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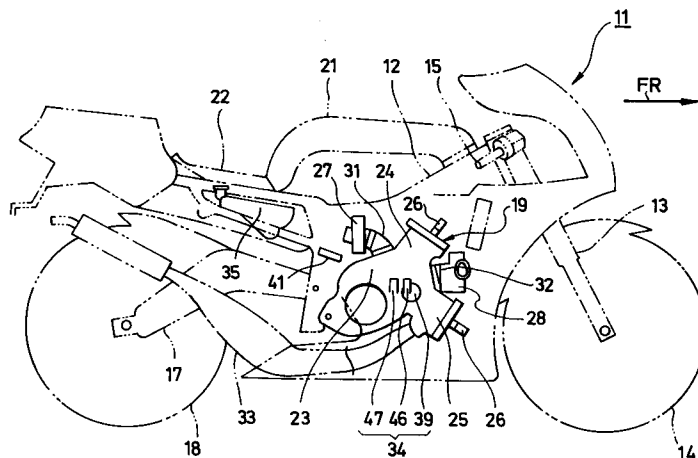
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(54) **Lubricating system for an internal combustion engine.**

(57) The present invention relates to a lubricating system for an internal combustion engine (19) comprising an oil pump (39) driven by the engine, (19) an oil supply passage (38) means for supplying lubricating oil from an oil tank (35) to the oil pump (39) and for delivering lubricating oil from the oil pump (39) to the engine, (19) and a delivery valve (46,47) for regulating the supply of lubricating oil to

the engine (19) in response to the operating conditions of said engine. Moreover, the oil pump (39) and the delivery valve (46,47) are disposed in close proximity to each other and to the engine, keeping the lengths of connecting conduits (44,45) between the oil pump (39) and the delivery valve (46,47) short.

**FIG.1****EP 0 556 437 A1**

This invention relates to a lubricating system for an engine and more particularly to a separate lubricating system that insures that the desired amount of lubricant will be supplied to the engine under all running conditions and only when the engine is running.

Heretofore it has been the practice to lubricate two cycle internal combustion engines by mixing lubricant with the fuel supplied to the engine. Although such an arrangement has the advantage of simplicity, it results in excess consumption of lubricant because it is necessary to maintain a lubricant/fuel mixture that will supply the most severe condition under which the engine is expected to operate. Hence, excess lubricant is supplied to the engine under most running conditions.

To avoid these problems, it has been proposed to provide a separate lubricating system for two cycle engines. One type of such systems comprises an engine driven oil pump from which the oil is supplied towards the engine through a solenoid-type oil amount regulating delivery valve. The duty ratio of said solenoid valve is controlled in response to the engine operating conditions. Accordingly, an appropriate amount of lubricating oil corresponding to the engine running state is supplied to the engine accurately.

Lubrication systems of the type described are extremely effective in providing good control of the lubricant, adequate lubrication under all circumstances and a minimum of lubricant consumption and smoke in the exhaust of the engine. However, there is always the possibility that lubricant may be carried entrain air. If air is entrained in the lubricant, then the duty cycle of the valve may not provide adequate control of the amount of lubricant supplied. That is, if there is air in the lines the lubricant will expand and contract and displace lubricant so that in a given time period of supply of the flow controlling valve, varying amounts of lubricant may be supplied.

Accordingly, it is an objective of the present invention to provide an improved lubricating system as indicated above which allows to improve the accuracy of the amount of oil supplied to the engine substantially excluding adverse effects from air entrainment in the oil to a precise supply of lubricating oil to the engine.

Moreover, advantageous embodiments of the present invention should ensure design of the lubricating system such that lubricating oil is reliably prevented from draining into the engine when the engine is out of operation. Finally, it is preferred that the present invention provides a basis for developing the system such that entrained air can easily be purged off of the system and any undesirable leakage of oil from the system to the engine is precluded after the engine has stopped

thus, also contributing to improve the cold-start capabilities, reducing oil consumption and preventing blue or white smoke from being generated.

According to the present invention, the above mentioned main objective is performed in that the oil pump and the delivery valve are disposed in close proximity to each other keeping the length of connecting conduits between the oil pump and the delivery valve short.

In this way, not only a highly compacted arrangement of the lubricating system and improved mounting facilities can be obtained but the minimizing of the distance between the lubricating pump and the delivery valve drastically reduces the effects of air in the lubricating oil to variations in the amount of oil supplied and, therefore, enhances the accuracy of oil supply to the engine.

According to a preferred embodiment of the present invention, the delivery valve is disposed downstream of the oil pump, arranging same both on the same side of the engine and, preferably, mounting them directly on the engine.

In this way, the oil pump and the oil amount regulating valve are prevented from being separated from each other by the engine so that they can be located closely adjacent to each other keeping the tubing in between minimal. Thus, it is easy to adjust the timings of the oil supply regulating delivery valves to correspond to the timing of oil delivery through the oil pump.

According to yet another preferred embodiment of the present invention, enabling any leakage of lubricating oil to the engine when the engine is not running the layout of the system is preferably designed in that the outlet of the oil supply passage means at the engine is disposed at a level higher than the supply outlet of the delivery valve thus, precluding the flow of oil towards the engine under standstill of same.

