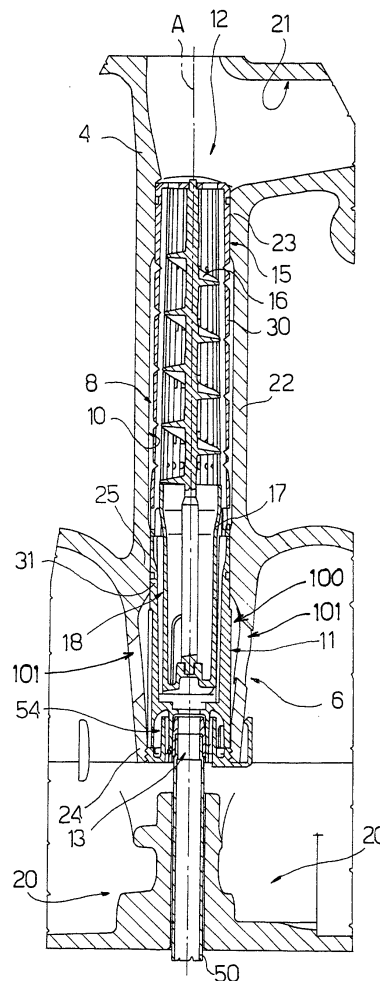
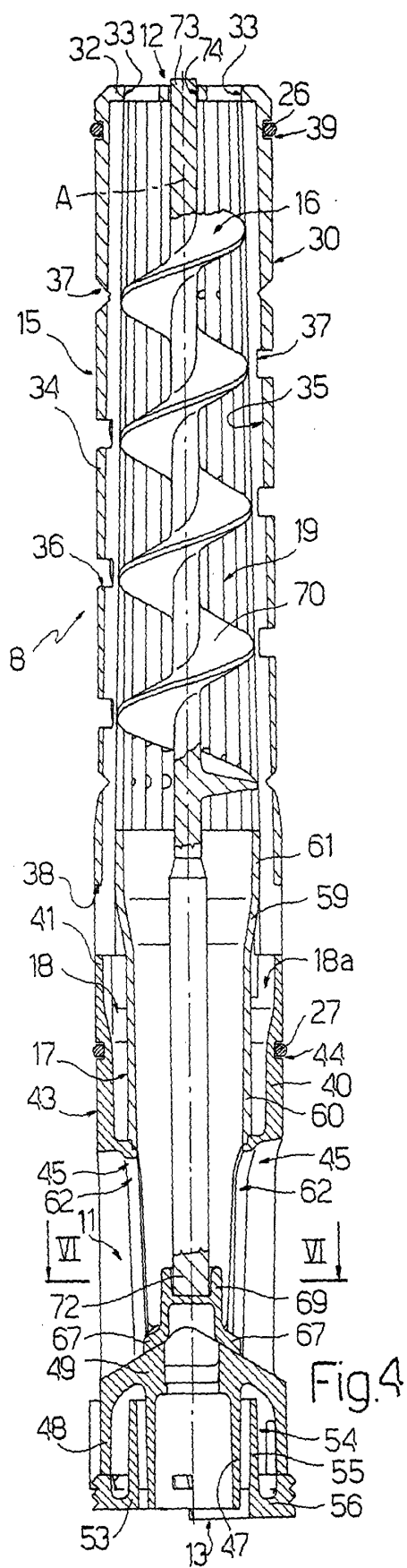


Fig.3



Description

[0001] The present invention relates to an internal-combustion engine provided with a purifying device for the separation of particles of lubricating oil from the crankcase blow-by gases.

[0002] It is known that internal-combustion engines are provided with a crankcase breather circuit designed to discharge to the outside of said crankcase the so-called 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 other impurities, for example particles of unburnt matter of carbon type (particulates).

[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] Sometimes the breather circuit is of the closed type and it recirculates the blow-by gases to the engine intake so as to ensure the complete combustion of the particulates. However, in this case too, the problem arises of purifying these gases of oil and particulates which tend to form resinous sediments on the components through which the gases pass before reaching the cylinders (particularly, on the valves and, in forced-induction engines, in the compressor and intercooler, thus compromising their efficiency as a result of the aerodynamic disturbance in the former and of the increased thermal resistance in the latter). Moreover, in vehicles with a catalytic converter the combustion of any engine oil recirculated to the intake has harmful effects on the catalytic converter and on the Lambda sensor. The oil entrained in the blow-by gases, whether it is recirculated or not, represents a consumption which, for a given volume of the reservoirs intended to contain it, typically the oil sumps, reduces the topping-up interval.

[0006] With a view to bringing about the separation of the lubricating oil from the blow-by gases it is known to use purifying devices of various types, for example, impact separators, in which the flow of gas interacts with walls which cause it to undergo sudden changes in direction; however, separators of this type have the disadvantage of occupying a relatively large amount of space and of causing high flow resistance during the passage. The use of conventional filter elements, combined or not with impact separators, has also been found to be unsatisfactory per se because they give rise to substantial flow resistance and they undergo rapid clogging.

[0007] In general, the known purifying devices are difficult to integrate into the engine and, particularly in the

case of impact separators, they occupy additional space, as well as creating difficulties in respect of assembly and maintenance.

[0008] The object of the present invention is to devise an internal-combustion engine provided with a purifying device for the separation of particles of lubricating oil from the crankcase blow-by gases, which makes it possible in a simple and economical manner to obviate the drawbacks associated with the above-mentioned known purifying devices.

[0009] This object is achieved by the present invention in that it relates to an internal-combustion engine comprising a cylinder head, a crankcase, a plurality of cylinders and breather means for the gases which have escaped into said crankcase through said cylinders and containing in suspension particles of lubricating oil, said breather means comprising a purifying device adapted to separate said particles of oil from said gases and having an inlet section for the gases to be purified, a first outlet section for the purified gases and a second outlet section for the separated oil particles, characterised in that said purifying device is a column-type integrated unit accommodated in a vertical cavity of said crankcase and comprising a hollow outer casing defining said inlet section and said first and second outlet sections, deflector means of generally helical configuration accommodated inside said casing and adapted to divert said gases to be purified along an ascending helical conveying path for separating under centrifugal action the particles of oil from said gases, and a substantially tubular intermediate element accommodated inside said casing downwardly with respect to said deflector means, through which the gases to be purified flow internally and upwardly towards said deflector means, and which delimits externally with said casing a separate chamber for conveying under gravity towards said second outlet section the oil particles projected under centrifugal action against an internal surface of said casing adjacent to said deflector means.

