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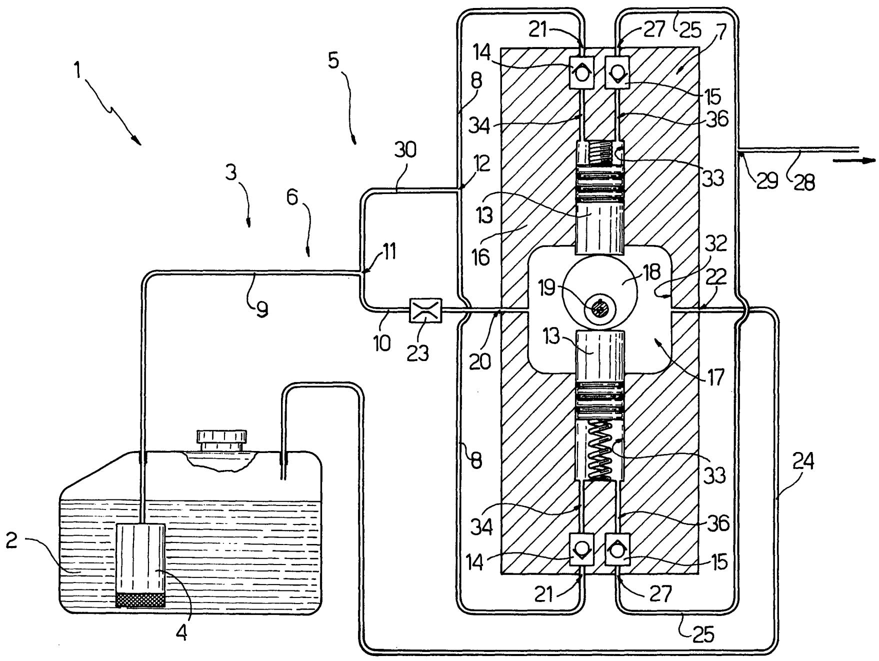
(54) A high-pressure pump for an internal-combustion engine

(57) Described herein is a pump (7) for supplying a pressurized fuel to an internal-combustion engine, provided with: a body (16); a compartment (17) made within the body (16); at least one pumping element (13) housed in a mobile way in the compartment (17) for raising the pressure of the fuel; fluid-supply means (21) for delivering the fuel to the pumping element (13); and an inlet mouth (20) made in the body (16), supplied with the fuel coming directly from an external source (2) and fluidically connected to the compartment (17) for supplying it with the fuel for the purpose of lubricating and/or cooling the pump (7) itself; the fluid-supply means (21) comprise at least one further inlet mouth (21), which is made in the body (16) and is fluidically connected to the pumping element (13) for supplying it with the fuel received directly from the external source (2).



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Description

[0001] The present invention relates to a high-pressure pump and to a compression assembly for an internal-combustion engine.

Known in the field of internal-combustion engines are fuel-injection systems comprising a tank for accumulation of the fuel and a system for compression of the fuel, which is fluidically connected to the tank itself and is provided so as to make the fuel available to the engine at a pre-set pressure.

[0002] In particular, the compression system generally comprises a priming pump for the fuel contained in the tank and a compression assembly for making the fuel available, possibly via a common rail, to a plurality of injectors associated to respective combustion chambers of the engine itself.

[0003] Operation of the aforesaid systems envisages that the priming pump will take in fuel from the tank and make it available at a low pressure to the compression assembly for a further compression that brings the fuel to an optimal pressure value for injection into the combustion chamber.

[0004] In greater detail, the compression assembly comprises a high-pressure pump and a distribution circuit set between the priming pump and the high-pressure pump to make the fuel available to the high-pressure pump itself.

[0005] More precisely, the high-pressure pump has a full body, generally made of cast iron, inside which there is made a hollow chamber, referred to as "guard".

[0006] The guard houses: a plurality of pumping elements designed to compress the fuel; a portion of a shaft for controlling the pumping elements, which is, in turn, actuated by the internal-combustion engine or by an auxiliary motor; and a cam designed to transmit motion from the shaft to each pumping element.

[0007] In particular, each pumping element has an intake valve for regulating delivery of the fuel to be compressed by the distribution circuit, and a discharge valve for exit of the compressed fuel to the engine.

[0008] In high-pressure pumps of a known type, the fuel, in addition to being compressed in the pumping elements, performs a further function of lubrication and cooling of the guard, shaft, cams and pumping elements.

[0009] For this purpose, a pipe for delivery of the fuel coming from the distribution circuit traverses the full body of the high-pressure pump and connects the guard to a single inlet mouth made in the body itself.