As an alternative or in addition to said measure, leakage of oil towards the engine is prevented by means of a check valve provided between the delivery valve and the outlet of the oil supply passage means at the engine or which is inserted in an oil return conduit. Said return conduit connects a return outlet of the delivery valve to an upper oil tank positioned at a level higher than the delivery valve in order to prevent a backflow of lubricating oil under gravity from the oil tank to the delivery valve through the oil return line.

According to yet another preferred embodiment of the present invention, the delivery valve is a three-way valve directing lubricating oil from a valve inlet communicating to the discharge side of the oil pump to either of a supply outlet leading to the engine or a return outlet connected to a return conduit leading to the oil tank which returns excess oil to a portion of the system upstream of the

delivery valve. In order to provide a self-air-purging system, it is preferred that the supply outlet of the valve is disposed at a lower end portion of the delivery valve while the return outlet is disposed at an upper end portion of that valve specifically, at the highest point of the delivery valve, most preferably said return outlet of the delivery valve is positioned vertically above the lower supply outlet of said valve.

Through the present invention including its preferred embodiments, the accuracy of the oil supply to the engine can be increased as the influence of air bubbles entrained in the oil to said accuracy of oil supply can be minimized as fluctuations of the oil pressure otherwise arising are reduced. Moreover, it is easy to coordinate the timings of oil delivery of the delivery valve with the delivery timings of the oil pump.

By means of the upper position of ensuring the position of the entry of lubricating oil into the engine system to be at a level higher than that of the outlet end of the delivery valve, there is a permanent tendency for a backflow of lubricating oil from the engine towards the delivery valve under gravity when the engine is out of operation. Accordingly, undesirable leakage of oil into the engine system will be prevented enhancing the cold-start capabilities of the system preventing an excessive supply of oil, exhaust gas problems etc. to arise.

Moreover, the preferred design of the delivery valve or yet more preferred by a parallel pair thereof, renders air in the lubricating oil to be raised by its buoyancy to be purged off of the system through the lubricating oil return outlets of the delivery valve.

Also, through this design the self-purging capabilities of the lubricating system are considerably enhanced. Further preferred embodiments are laid down in the other sub-claims.

In the following, the present invention is explained in greater detail by means of several sub-claims in conjunction with the accompanying drawings wherein:

Figure 1 is a side elevational view of a motorcycle powered by an internal combustion engine having a lubricating system constructed in accordance with an embodiment of the invention. The motorcycle is generally shown in phantom while the engine and its lubricating system are shown in solid lines.

Figure 2 is a front elevational view, on an enlarged scale, showing the engine and surrounding portions of the motorcycle.

Figure 3 is an enlarged side elevational view, in part similar to Figure 1, and shows only the engine and the lubricating system.

Figure 4 is an enlarged cross sectional view taken through one of the delivery valves.

Figure 5 is a side elevational view, in part similar to Figure 3 and shows another embodiment of the invention.

Referring first to Figure 1, a motorcycle is shown partially in phantom and is identified generally by the reference numeral 11. The motorcycle 11 is depicted primarily for orientation purposes inasmuch as the lubricating system may be used in conjunction with other applications for internal combustion engines. A motorcycle, however, is a typical environment in which the invention may be employed since it has particular utility with two cycle internal combustion engines and such engines are frequently employed for powering motorcycles.

The motorcycle 11 includes a frame assembly, indicated generally by the reference numeral 12 that dirigibly supports a front fork 13. The front fork 13 journals a front wheel 14 and is steered by means of a handlebar assembly 15 in a known manner. A trailing arm assembly 17 is journaled at the rear of the frame assembly 12 in a known manner and rotatably journals a rear wheel 18. The rear wheel 18 is driven by an internal combustion engine, indicated generally by the reference numeral 19, and which is mounted in the frame assembly 12 in a known manner.

A fuel tank 21 is carried by the frame assembly 12 above the engine 19 and supplies fuel to the engine 19 in a known manner. A seat 22 is mounted on the frame assembly 12 to the rear of the fuel tank 21 for accommodating a rider.

The engine 19 is, in the illustrated embodiment, of the V-2 two cycle, crankcase compression type. It is to be understood, however, that the invention may be employed with engines having other cylinder numbers or other configurations, engines operating on other than the two stroke principal and also rotary type engines.

The engine 19 includes a cylinder block assembly 23 having a pair of angularly disposed cylinder banks 24 and 25, each forming a cylinder bore. As is typical with motorcycle practice, the cylinder block 23 is mounted in the frame assembly 12 so that the output shaft rotates about a transversely extending axis. A suitable change speed transmission is incorporated within the crankcase of the cylinder block 23 and drives the rear wheel 18 in any suitable manner. Cylinder heads are affixed to the cylinder banks 24 and 25 and each mount respective spark plugs 26 for firing the charge which is delivered to the combustion chambers of the engine in a well known manner.

The induction system includes a pair of carburetors 27 and 28 which draw air through an air cleaner system, as shown schematically by the

arrows 29 in Figure 3. The carburetors 27 and 28 discharge into the crankcase chambers associated with the individual cylinder banks 24 and 25 through respective intake manifolds 31 and 32.

In connection with the orientation of the engine 19, the front and rear sides of the engine are related to the front and rear of the motorcycle 11 with the front indicated by the arrow Fr. In addition to the front and rear sides, the engine 19 has a top side, a bottom side, a left hand side and a right hand side, all oriented relative to the body of the motorcycle 11. As used in the claims "sides" may be any of such sides.