[0010] The present invention also relates to a purifying device for the separation of particles of lubricating oil from the blow-by gases of the crankcase of an internal-combustion engine, said device having an inlet section for the gases to be purified, a first outlet section for the purified gases and a second outlet section for the separated oil particles, characterised by comprising a column-type integrated unit designed to be accommodated in a vertical cavity of said crankcase and comprising a hollow outer casing defining said inlet section and said first and second outlet sections, deflector means of generally helical configuration accommodated inside said casing and adapted to divert said gases to be purified along an ascending helical conveying path for separating under centrifugal action the particles of oil from said gases, and a substantially tubular intermediate element accommodated inside said casing downwardly with respect to said deflector means, through which the gases to be purified flow internally and upwardly to-

wards said deflector means, and which delimits externally with said casing a separate chamber for conveying under gravity towards said second outlet section the oil particles projected under centrifugal action against an internal surface of said casing adjacent to said deflector means.

[0011] 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 side view, partly in section, of an internal-combustion engine in accordance with the present invention;

Figure 2 is a section, on an enlarged scale, of part of the crankcase of the engine in Figure 1 provided with a purifying device for the separation of particles of lubricating oil from the blow-by gases of said crankcase;

Figure 3 is a section along the line III-III in Figure 2; Figures 4 and 5 are axial sections, on an enlarged scale and taken along different planes, of the purifying device in Figure 2;

Figure 6 is a section along the line VI-VI in Figure 4;

Figure 7 is a section along the line VII-VII in Figure 5;

Figures 8 and 9 are side views, on an enlarged scale and from different viewing points, of an upper element of an outer casing of the purifying device in Figure 2;

Figure 10 is a section along the line X-X in Figure 9;

Figure 11 is a section along the line XI-XI in Figure 8; and

Figure 12 is a view in perspective on an enlarged scale of deflector means for the purifying device in Figure 2.

[0012] Referring now to Figure 1, the reference numeral 1 denotes an internal-combustion engine for a motor vehicle, in particular for a commercial vehicle (not shown). The engine essentially comprises a cylinder head 2, a plurality of cylinders 3, a crankcase 4 and a sump 5 mounted under the crankcase 4 and designed to contain lubricating oil.

[0013] The engine 1 is also provided with a breather circuit 6 for the crankcase 4 for discharging to the outside of said crankcase 4 the so-called blow-by gases, i. e. the gases which escape between the cylinders and the associated pistons 7.

[0014] These gases contain particles of finely atomised lubricating oil in suspension and other impurities, for example solid particles of carbon type (particulates) partly formed by partially unburnt products of combustion and partly by solid impurities normally contained in the oil.

[0015] The breather circuit 6 comprises a purifying device 8 (Figures 2-5), forming the subject-matter of the invention, for the separation of the particles of oil from

the blow-by gases.

[0016] The purifying device 8 is formed by a column-type integrated unit, preferably made of plastics material, which is accommodated in a vertical cavity 10 of the crankcase 4 and has lower inlet section 11 for the gases to be purified, an upper outlet section 12 for the purified gases and a lower outlet section 13 for the separated oil particles.

[0017] The purifying device 8 comprises a hollow cylindrical outer casing having an axis A and defining said inlet and outlet sections 11,12,13, deflector means 16 of substantially helical configuration accommodated inside the casing 15 and adapted to divert the gases to be purified along an ascending helical conveying path so as to separate under centrifugal action the particles of oil from said gases, and a substantially tubular cylindrical intermediate element 17 having an axis A, which is accommodated inside the casing 15 downwardly with respect to the deflector means 16, through which the gases to be purified flow internally and which delimits with the casing 15 a separate chamber 18 for conveying under gravity towards the outlet section 13 the oil particles projected under centrifugal action by the deflector means 16 against an internal surface 19 of the casing 15.

[0018] With particular reference to Figures 2 and 3, the cavity 10 communicates at its lower end with a series of internal compartments 20 of the crankcase 4, through which the blow-by gases flow in operation, and at its upper end it opens into a further cavity 21 of said crankcase 4 suitably connected to the intake of the engine 1.

[0019] The cavity 10 is delimited by a lateral edge 22 of generally cylindrical configuration having an axis A of minimal section in the region of end portions 23, 24 thereof, respectively at the top and bottom, and in the region of an intermediate portion 25 thereof, and greater sections in the region of the connecting zones of said portions 23,24,25.

[0020] The purifying device 8 co-operates via a pair of sealing rings 26,27, preferably of O-ring type, respectively with the upper end portion 23 and with the intermediate portion 25 of the lateral edge 22 of the cavity 10 and it is releasably secured between the lower end portion 24.

[0021] As is evident from Figures 4 and 5, the casing 15 is suitably made of two interconnected parts, in particular a cylindrical inverted cup-shaped upper element 30 accommodating the deflector means 16 and a substantially tubular cylindrical lower element 31.

[0022] With particular reference to Figures 4,5,8,9,10 and 11, the upper element 30 comprises a disc-shaped upper end wall 32, in which are provided three openings 33 defining the outlet section 12 for the purified gases and adapted to allow said gases to be conveyed into the cavity 21 of the crankcase 4, and from the latter to the intake of the engine 1, and a substantially cylindrical side wall 34 delimited internally by the surface 19 is provided with a plurality of straight vertical grooves 35 ex-

tending parallel to the axis A. In particular, the grooves 35 serve to retain the oil particles which collide with the surface 19 of the side wall 34 and to allow said oil particles to descend under gravity while keeping them separate from the rising gases. As is evident from Figures 4, 5, 10 and 11, the internal surface 19 of the side wall 34 is of slightly frustoconical configuration and is of a section decreasing towards the upper end wall 32 so as to allow the upper element 30 to be removed from the mould.

[0023] The side wall 34 also has an outer substantially helical groove 36 which extends parallel to the conveying path of the gases and along which is provided a series of through-holes 37 serving to allow the oil particles separated from the rising gases to escape into the cavity 10 of the crankcase 4.

[0024] The side wall 34 is further provided with a series of windows 38 angularly spaced apart about the axis A and arranged in operation in the vicinity of and above the intermediate portion 25 of the lateral edge 22 of the cavity 10 and serving to convey into the interior of the chamber 18 of the casing 15 the oil particles escaping in the region of the holes 37 of the upper element 30.

[0025] Finally, the side wall 34 defines, in the vicinity of the upper end wall 32, an outer annular slot 39 which accommodates the sealing ring 26.

[0026] With particular reference to Figures 4-7, the lower element 31 comprises a substantially cylindrical side wall 40 having an axis A, which is connected with the side wall 34 of the upper element 30 and is substantially aligned externally with said side wall 34. More precisely, the side wall 40 is fitted, level with an upper end portion 41 thereof, on four tongues 42 projecting from a lower end edge of the side wall 34.

[0027] The lower element 31 extends substantially between the portions 24 and 25 of the lateral edge 22 of the cavity 10 and has, on an outer surface 43 of the side wall 40 thereof and in the region of said portion 25, an annular slot 44 accommodating the sealing ring 27.