[0010] In a first embodiment of high-pressure pumps of a known type, a plurality of pipes for supplying the respective pumping elements branches off from the delivery pipe, in a position between the inlet mouth and the guard, and extends as far as the respective pumping elements.

[0011] In a different embodiment, the delivery pipe does not present any branching and is provided with a plurality of supply pipes extending from the guard as far as the respective pumping elements.

[0012] In both of the aforesaid embodiments, each supply pipe is made within the body of the pump and supplies the corresponding pumping element through the corresponding intake valve.

[0013] In compression assemblies of a known type, when the fuel traverses the intake valves of the pumping elements, it is at a high temperature in so far as it has been heated by conduction by the body of the high-pressure pump or by the components housed in the guard.

[0014] As a result there is a considerable leakage, which brings about a reduction in the efficiency of the high-pressure pump.

Furthermore, the engine, especially at high r.p.m., leads to a whirling motion of the fuel present in the guard, thus disturbing flow of the fuel itself towards the pumping elements and causing a further reduction in the efficiency of the high-pressure pump.

[0015] In addition, the fuel, with reference to the embodiment according to which it reaches the pumping elements after having cooled the guard directly, may be contaminated by possible machining swarf and by impurities generated by the detachment of parts of members in mutual contact. In this circumstance, there could arise faulty operation of the high-pressure pump and the need for burdensome and frequent maintenance interventions.

[0016] The purpose of the present invention is to provide a high-pressure pump for an internal-combustion engine, which is without the drawbacks linked to known high-pressure pumps and specified above.

[0017] The aforesaid purpose is achieved by the present invention, in so far as it relates to a high-pressure pump, as defined in Claim 1.

[0018] The present invention likewise relates to a compression assembly for an internal-combustion engine, as defined in Claim 3.

[0019] For a better understanding of the present invention, described in what follows is a preferred embodiment, which is provided purely by way of non-limiting example and with reference to the attached figure, which illustrates partially an injection system of an internal-combustion engine comprising a high-pressure pump and a compression assembly.

[0020] With reference to the attached figure, designated as a whole by 1 is an injection system for an internal-combustion engine (in itself known and not illustrated).

[0021] The system 1 is illustrated only as far as is required for an understanding of the present invention, and basically comprises a tank 2 for the fuel and a compression system 3 fluidically connected to the tank 2 and designed to compress the fuel taken in from the tank 2 to make it available to the internal-combustion engine at the desired pressure.

[0022] In particular, the compression system 3 comprises a priming pump 4 immersed in the tank 2 and a compression assembly 5 fluidically connected to the priming pump 4 for compressing the fuel to a pre-set pressure value.

[0023] The compression assembly 5 comprises a circuit 6 for distribution of the fuel, fluidically connected to the priming pump 4, and a high-pressure pump 7, supplied by the circuit 6 and fluidically connected to the internal-combustion engine.

[0024] The circuit 6 is preferably made of a material with low thermal conductivity, is fluidically set between the priming pump 4 and the high-pressure pump 7, and comprises: a pipe 9 connected to the priming pump 4; one or more supply pipes 8 (in the case in point illustrated two in number), for supplying the fuel to the high-pressure pump 7; and a pipe 10 for lubrication/cooling of the high-pressure pump 7 itself.

[0025] More in particular, the pipe 9 connects the priming pump 4 to a union tee 11, from which there depart the lubrication/cooling pipe 10 and a connector pipe 30.

[0026] The connector pipe 30 terminates in a position corresponding to a further union tee 12, from which there depart the supply pipes 8, which extend as far as the high-pressure pump 7.

[0027] Advantageously, the supply pipes 8 lie on the outside of the high-pressure pump 7 and are distinct from one another and from the lubrication/cooling pipe 10.

[0028] A flow regulator 23 with fixed cross section is moreover provided on the lubrication/cooling pipe 10 in a position between the union tee 11 and the high-pressure pump 7.

[0029] The aforesaid flow regulator 23 is sized on the basis of the design characteristics of the high-pressure pump 7 so as to enable passage of a flow of fuel sufficient to lubricate/cool the high-pressure pump 7.

[0030] The high-pressure pump 7 comprises one or more pumping elements 13 (in the case in point two in number), provided for compressing the fluid to a pre-set pressure and actuated, via a cam 18, by a shaft 19 operatively connected to the internal-combustion engine.

[0031] More precisely, each pumping element 13 has an intake valve 14, for delivery of the fuel to be compressed coming from the corresponding supply pipe 8, and a discharge valve 15, for outflow of the compressed fuel to the internal-combustion engine.