A pair of exhaust pipes and muffler arrangements 23 extend from the exhaust ports of the respective cylinder banks 24 and 25 on opposite sides of the motorcycle 11 and discharge exhaust gases to the atmosphere in a well known manner.

No details of the internal construction of the engine 19 have been illustrated nor is any further description of the basic construction of the engine 19 believed to be necessary to permit those skilled in the art to understand the construction and operation of the invention, which relates primarily to the lubricating system for the engine 19. This lubricating system is indicated generally by the reference numeral 34 and will now be described in greater detail by particular reference initially to Figures 1 and 3.

The lubricating system 34 includes a lubricant tank 35 that is mounted at the rear of the frame assembly 12 at an elevated position. The lubricant tank 35 contains lubricant at a level indicated by the broken line 36 in Figure 3 which, it should be noted, lies above the upper level of the engine 19.

An outlet nipple 37 of the lubricant tank 35 is connected to a first conduit 38 for gravity delivery of lubricant from the tank 35 to a lubricating pump, indicated generally by the reference numeral 39 and mounted at one side of the engine (the right hand side in the illustrated embodiment). An oil filter 41 is provided in the first conduit 38 for filtering the lubricant before it is delivered to the lubricant pump 39.

The lubricant pump 39 may be a conventional reciprocating type pump that is driven by the engine in a suitable manner. The pump 39 has a pair of outlet fittings 42 and 43 to which one end of second conduits 44 and 45 are affixed. The opposite ends of the conduits 44 and 45 are connected to inlet fittings of respective delivery valves 46 and 47, each having a construction as shown in Figure 4.

Referring specifically to Figure 4, the delivery valves 46 and 47 each are comprised of an outer housing 48 having an internal cavity in which a solenoid winding 49 is provided. The winding 49 encircles a core 51. This cavity is closed by means

of a cover plate 52 that is affixed to an outwardly extending flange of the outer housing 48 with an interposed gasket 53 by means of threaded fasteners 54. The fasteners 54 also secure the delivery valves 46 and 47 to the side of the engine 19 and specifically the cylinder block 23 closely adjacent the lubricant pump 39 so as to minimize the length of the conduits 44 and 45. A mounting bracket 55 is affixed to the cylinder block 23 for mounting purposes.

An inlet passage 56 is formed in the cover plate 52 and receives the ends of the respective conduits 44 and 45 so as to permit lubricant to flow under pressure from the pump 39 into an internal cavity 57 formed within the cover plate 52. A slideably supported valve member 58 is mounted in the core 51 and has a ferromagnetic portion that is operated on by the winding 49 so as to effect a changing flow path from the lubricant pump 39.

A coil compression spring 59 normally urges the valve member 58 upwardly and opens communication with a delivery passage 61 formed centrally in the core 51 and which has an outlet fitting 62 formed at its lower end. A check valve 63 is connected to the outlet fitting 62 and functions to permit flow from the passage 61 to the engine, in a manner to be described, while precluding flow in the opposite direction. In addition, the check valve 63 will function to prevent any drainage of lubricant when the engine 19 is not running.

The check valve 63 includes a ball type valve member 64 which is urged by a coil compression spring 65 to a normally closed position. When the pressure is exerted in the passage 61, the ball valve member 64 will be urged downwardly against the action of the coil spring 65 and lubricant may flow from a discharge fitting 66 to the engine through conduits 67 and 68.

The conduits 67 and 68, as may be best seen in Figure 3, extend to lubricant discharges 69 and 71, respectively, which are tapped into the intake manifolds 31 and 32. Although in the illustrated system there is one lubricant fitting 69 and 71 for each intake manifold 31 and 32, it is to be understood that various other ways of delivering the lubricant to the engine 19 other than through its intake manifolds may be employed in conjunction with the invention. It is important, however, to note that the fittings 69 and 71 are positioned at a higher level than the outlet of the discharge fittings 66 from the delivery valves 46 and 47. This insures that lubricant also will not drain from the delivery valves 46 and 47 to the engine when the engine is not running. In addition, by providing the supply outlet fitting 62 at the lower portion of the delivery valves 46 and 47, it will be insured that air is less likely to flow through the delivery valves 46 and 47 to the engine.

Returning again to Figure 4, a return passage 72 is formed in the cover plate 52 and communicates with the chamber 57. The return passage 72 is normally closed by a seal 73 of the valve member 58 when the valve member 58 is in the position shown in Figure 4. However, when the solenoid winding 49 is energized, a seal portion 74 will engage and close the passage 61 while opening the return passage 72. Lubricant is then returned to the lubricant tank 35 through a pair of return conduits 75 and 76 which merge at a T-connection 77. The T-connection 77 is connected to a conduit 78 which extends back to a return fitting 79 of the lubricant tank 35 positioned above the normal lubricant level therein. Because of this elevated orientation, air which may be entrapped in the lubricant will flow by buoyancy upwardly and be collected in the chambers 58 for return along with the lubricant to the tank 35 during the non-delivery portion of the cycle.

It is desirable to insure that the return paths from each of the delivery valves 46 and 47 has substantially the same flow resistance. This will insure equal flow when the delivery valves are in either position and will prevent any irregularities in the amount of lubricant supplied to the engine 19. Therefore, the conduits 75 and 76 are configured to have the same effective cross sectional flow area and substantially the same length. Rather than use a T-connection as the connection 77, a Y-connection may also be employed and this will provide even greater balancing in the flow resistance in the two return paths.