[0028] The side wall 40 is provided, below the portion 25 of the lateral edge 22 of the cavity 10, with a pair of lateral openings 45 defining the inlet section 11 for the gases to be purified and communicating with the internal compartments 20 of the crankcase 4.

[0029] As is evident from Figures 5-7, the side wall 40 of the lower element 31 is provided, on its outer surface 43, with a plurality of ribs 46 parallel to the axis A and defining between one another a plurality of gaps adapted to allow downward movement under gravity of the oil particles separated by impact against said side wall 40 as the gases enter the interior of the casing 15. In particular, as is apparent from Figure 2, the crankcase 4 defines between the portions 24 and 25 of the lateral edge 22 of the cavity 10 a chamber 100 communicating with the internal compartments 20 of said crankcase 4 via two apertures 101 opposite respective lateral apertures 45 of the casing 15. In this way, the oil particles of larger dimensions collide with the surface 43 provided

with the ribs 46 and, under gravity, they run downwards where they are returned into the compartments 20 via a syphon 54.

[0030] The lower element 31 further comprises integrally a cylindrical collar 47 accommodated inside a lower end portion 48 of the side wall 40 below the lateral apertures 45 and joined to said side wall 40 by an annular flange 49.

[0031] The collar 47 projects downwards with respect to the side wall 40 and is fitted on to an end portion of a duct 50 for conveying the separated oil particles towards the sump 5; therefore, the collar 47 defines the outlet section 13 for the separated oil particles.

[0032] The lower end portion 48 of the side wall 40 is further provided with apertures 51 for conveying into the syphon 54 particles of oil accumulated at the bottom of the chamber 100.

[0033] The syphon 54 is defined by a sleeve-like cover 53 force-fitted into the lower end portion 24 of the lateral edge 22 of the cavity 10, and by the lower element 31. The syphon 54 is adapted to prevent the blow-by gases from penetrating directly into the interior of the casing 15 via the collar 47, while allowing, however, the oil separated in the chamber 100 after colliding with the ribbed surface 43 to return into the compartments 20.

[0034] In particular, the cover 53 comprises a cylindrical sleeve 55 inserted with radial clearance between the lower end portion 48 of the side wall 40 and the collar 47, and an annular flange 56, which projects radially from a lower end of the sleeve 55, is force-fitted into the portion 24 of the lateral edge 22 of the cavity 10 and it is provided with flutes which are deformable in contact with the crankcase 4 so as to ensure a fluidtight seal in downward direction.

[0035] With reference to Figures 2-7, the intermediate element 17 comprises a substantially cylindrical main portion 60 with an axis A and accommodating with radial clearance inside the lower element 31, and an upper end portion 61 which is also cylindrical with an axis A and which is of larger section than the section of the main portion 60, which is connected to said main portion 60 by a frustoconical portion 59 and which is engaged in a lower end portion of the side wall 34 of the upper element 30 in contact with the internal surface 19; in particular, the contact between the upper end portion 61 and the internal surface 19 of the upper element 30 takes place in a position above the windows 38.

[0036] The main portion 60 of the intermediate element 17 has a pair of lateral openings 62 arranged in the region of respective lateral apertures 45 of the lower element 31 and adapted to allow the gases to be purified to be admitted into the interior of said intermediate element 17.

[0037] Advantageously, the lateral apertures 45 of the lower element 31 are delimited by associated peripheral edges 63 bent over in an L-shape on corresponding peripheral edges 64 of the lateral apertures 62 of the intermediate element 17 and co-operating in contact with

said peripheral edges so as to prevent the oil particles descending towards the duct 50 from being intercepted and entrained by the gases entering the casing 15. In more detail, the lateral apertures 65 divide the main portion 60 of the intermediate element 17 into two curved lamellar arms 65 extending on opposite sides with respect to the axis A and opposite and enclosed between respective C-shaped portions 66 of the side wall 40 (Figure 6).

[0038] Therefore, the chamber 18 for the downward movement of the oil particles is formed by an annular portion 18a defined between the side wall 40 of the lower element 31 and the portions 59 and 61 of the intermediate element 17, and by a pair of angular portions 18b which are diametrically opposed with respect to the axis A, and which communicate upwardly with the annular portion 18a and which are defined between the side wall 40 of said lower element 38 and the arms 65 of the intermediate element 17.

[0039] The lateral apertures 62 of the intermediate element 17 are closed at the bottom by respective feet 67 extending on diametrically opposite sides with respect to the axis A and arranged bearing on the inner flange 49 of the lower element 31.

[0040] At the bottom the feet 67 contact, level with opposite ends thereof, respective lateral end portions of the lower edge of the arms 65 of the intermediate element 17 and they define with these lower edges associated outlet apertures 68 of the angular portions 18b of the chamber 18.

[0041] As is evident from Figures 4 and 5, the feet 67 are extended into the interior of the intermediate element 17 and define a collar 69 with an axis A, which is externally cylindrical and internally prismatic, the function of which will be explained in the following paragraphs.

[0042] With reference to Figures 2-5 and 12, the deflector means 16 are defined by a helical wall 70 wholly accommodated inside the upper element 30 and extending around a central rod 71 which has an axis A and which is supported, at opposite prismatic ends 72,73 thereof, by the collar 69 of the intermediate element 17 and by end wall 32 of the upper element 30. More precisely, the lower end 72 of the rod 71 engages the collar 69, whereas the upper end 72 engages an opening 74 of complementary shape provided in the end wall 32 of the upper element 30.

[0043] In operation, the blow-by gases present in the crankcase 4 pass through the purifying device 8 from the bottom upwards as a result of the pressure difference existing between the internal compartments 20 of the crankcase 4 and the cavity 21 connected to the intake of the engine 1.

[0044] In particular, the blow-by gases originating from the internal compartments 20 of the crankcase 4 enter the cavity 10 from the bottom through lateral apertures in this latter. The blow-by gases then fill the chamber 100 between the portions 24 and 25 of the lat-

eral edge 22 of said cavity 10. An initial coarse separation of the oil particles of larger size takes place in this zone, which particles collide with the outer surface 43 of the lower element 31 of the casing 15 and they descend under gravity along the gaps formed between the ribs 46. Said oil particles accumulate at the bottom of the chamber 100, from where they are readmitted into the compartments 20 of the crankcase 4 via the syphon 54. The function of the syphon 54 is to enable the oil to pass from the cavity 10 to the compartments 20 in which a slightly higher pressure prevails.

[0045] More precisely, the oil accumulated at the bottom of the chamber 100 passes through the apertures 51 in the side wall 40 of the lower element 31 to the interior of the casing 15 and they accumulate outside the cover 53 until reaching such a level as to enable the fraction situated uppermost to pass beyond said cover 53; this fraction can then flow into the compartments 20 of the crankcase 4.