[0032] Each pumping element 13 is moreover connected, downstream of the discharge valve 15, to a respective delivery pipe 25 set at least in part on the outside of the high-pressure pump 7.

[0033] In greater detail, the high-pressure pump 7 is defined by a full body 16, generally made of a thermoconductive material, made inside which is a cavity, referred to hereinafter by the term "guard" 17, which houses the pumping elements 13, the cam 18, and an end portion of the shaft 19.

[0034] More precisely, the guard 17 comprises a chamber 32 set in a centroidal position within the body 16 and designed to house the shaft 19, the cam 18, and a portion of the pumping elements 13.

[0035] The guard 17 further comprises a pair of liners 33 communicating with the chamber 32, each of which defines a seat for the motion of a respective pumping element 13 and houses a return spring acting on the pumping element 13 itself.

[0036] Each liner 33 is fluidically connected to the intake valve 14 and discharge valve 15 of the respective pumping element 13 via an intake pipe 34 and a discharge pipe 36, respectively, made within the body 16.

[0037] The body 16 moreover has an inlet mouth 20 to enable delivery of the fuel for cooling and lubrication of the guard 17 through the lubrication/cooling pipe 10.

[0038] In particular, the lubrication/cooling pipe 10 is in part housed within the body 16 and terminates in the guard 17.

[0039] Advantageously, the body 16 further has one or more inlet mouths 21, in the case in point two in number, to enable, through the respective supply pipes 8, delivery of the fuel with which to supply the respective pumping elements 13, said fuel coming directly from an external source, in the specific case defined by the tank 2.

[0040] In greater detail, each intake valve 14 connects a respective pumping element 13 to a respective supply pipe 8 and is set within the body 16 in the proximity of a respective inlet mouth 21.

[0041] In addition, the body 16 has an outlet mouth 22 traversed by a recirculation pipe 24 connecting the guard 17 to the tank 2 and designed to take the fuel used for cooling and lubricating the guard 17 back into the tank 2 itself.

[0042] Finally, the body 16 has one or more outlet mouths 27, in the case in point two in number, to enable, through respective delivery pipes 25, outflow of the fuel compressed by the respective pumping elements 13.

[0043] More precisely, each discharge valve 15 is fluidically set between the respective pumping element 13 and the respective delivery pipe 25, and is housed in the proximity of the respective outlet mouth 27 and within the body 16 of the high-pressure pump 7.

[0044] The delivery pipes 25 converge in a union tee 29 from which there departs a single supply pipe 28 of the engine.

[0045] In use, the fuel present in the tank 2 is taken up and precompressed by the priming pump 4 and sent, via the circuit 6, to the high-pressure pump 7.

[0046] In particular, the fuel at outlet from the priming pump 4 fills the pipe 9 and subsequently, via the union tee 11, according to proportions that are established by the flow regulator 23, flows partly into the lubrication/cooling pipe 10 and partly into the connector pipe 30.

[0047] The fuel that flows into the lubrication/cooling pipe 10 accesses the body 16 of the high-pressure pump 7 through the inlet mouth 20 and then fills the guard 17, lubricating and cooling the pumping elements 13, the cam 18, and the shaft 19.

[0048] The fuel that has cooled and lubricated the guard 17 fills the recirculation pipe 24 and, through the outlet mouth 22, leaves the body 16 and is sent back into the tank 2.

[0049] Instead, the fuel that flows into the connector pipe 30, through the union tee 12 fills each supply pipe

8 and accesses the body 16 via the respective inlet mouths 21.

[0050] The fuel that enters the body 16 through each inlet mouth 21 feeds, through the respective intake valve 14, the respective pumping element 13 by which it is compressed up to a given pressure.

[0051] The compressed fuel is discharged, through the respective discharge valve 15, from each pumping element 13, and leaves the body 16 via the respective outlet mouths 27, filling the respective delivery pipes 25.

[0052] The fuel that flows into each delivery pipe 25, through the union tee 29, is collected in the supply pipe 28 of the internal-combustion engine.

[0053] From an examination of the characteristics of the high-pressure pump 7 and of the compression assembly 5 made according to the present invention the advantages that they enable are evident.

[0054] In particular, when the fuel entering the high-pressure pump 7 traverses the intake valves 14 of each pumping element 13, it has not traversed the guard 17.

[0055] Hence, the fuel is at a level of temperature similar to that present in the tank 2 and presents a non-whirling motion. In other words, the fuel is supplied to the intake valves 14 relatively "cold", i.e., not subjected to any heating due to the preliminary passage through the high-pressure pump 7.

[0056] The efficiency of said pump is therefore optimal in so far as it does not undergo any decrease due to the high temperature of the fuel at inlet to the intake valves 14 and to the presence of whirling motion of the fuel itself.