As described in the aforementioned co-pending application Serial No. 862,984, the amount of lubricant delivered to the engine is controlled by varying the duty cycle and time when the solenoid winding 49 is energized.

In the embodiment as thus far described, the return lubricant has been returned directly to the tank 35. It is to be understood, however, that the lubricant may be returned anywhere to the system but preferably upstream of the filter 41. Flow may be returned either to the conduit 37 upstream of the filter 41 as shown by the alternative location 79' or to the upstream side of the filter element 41 as shown by the phantom line position 79'' in Figure 3.

The described system is extremely effective in insuring against variations in the amount of lubricant delivered to the engine as might be caused by air entrainment and also avoids against the draining of lubricant into the engine during such times when the engine is not operated. The foregoing feature is achieved by positioning the lubricant pump 39 and delivery valves 46 and 47 in close proximity to each other so as to minimize the length of the conduits 44 and 45. In fact, the delivery valves and

lubricant pump may be contained within a common body. In addition, the fact that the return outlet 72 is at the upper portion of the delivery valves also assist in air extraction. The low position off the supply outlet 62 and the use of the check valve 63 insures against draining of the lubricant to the engine when the engine is not operating. Of course, the foregoing description is that of a preferred embodiment of the invention and various changes and modifications may be made without departing from the spirit and scope of the invention, as defined by the appended claims.

In the embodiments of the invention as thus far described, the check valves 63 have been positioned in the supply outlet fittings 62 of the delivery valves 46 and 47. With such an arrangement, flow from the delivery valves 46 and 47 to the engine 19 when the engine 19 is not running will be precluded. In some instance, it may be desirable to locate the check valves at a different location and Figure 5 shows such an arrangement. Except for the locations of the check valves in this embodiment, all of the elements of the system are the same as that of the embodiment previously described and, for that reason, those elements will not be described again, except insofar as how they relate to this embodiment.

In this embodiment, there are no check valves in the supply outlet fittings 62 of the delivery valves 46 and 47. Rather, there are provided a pair of check valves 101 in the outlet from the pump 39 where it enters the conduits 44 and 45. The check valves 101 normally permit flow from the pump 39 into the lines 44 and 45 but preclude reverse flow. Also, when the pump 39 is not operating due to the fact that the engine 19 is not running, the check valves 101 will preclude any leakage of fluid past the pump 39 into the engine.

In the previously described embodiment, the location of the check valve 63 was such so as to preclude any leakage from the return line 78 back to the engine through the delivery valves 46 and 47. To prevent such return flow in this embodiment, a further check valve 102 is provided in the return line 78 at an appropriate location, and primarily downstream from the T or Y fitting 77. The check valve 102 will permit pressurized flow of lubricant back to the tank 35 through the line 78 but will preclude flow in the opposite direction as might occur when the engine is shut off.

It should be readily apparent from the foregoing description that the described systems are extremely effective in insuring good supply of lubricant to the engine when it is running and at the same time precluding any leakage of lubricant to the engine when it is shut down. In addition, the system also provides an arrangement whereby multiple delivery valves may be employed for con-

trolling lubrication delivery to various points in the engine and wherein the return systems for these multiple delivery valves is such that the flow resistance in a return line from all delivery valves will be substantially the same. Of course, the preceding description is that of preferred embodiments of the invention and various changes and modifications may be made without departing from the spirit and scope of invention, as defined by the appended claims.

Claims

1. Lubricating system (34) for an internal combustion engine (19) comprising an oil pump (39) driven by the engine (19), an oil supply passage means (38,44,45,67,68) for supplying lubricating oil from an oil tank (35) to the oil pump (39) and for delivering lubricating oil from the oil pump (39) to the engine (19), and a delivery valve (46,47) for regulating the supply of lubricating oil to the engine in response to the operating conditions of said engine (19), **characterised in that** the oil pump (39) and the delivery valve (46,47) are disposed in close proximity to each other, keeping the lengths of connecting conduits (44,45) between the oil pump (39) and the delivery valve (46,47) short.
2. Lubricating system as claimed in claim 1, **characterised in that** the delivery valve (46,47) is disposed downstream of the oil pump (39).
3. Lubricating system as claimed in claims 1 or 2, **characterised in that** the oil pump (39) and the delivery valve (46,47) are both disposed on the same side and in close proximity to the engine (19) or to a body supporting the engine (19).
4. Lubricating system as claimed in at least one of the preceding claims 1-3, **characterised in that** the delivery valve (46,47) is a three-way valve directing lubricating oil from a valve inlet (56) communicated to the discharge side of the oil pump (39) to either of a supply outlet (66) leading to the engine (19) or a return outlet (72) connected to a return conduit (78) leading to the oil tank (35) which returns excess oil to a portion of the system upstream of the delivery valve (46,47).
5. Lubricating system as claimed in claim 4, **characterised in that** the supply outlet (66) is disposed at a lower end portion of the delivery valve (46,47) while the return outlet (72) is disposed at an upper end portion specifically, at the highest point of said delivery valve (46,47).
6. Lubricating system as claimed in at least one of the preceding claims 1-5, **characterised in that** the outlet (30c,31c) of the oil supply passage means (38,44,45,67,68) at the engine (19) is disposed at a level above the supply outlet (66) of the delivery valve (46,47) to preclude the flow of oil to the engine (19) when the engine (19) is out of operation.
7. Lubricating system as claimed in at least one of the preceding claims 4-6, **characterised in that** the return outlet (72) of the delivery valve (46,47) is positioned above, specifically, vertically above the supply outlet (66) of the delivery valve (46,47) for self-purging of air from the system.
8. Lubricating system as claimed in at least one of the preceding claims 1-7, **characterised in that** the oil tank (35) is disposed at a level higher than that of the oil pump (39) and the delivery valve (46,47).
9. Lubricating system as claimed in at least one of the preceding claims 1-8, **characterised in that** an oil filter (41) is provided upstream of the delivery valve (46,47) and/or downstream of a return opening (79', 79'') of the return conduit (78).
10. Lubricating system as claimed in at least one of the preceding claims 1-9, **characterised in that** a pair of delivery valves (46,47) is disposed substantially in parallel to each other supplied with oil through a pair of connecting conduits (44,45) from a pair of supply outlets (42,43) of the oil pump (39).
11. Lubricating system as claimed in claim 10, **characterised in that** the oil return outlets (72) of both delivery valves (46,47) are connected to a joint return conduit (78) via return tubes (75,76) and a Y-type or T-type joint (77).
12. Lubricating system as claimed in at least one of the preceding claims 1-11, **characterised in that**