[0046] The blow-by gases then enter the interior of the casing 15 and of the intermediate element 17 through the lateral apertures 45,62 and they start to rise again through the purifying device 8 towards the upper outlet section 12. At this stage, the gases encounter the helical wall 70 which constrains them to undergo helicoidal movement; the range of centrifugal acceleration which results from this helicoidal movement of the fluid stream projects the particles of oil in suspension, being of higher density than that of the gases, against the internal surface 19 of the upper element 30, along which they coalesce.

[0047] In particular, the oil particles which collide with the surface 19 of the upper element 30 partly descend under gravity along the grooves 35 remaining separated from the fluid stream, and partly they escape into the cavity 10 through the holes 37 so as then to re-enter lower down the interior of the chamber 18 of the casing 15 through the windows 38.

[0048] At this point, the oil descends along the annular portion 18a and the angular portions 18b of the chamber until it enters the duct 50 through the outlet apertures 68, from where it is conveyed towards the sump 5. At this stage, owing to the fact that the peripheral edges 63 of the lateral apertures 45 of the lower element 31 are closed on the peripheral edges 64 of the lateral apertures 62 of the intermediate element 17, the descending oil still remains separated from the flow of gas entering the purifying device 8.

[0049] Once they have passed the helical wall 70 the gases purified of lubricating oil leave the purifying device 8 through the upper apertures 33 of the end wall 32 of the upper element 30 and they are conveyed to the intake of the engine 1.

[0050] 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 8 designed in accordance therewith.

[0051] In particular, owing to its column-type con-

struction, the purifying device 8 can be easily integrated inside the engine 1 by being inserted in a vertical cavity (10) of the crankcase of said engine, without occupying any additional space.

[0052] Moreover, the purifying device 8 is composed of a limited number of components (five to be exact) which are preferably made of plastics material and which can easily be assembled together and their total cost is reasonable.

[0053] Finally, because of the particular configuration of the intermediate and lower elements 17,31 in alignment with respective apertures 45,62, the oil descending through the chamber 18 is constantly separated from the flow of gas ascending through said intermediate element 17.

[0054] Finally, it is evident that the engine 1 and, in particular, the purifying device 8 described and illustrated can be subject to modifications and variations without departing from the scope of the claims.

Claims

1. An internal-combustion engine (1) comprising a cylinder head (2), a crankcase (4), a plurality of cylinders (3) and breather means (6) for gases which have escaped into said crankcase (4) through said cylinders (3) and containing in suspension particles of lubricating oil, said breather means (6) comprising a purifying device (8) adapted to separate said particles of oil from said gases and having an inlet section (11) for the gases to be purified, a first outlet section (12) for the purified gases and a second outlet section (13) for the separated oil particles, **characterised in that** said purifying device (8) is a column-type integrated unit accommodated in a vertical cavity (10) of said crankcase (4) and comprising a hollow outer casing (15) defining said inlet section (11) and said first and second outlet sections (12,13), deflector means (16) of generally helical configuration accommodated inside said casing (15) and adapted to divert said gases to be purified along an ascending helical conveying path for separating under centrifugal action the particles of oil from said gases, and a substantially tubular intermediate element (17) accommodated inside said casing (15) downwardly with respect to said deflector means (16), through which the gases to be purified flow internally and upwardly towards said deflector means (16), and which delimits externally with said casing (15) a separate chamber (18) for conveying under gravity towards said second outlet section (13) the oil particles projected under centrifugal action against an internal surface (19) of said casing (15) adjacent to said deflector means (16).
2. An engine according to claim 1, **characterised in that** said deflector means (16) are accommodated in an upper portion (30) of said casing (15) having, along said internal surface (19), a plurality of vertical grooves (35) for allowing the oil particles to descend under gravity while keeping them separate from the rising gas flow.
3. An engine according to claim 2, **characterised in that** said upper portion (30) of said casing (15) has a plurality of through-holes (37) spaced apart in succession parallel to said conveying path for said gases so as to allow the passage into said cavity (10) of said crankcase (4) of the oil particles projected towards said internal surface (19) of said casing (15).
4. An engine according to claim 3, **characterised in that** said upper portion (30) has a plurality of lower through-windows (38) for allowing the oil particles which have escaped from said holes (37) to be conveyed into the interior of said chamber (18).
5. An engine according to any one of the preceding claims, **characterised in that** said first outlet section (12) is defined by at least one upper opening (33) provided in an upper end wall (32) of said casing (15).
6. An engine according to any one of the preceding claims, **characterised in that** said inlet section (11) is defined by at least first lateral opening (45) provided in a lower portion (31) of said casing (15).
7. An engine according to claim 6, **characterised in that** said lower portion (31) of said casing (15) has externally a plurality of vertical ribs (46) delimiting between them a plurality of gaps adapted to allow downward movement under gravity of the oil particles separated by impact against said lower portion (31) in the inlet stage of said gases into said casing (15) through said first lateral opening (45).
8. An engine according to any one of claims from 5 to 7, **characterised in that** said second outlet section (13) is defined by a lower opening (47) [sic] of said casing (15) opposite said upper aperture (33) and is connected to a duct (50) for conveying the separated oil particles towards a sump (5) collecting the oil of said engine (1), said intermediate element (17) extending with clearance inside said lower portion (31) of said casing (15), downwardly defining an outlet (68) towards said lower aperture (47), and being provided with at least one second lateral opening (62) arranged level with said first lateral aperture (45) and delimited by a peripheral edge (64) co-operating in contact with a peripheral edge (63) of said first lateral aperture (45) so as to prevent the oil particles descending towards said duct (50) from being intercepted and entrained by the flow of gases en-

tering said casing (15).

9. An engine according to claim 8, **characterised in that** said lower portion (31) of said casing (15) and said intermediate element (17) respectively comprise two of said first lateral apertures (45) and two of said second lateral apertures (62). 5

10. An engine according to claim 8 or 9, **characterised in that** said purifying device (8) comprises a syphon (54) provided between the bottom of said cavity (10) of said crankcase (4), said lower portion (31) of said casing (15) and an internal compartment (20) of the crankcase (4) so as to prevent the admission of gas inside the said casing (15) through said lower aperture (47). 10 15