[0057] Furthermore, the fuel that is to be compressed in the pumping elements 13 is not contaminated by any possible machining swarf or by impurities present in the guard 17.

[0058] Consequently, operation of the high-pressure pump 7 is free from the faults deriving from the presence of impurities in the fuel and requires interventions of maintenance that are less frequent and less costly.

[0059] Finally, it is clear that the high-pressure pump 7 and the compression assembly 5 described and illustrated herein may undergo modifications and variations that do not depart from the sphere of protection defined by the ensuing claims.

[0060] In particular, the circuit 6 could be made of a material that is not thermoinsulating and connected to the high-pressure pump 7 via thermoinsulating connection means.

[0061] Furthermore, the circuit 6 could be made of a material that is not thermoinsulating and constrained to one or more intermediate elements set at a sufficient distance from the high-pressure pump 7 as to contain heating of the fuel prior to intake into the pump 7 itself.

Claims

1. A pump (7) for supplying a pressurized fuel to an internal-combustion engine, said pump (7) comprising: a body (16); a compartment (17) made within said body (16); at least one pumping element (13) housed in a mobile way within said compartment (17) for raising the pressure of said fuel; fluid-supply means (21, 14) for delivering the fuel to said pumping element (13); and an inlet mouth (20) made in said body (16), supplied with the fuel coming directly from an external source (2) and fluidically connected to said compartment (17) for supplying it with said fuel for the purpose of lubrication and/or cooling of the pump (7) itself; said pump being
characterized in that said fluid-supply means (21, 14) comprise at least one further inlet mouth (21) made in said body (16) and fluidically connected to said pumping element (13) for supplying it with the fuel received directly from said external source (2).

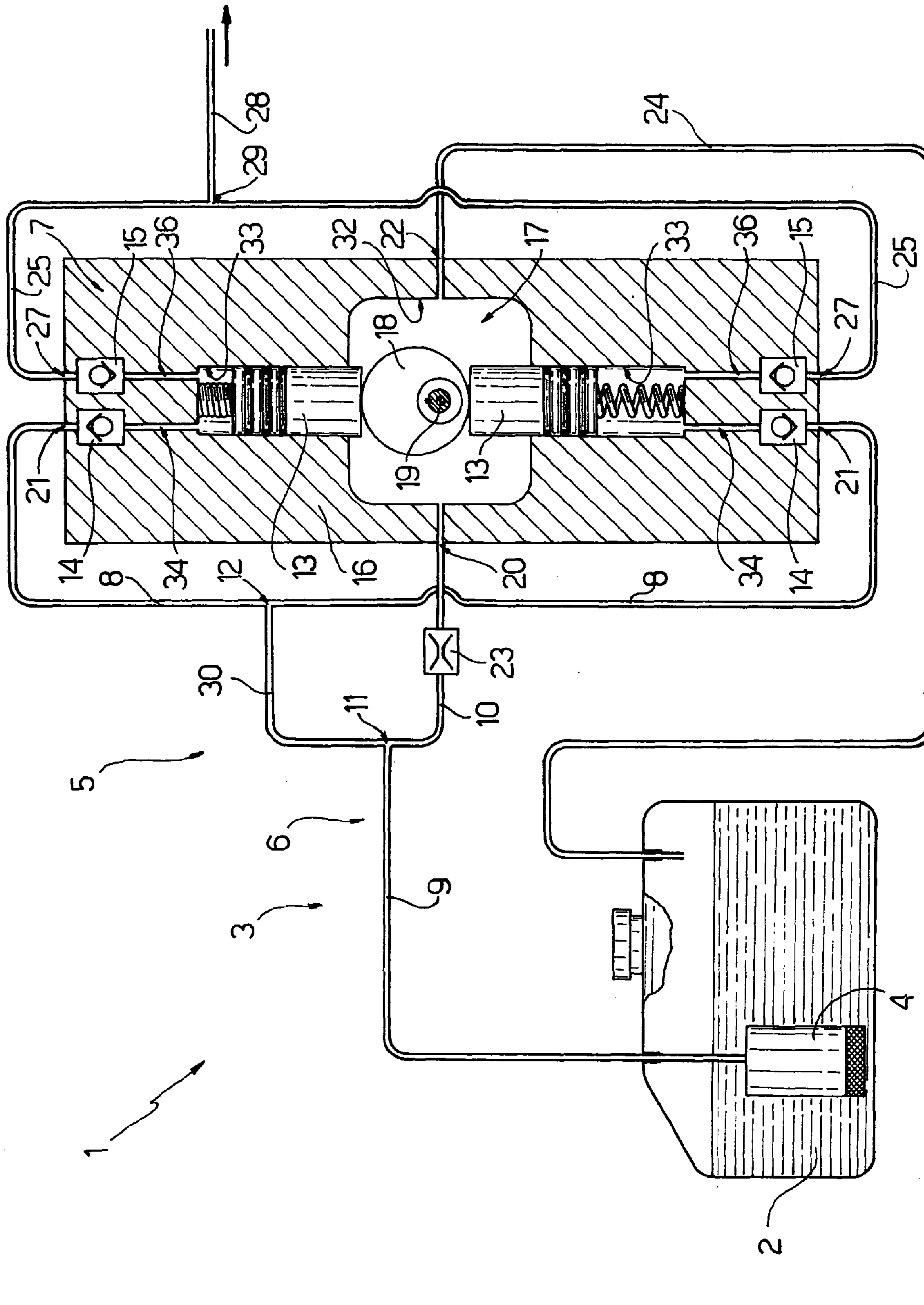
2. A pump according to Claim 1, **characterized in that** said fluid-supply means (21, 14) comprise an intake valve (14) fluidically connecting said further inlet mouth (21) to said pumping element (13) and set in the proximity of the further inlet mouth (21) itself.