a check valve (63) is provided to permit oil flow towards the engine while precluding the flow of oil in the opposite direction.

13. Lubricating system as claimed in claim 12, 5
characterised in that
said check valve (63) is provided integrally with the delivery valve (46,47).
14. Lubricating system as claimed in claims 12 or 10
13,
characterised in that
said check valve (63) is disposed to control the supply outlet (66) of the delivery valve (46,47). 15
15. Lubricating system as claimed in claims 12 or 13,
characterised in that
said check valve (63) comprises a ball-type valve member (64). 20

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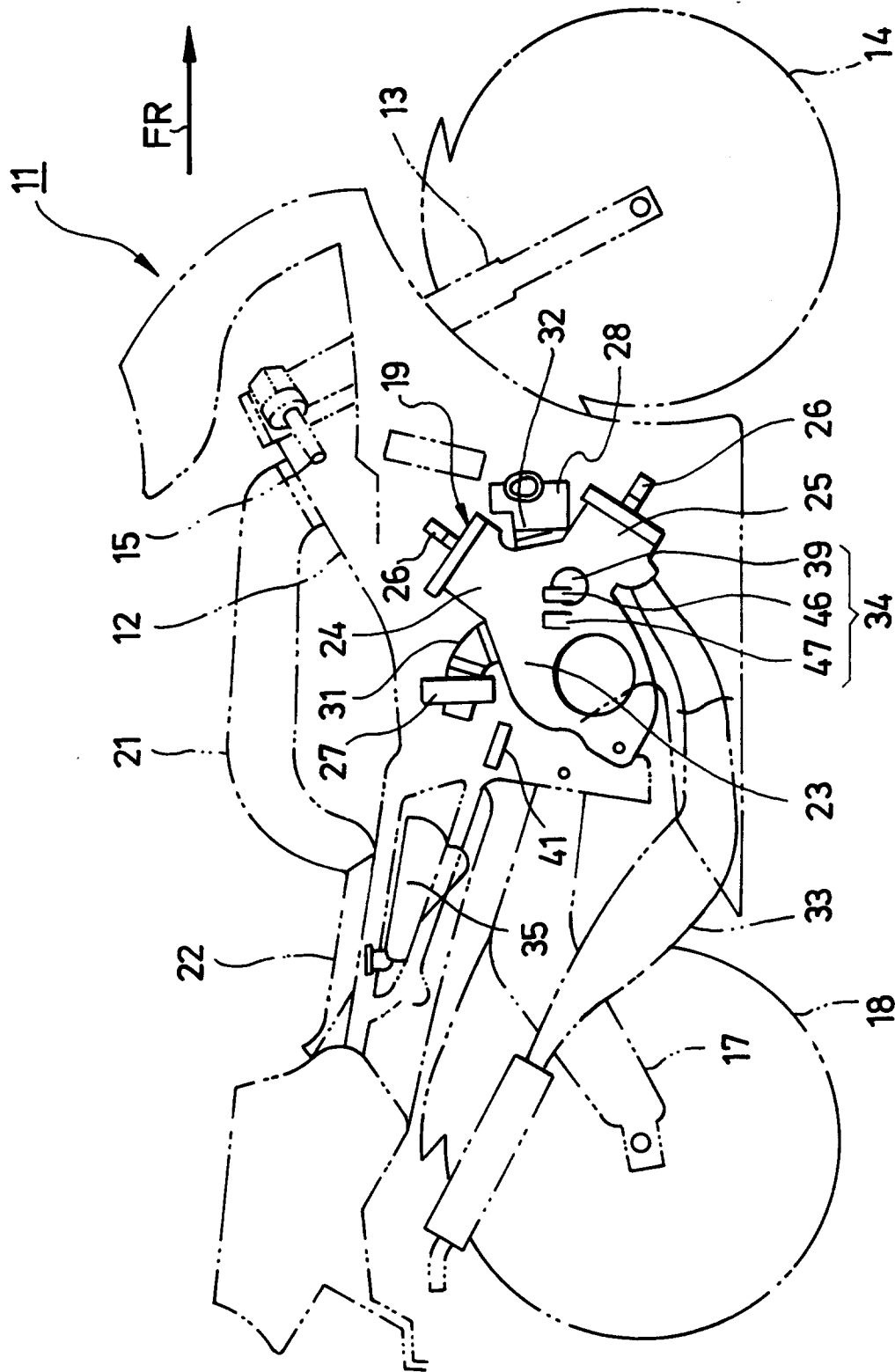
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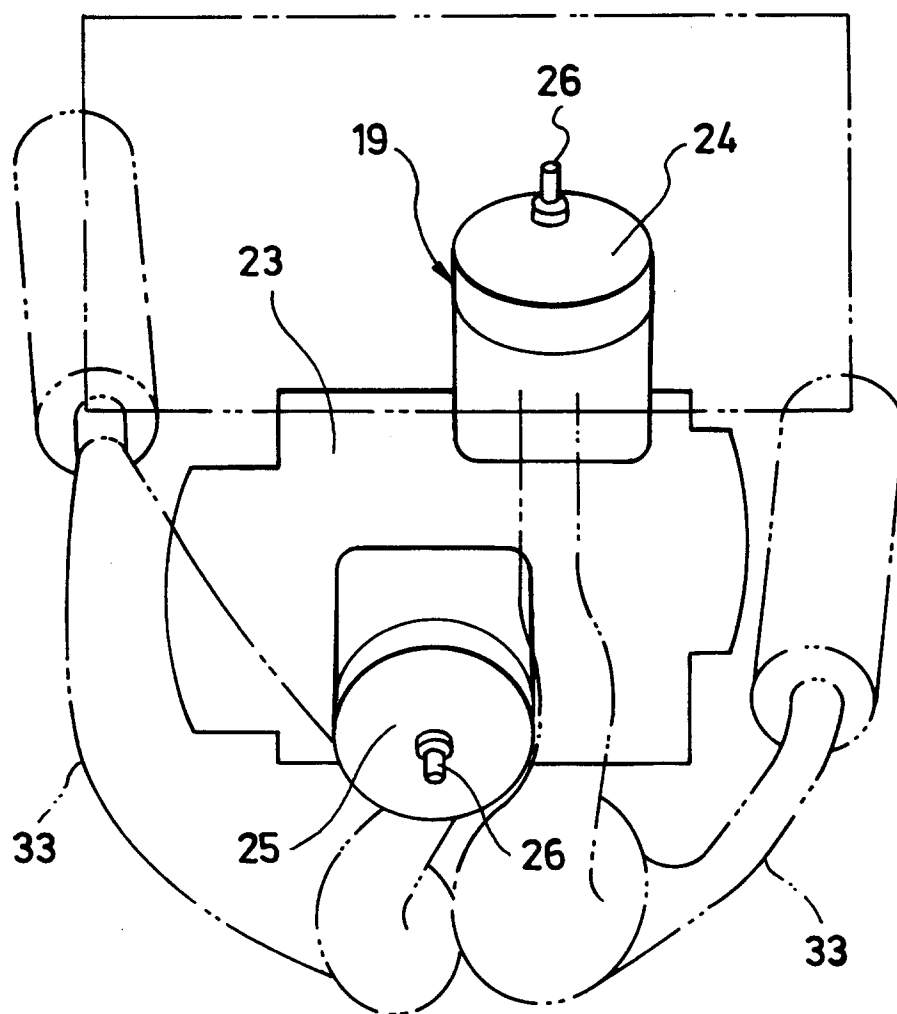