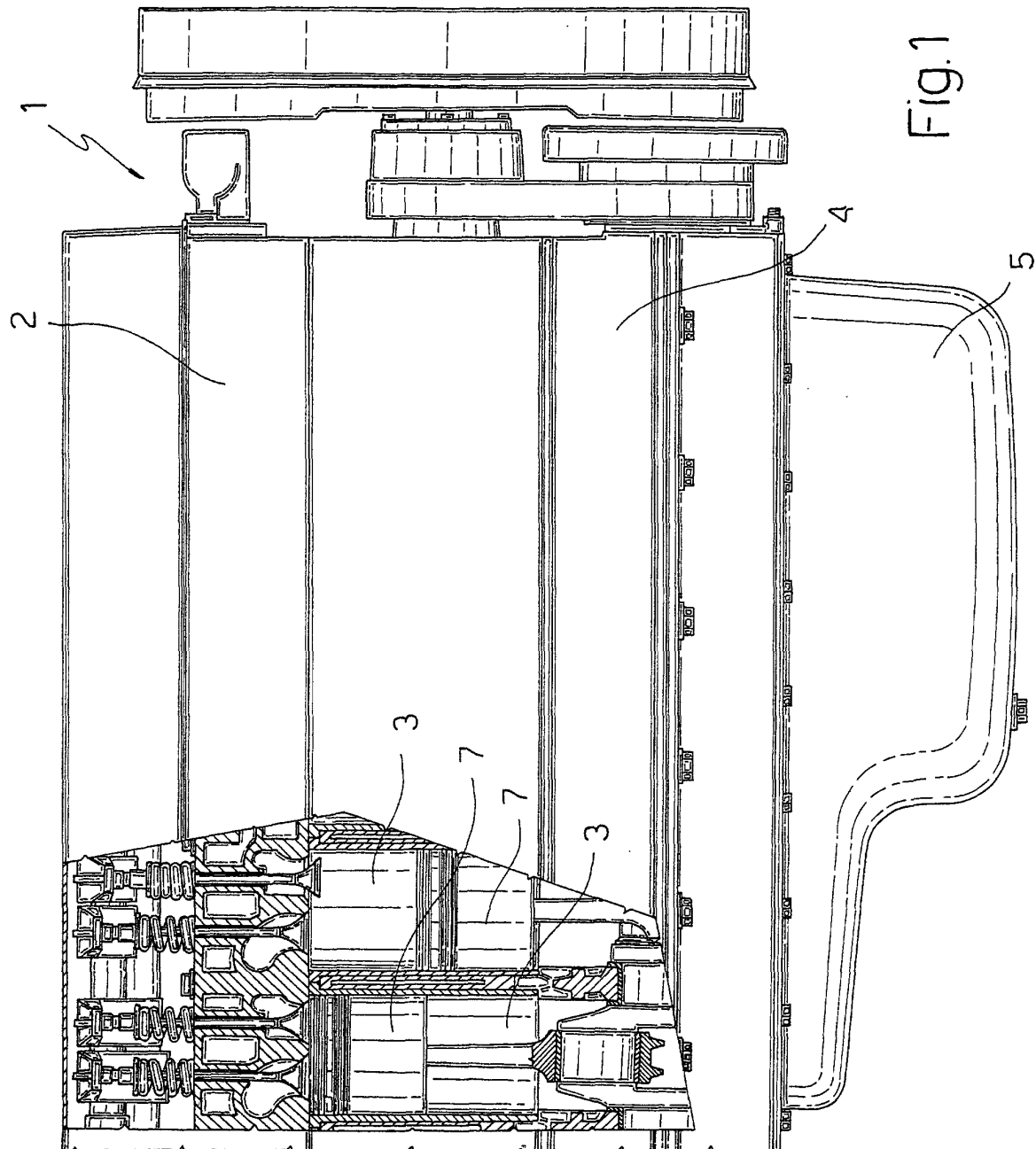
11. An engine according to any one of claims from 6 to 10, **characterised in that** said lower and upper portions of said casing (15) are defined by separate elements (30,31) which are connected to one another. 20

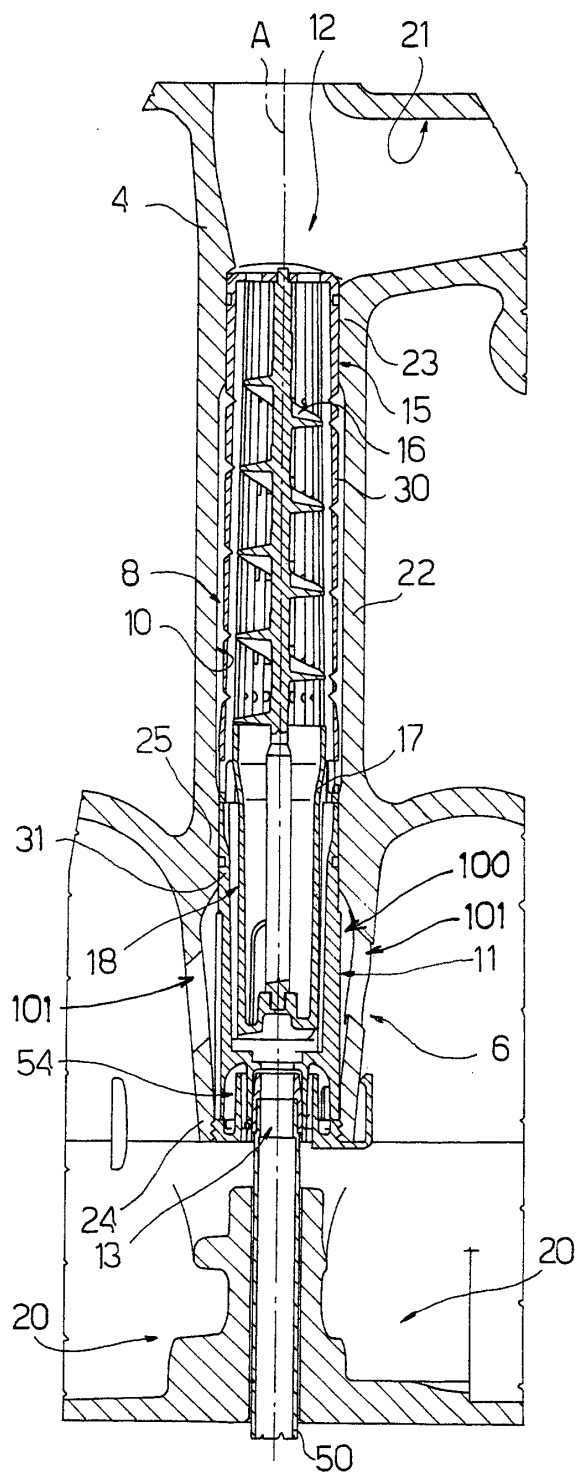
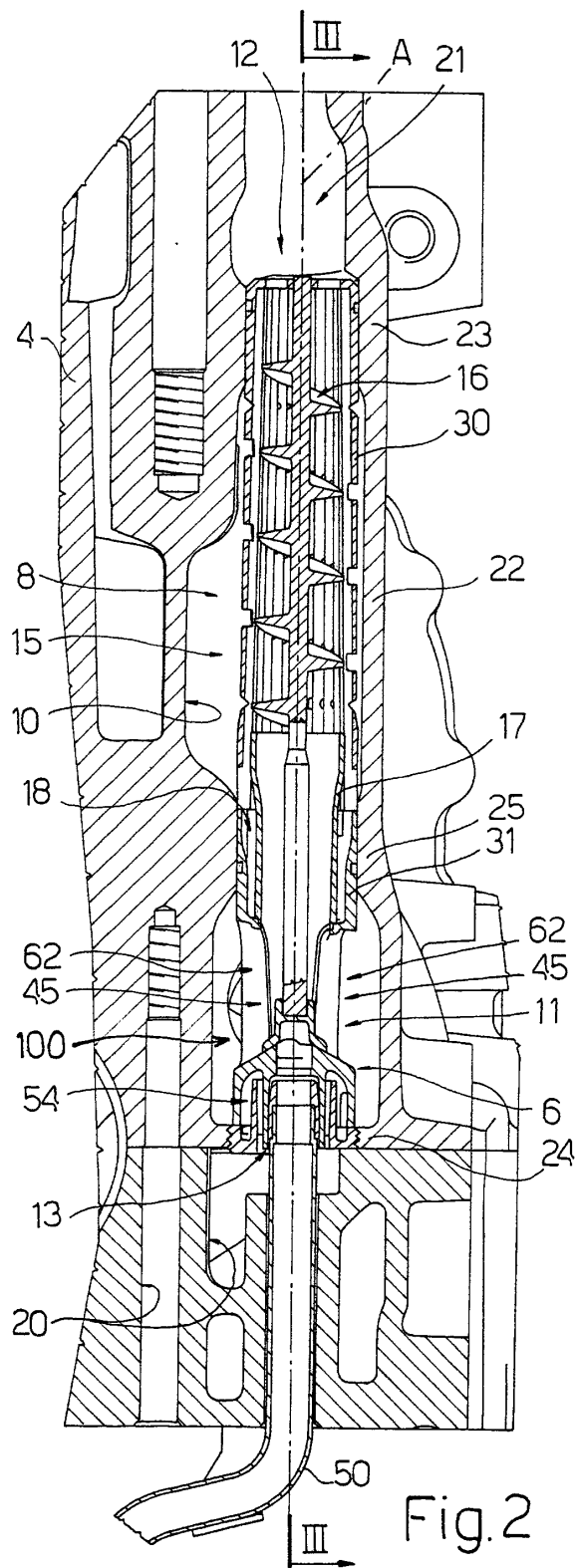
12. An engine according to any one of the preceding claims, **characterised in that** said deflector means (16) are formed by a helical wall (70) extending around a central vertical rod (71) supported at opposite ends (72,73) thereof between said casing (15) and said intermediate element (17). 25 30