3. A pump according to Claim 2, **characterized in that** said intake valve (14) is set in a position corresponding to said further inlet mouth (21).

4. A compression assembly (5) for supplying a pressurized fuel to an internal-combustion engine, said assembly (5) comprising a pump (7) for raising the pressure of the fuel and distribution means (6) for making the fuel to be compressed available to said pump (7), said pump (7) comprising: a body (16); a compartment (17) made within said body (16); at least one pumping element (13) housed in a mobile way in said compartment (17) for raising the pressure of said fuel; fluid-supply means (21) for delivering the fuel to said pumping element (13) ; and a first inlet mouth (20) made in said body (16) and fluidically connected to said compartment (17) for supplying it with said fuel for the purpose of lubrication and/or cooling of the pump (7) itself; said distribution means (6) comprising a first fluid line (10) for supply of said first inlet mouth (20) of said pump (7); said compression assembly (5) being **characterized in that** said fluid-supply means (21, 14) comprise at least one second inlet mouth (21) made in said body (16) of said pump (7) and fluidically connected to said pumping element (13), and **in that** said distribution means (6) comprise at least one second fluid line (8) distinct from said first fluid line (10), which supplies said second inlet mouth (21) of said pump (7) and is set outside the body (16) of the pump (7) itself.

5. A compression assembly according to Claim 4, **characterized in that** it comprises means with low transmission of heat cooperating with the fuel along said second fluid line (8).

6. A compression assembly according to Claim 5, **characterized in that** said means with low transmission of heat are defined by the material constituting said second fluid line (8).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EUROPEAN SEARCH REPORT

Application Number
EP 04 42 5838

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X Y	US 2003/037768 A1 (KANNE SEBASTIAN ET AL) 27 February 2003 (2003-02-27) * paragraphs [0034], [0035], [0037]; figure 1 *	1-4 5,6	F02M59/06 F02M53/00 F02M63/00 F02M59/44 F02M59/08
Y	US 5 501 196 A (BRUNNHOFER ET AL) 26 March 1996 (1996-03-26) * column 2, line 40 - line 51; figure 1 *	5,6	
X	US 2003/029423 A1 (BOEHLAND PETER ET AL) 13 February 2003 (2003-02-13) * paragraphs [0029], [0042]; figure 1 *	1-4	
X	DE 102 59 178 A1 (ROBERT BOSCH GMBH) 8 July 2004 (2004-07-08) * paragraphs [0008], [0010]; figure 2 *	1,2,4	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			F02M

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	7 April 2005	Jucker, C

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CATEGORY OF CITED DOCUMENTS

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07-04-2005

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2003037768 A1	27-02-2003	DE 10139055 A1	27-02-2003
		FR 2828526 A1	14-02-2003
		JP 2003065184 A	05-03-2003
US 5501196 A	26-03-1996	DE 4344775 A1	29-06-1995
		BR 9405270 A	19-09-1995
		DE 59405100 D1	26-02-1998
		EP 0661438 A1	05-07-1995
		ES 2114121 T3	16-05-1998
		JP 2651126 B2	10-09-1997
		JP 7286564 A	31-10-1995
US 2003029423 A1	13-02-2003	DE 10139054 C1	30-01-2003
		FR 2828525 A1	14-02-2003
		JP 2003113758 A	18-04-2003
DE 10259178 A1	08-07-2004	WO 2004055368 A1	01-07-2004

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