FIG.2

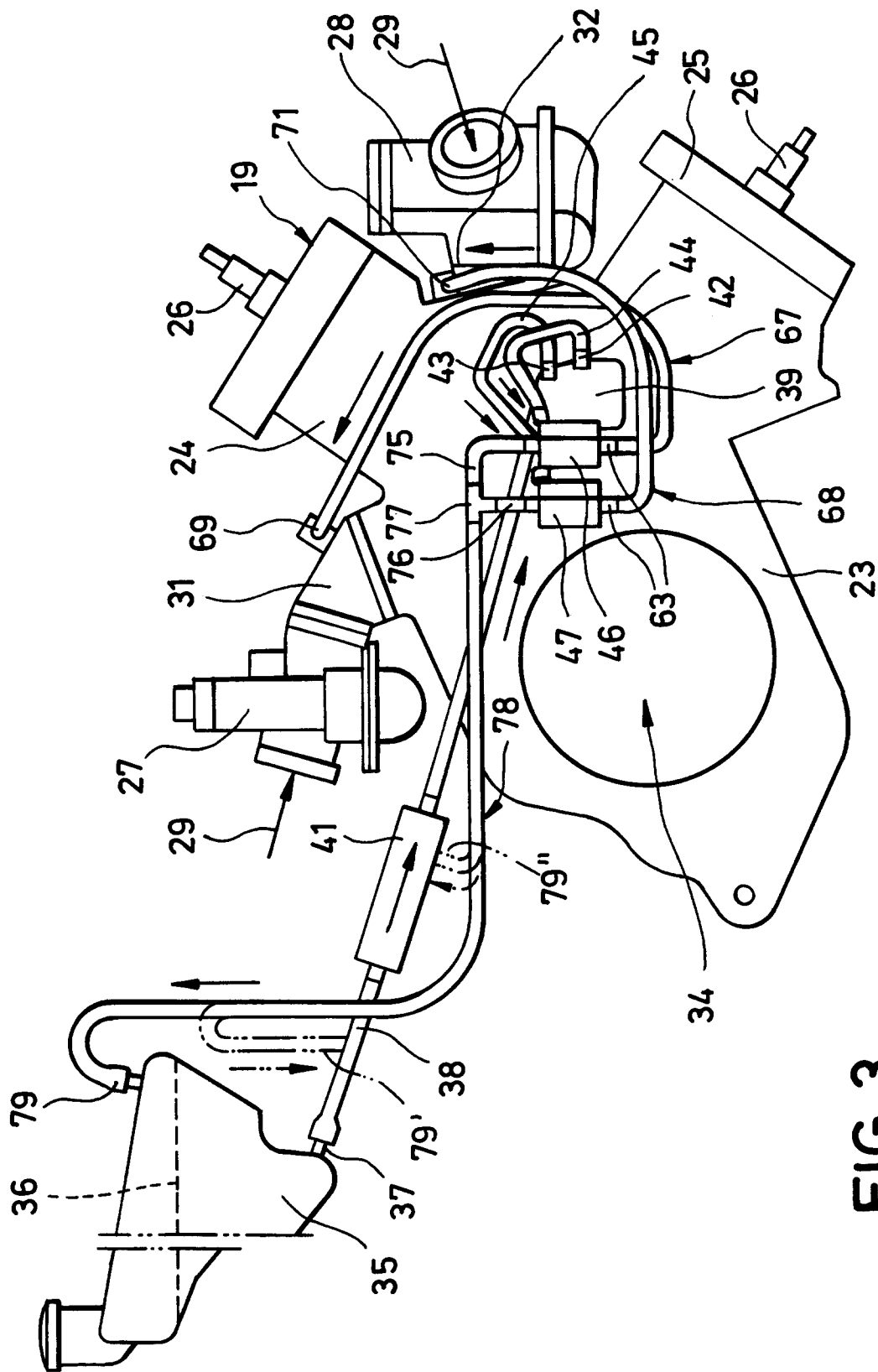


FIG. 3

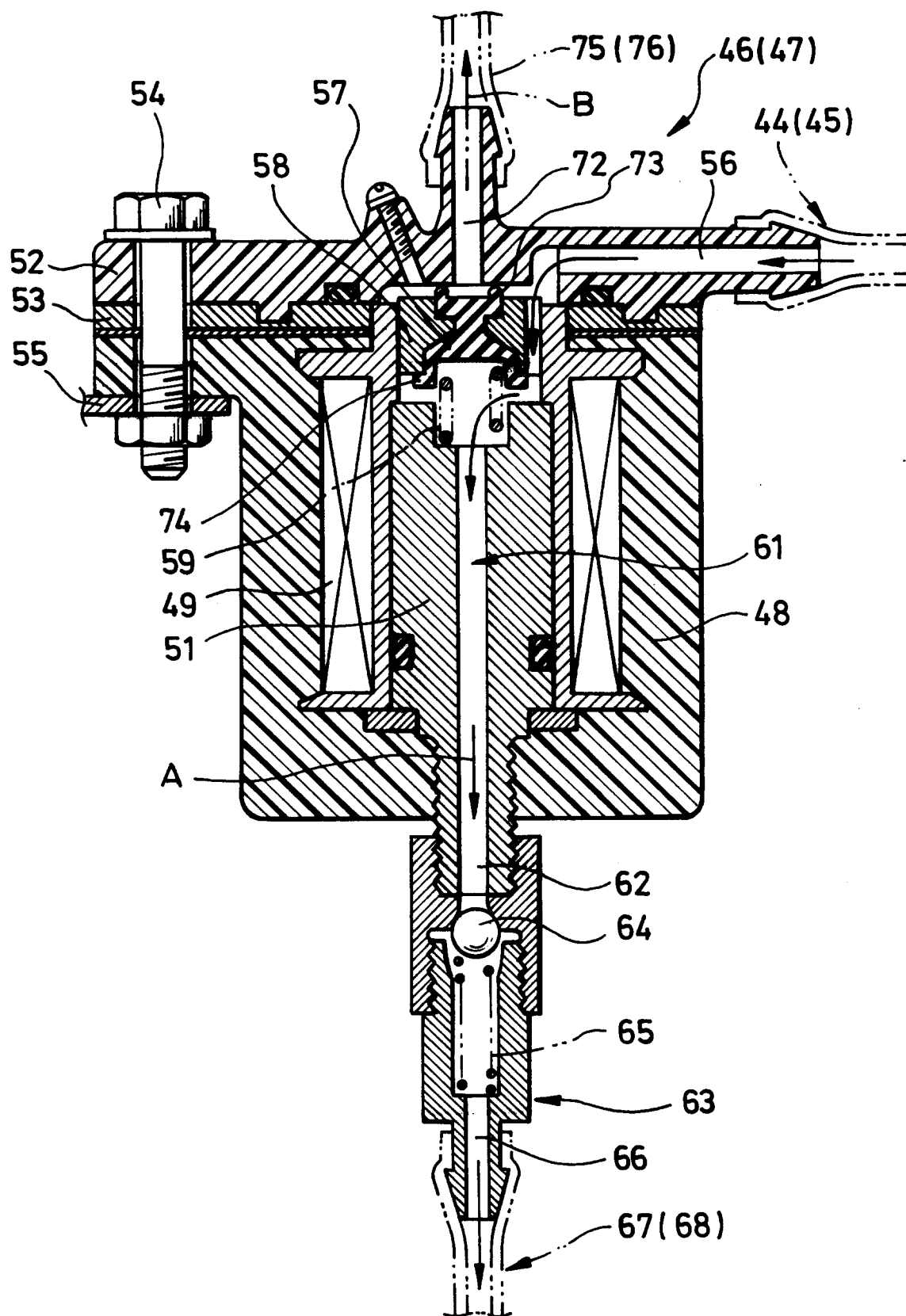


FIG. 4

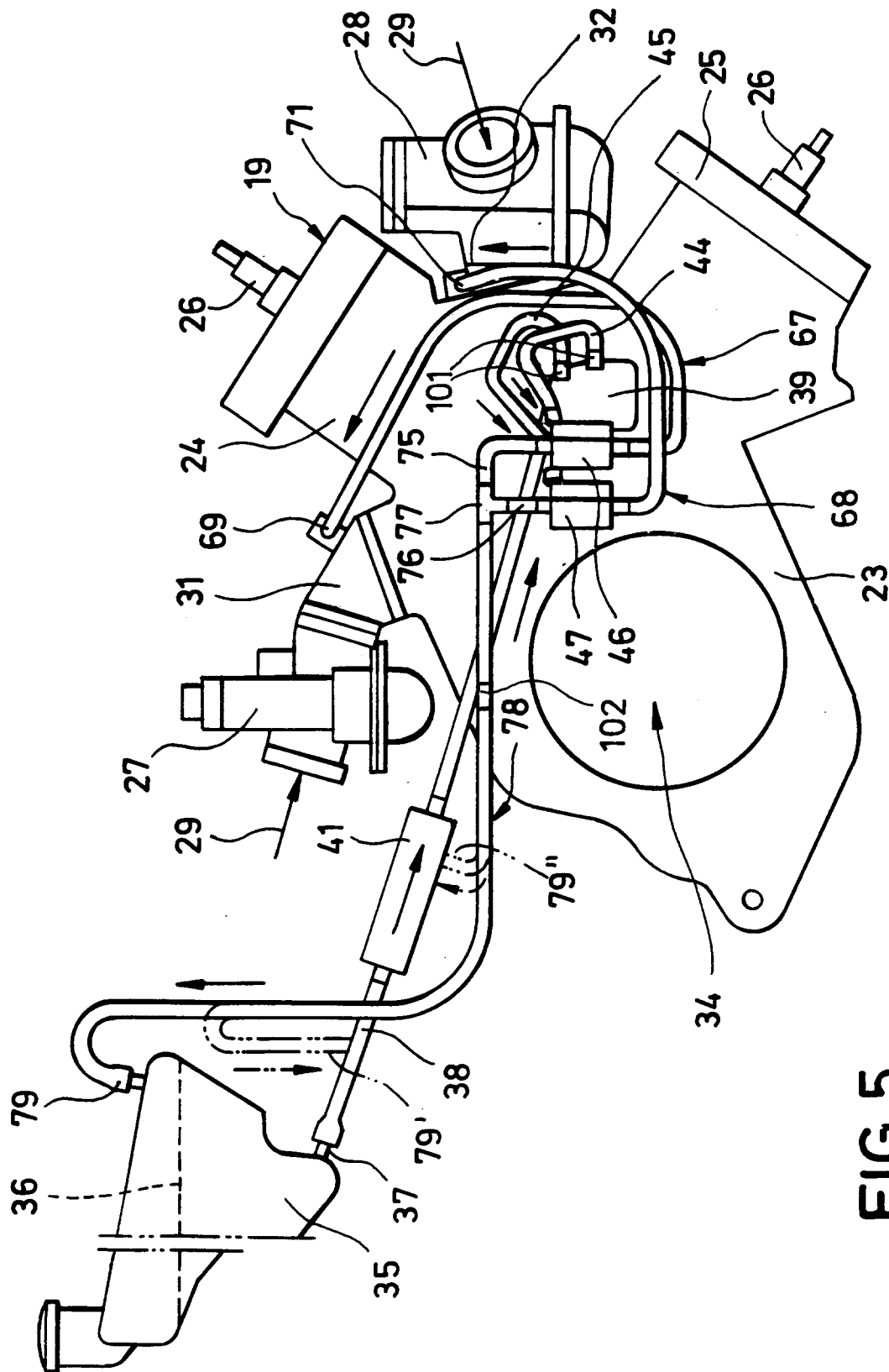


FIG. 5



European Patent
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EUROPEAN SEARCH REPORT

Application Number

EP 92 11 1479

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.5)
A	US-A-2 796 075 (FOCHT) * column 1, line 68 - column 2, line 39; figure 2 * ---	1,2,5	F01M3/02 F02B61/02
A	US-A-4 286 632 (ABEL) * abstract; figure 1 * ---	1	
A	DE-C-949 855 (VENEDIGER) * the whole document * ---	1,2,4	
A	PATENT ABSTRACTS OF JAPAN vol. 9, no. 231 (M-414)(1954) 18 September 1985 & JP-A-60 88 811 (SANSIN KOGYO K.K.) 18 May 1985 * abstract * -----	1,2,7	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			F01M F02B
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 10 FEBRUARY 1993	Examiner WASSENAAR G.C.C.
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			