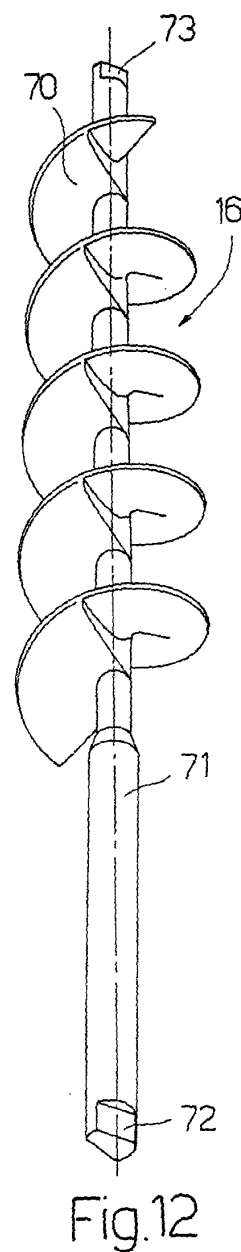
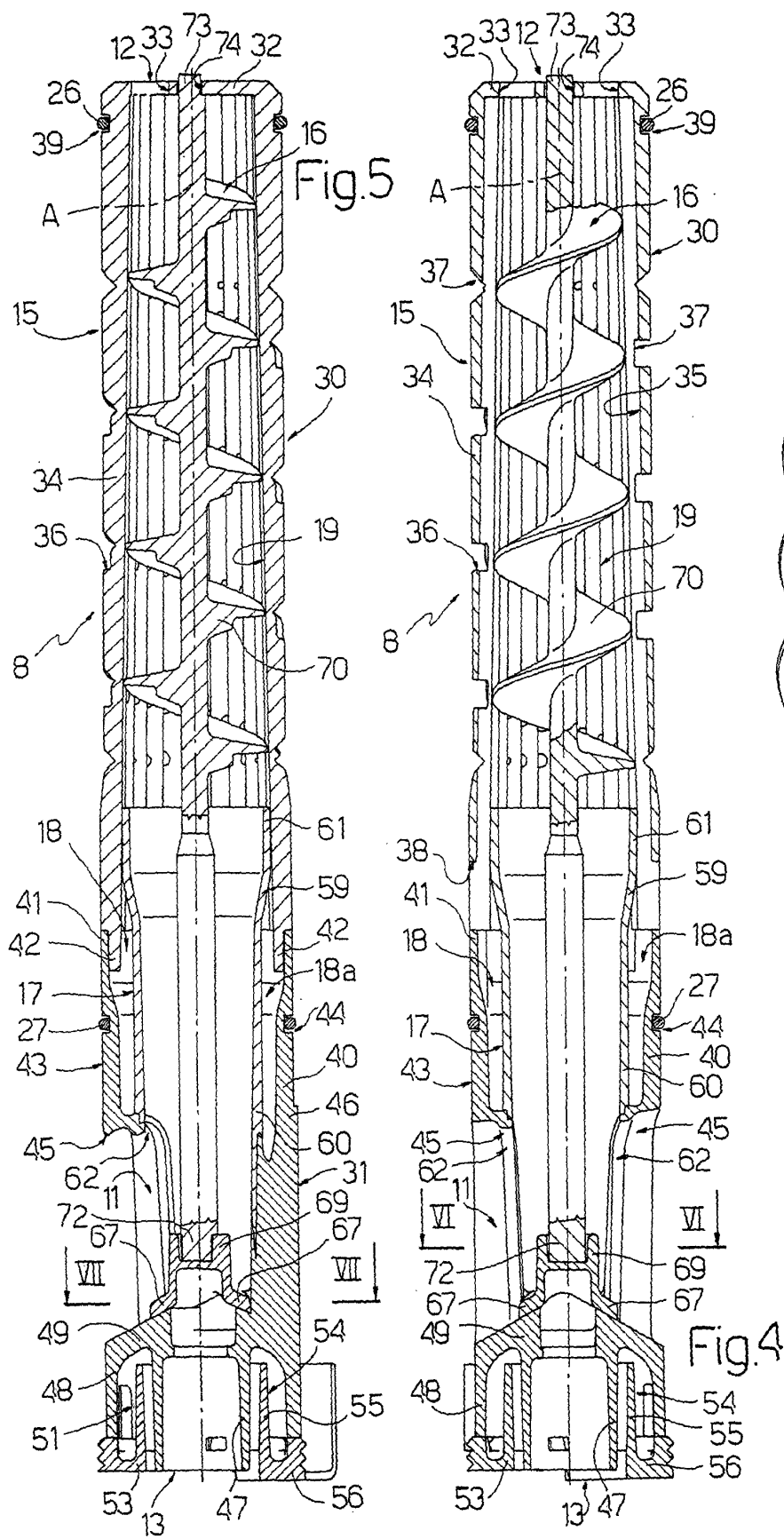
13. An engine according to any one of the preceding claims, **characterised in that** said purifying device (8) is made of plastics material.

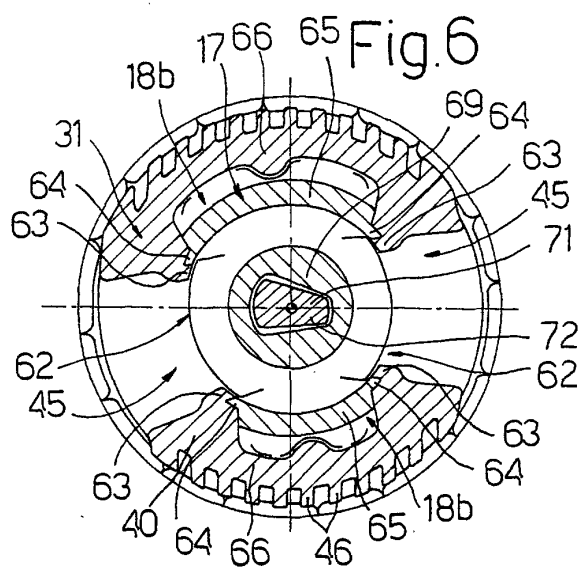
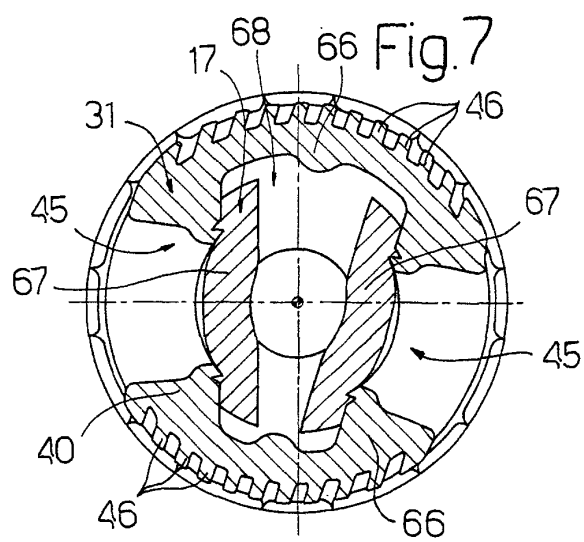
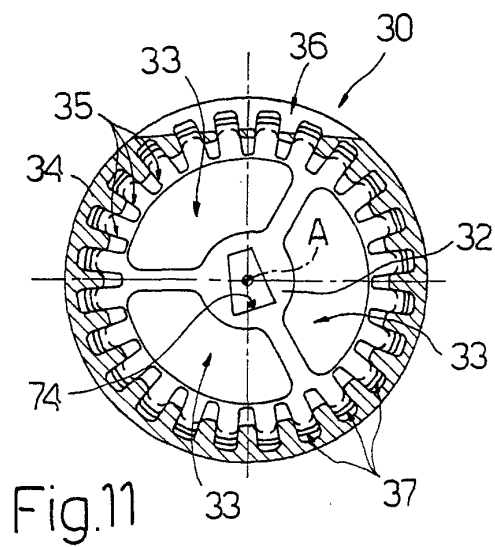
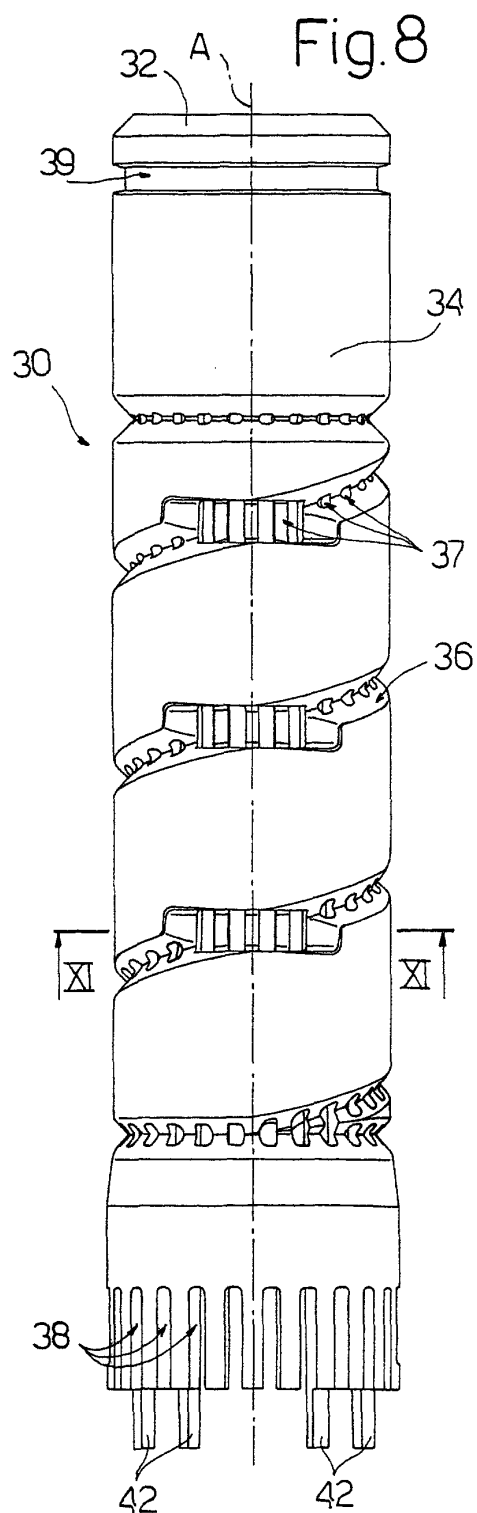
14. A purifying device (8) for the separation of particles of lubricating oil from the blow-by gases of the crankcase (4) of an internal-combustion engine (1), said device having an inlet section (11) for the gases to be purified, a first outlet section (12) for the purified gases and a second outlet section (13) for the separated oil particles, **characterised by** comprising a column-type integrated unit designed to be accommodated in a vertical cavity (10) of said crankcase (4) and comprising a hollow outer casing (15) defining said inlet section (11) and said first and second outlet sections (12,13), deflector means (16) of generally helical configuration accommodated inside said casing (15) and adapted to divert said gases to be purified along an ascending helical conveying path for separating under centrifugal action the particles of oil from said gases, and a substantially tubular intermediate element (17) accommodated inside said casing (15) downwardly with respect to said deflector means (16), through which the gases to be purified flow internally and upwardly towards said deflector means (16), and which delimits externally with said casing (15) a separate chamber (18) for conveying under gravity towards said second 35 40 45 50 55

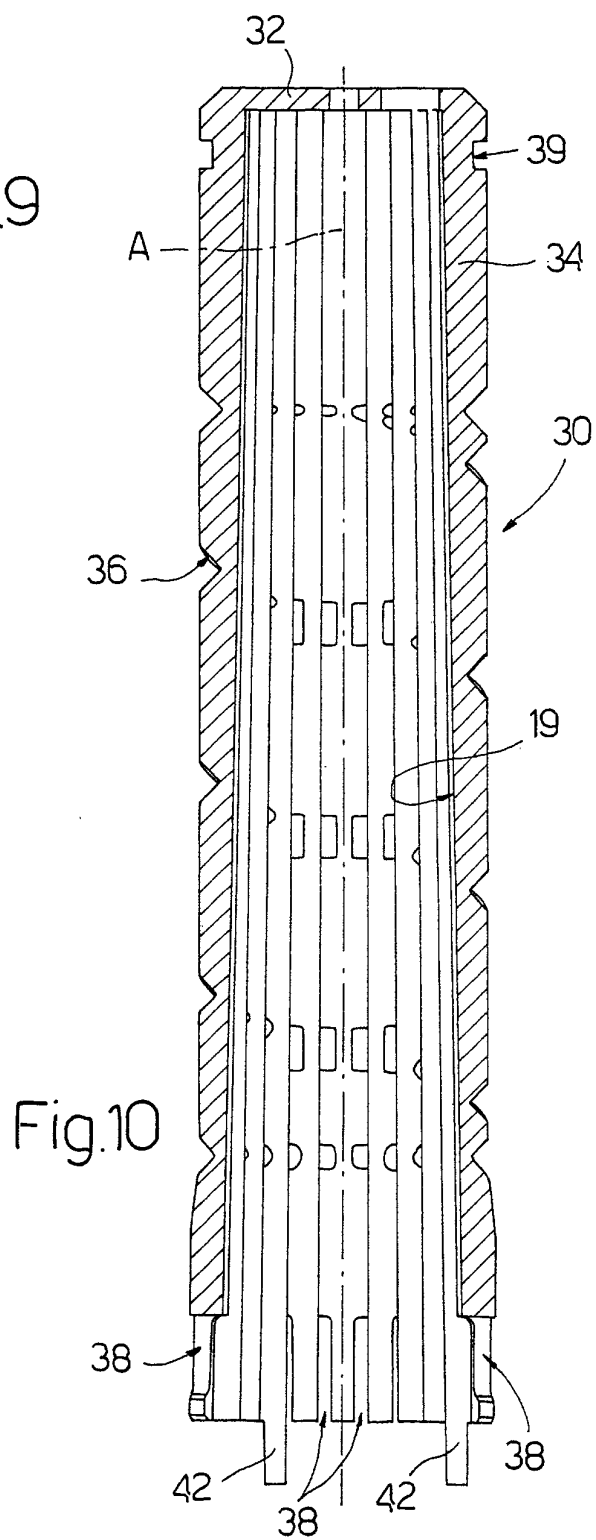
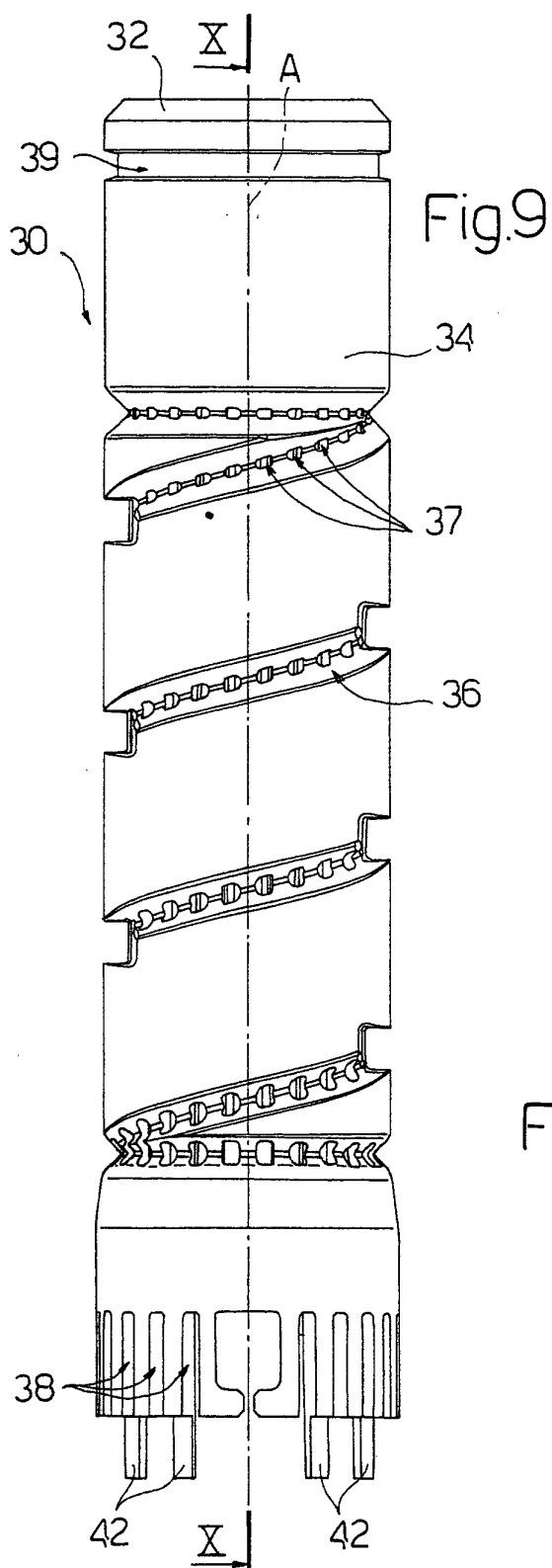
outlet section (13) the oil particles projected under centrifugal action against an internal surface (19) of said casing (15) adjacent to said deflector means (16).













European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 01 12 4657

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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	US 5 531 811 A (KLOBERDANZ THOMAS W) 2 July 1996 (1996-07-02) * column 2, line 56 - column 4, line 20; figures *	1	
A	US 5 902 378 A (OBREJANU MARCEL) 11 May 1999 (1999-05-11) * column 2, line 37 - column 4, line 3; figure 67; examples *	1	
A	US 2 413 324 A (HOLZWARTH) 31 December 1946 (1946-12-31) * the whole document *	1	
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The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 10 January 2002	Examiner Mouton, J
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03/82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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