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(54) Device for the combustion improvement of endothermic engines.

(57) According to the invention a device has the task of recovering and enriching the partially burnt fumes of endothermic engines, so as to make them suited to undergo further combustion.

The device comprises a tank (2) containing an enriching fuel, a tank (16) containing air under pressure and ducts (15, 21, 22) for connecting the tank (2) containing the enriching fuel both with the tank (16) containing air under pressure, and with the fuel and exhaust manifolds.

The partially burnt fumes recovered from the exhaust manifold are mixed with the enriching fuel through a mixing valve (37) and then they are sent back to the combustion chamber for a re-combustion, which in this case will be practically complete.

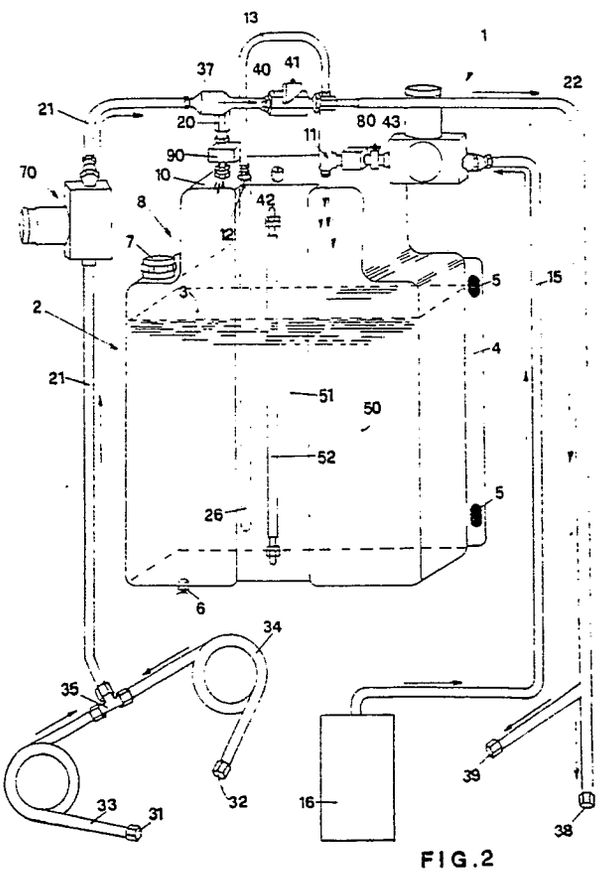

FIG.2

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DEVICE FOR THE COMBUSTION IMPROVEMENT OF ENDOTHERMIC ENGINES

The invention concerns a device for enriching the exhaust fumes of endothermic engines, so as to make them suitable to undergo further combustion. It is known, that one of the most relevant problems of internal combustion of endothermic engines arises from the fact that the combustion taking place within them is never complete. The presence of unburnt particles in the exhaust fumes does not only cause a power loss in the engine and, therefore a decrease in its performance, but they also entail an unjustified increase in fuel consumption.

Another inconvenience concerns the pollution created in the environment by an incomplete combustion, since through the exhaust fumes vapors of unburnt hydrocarbons and large quantities of CO (carbonoxide) are let into the atmosphere.

In compression ignition engines a gradual clogging of the air filters takes place, particularly during their performance. This leads to an increased amount of exhaust fumes and, therefore, to an increased degree of environmental pollution.

Some devices have been made with the purpose of improving the combustion efficiency in endothermic engines, so as to eliminate the above-mentioned inconveniences. One of such devices allows one part of the partially burnt fumes to be recovered from the exhaust manifold. They are then mixed with a combustion fluid and sent back to the combustion chamber, where they are burnt again, whereby their combustion is almost complete.

In said devices, the mixture of the enriching fuel with the part of exhaust fumes, which has been recovered from the manifold, is achieved by exploiting the depression caused by the piston during its down-stroke into the cylinder.

A first inconvenience of said devices is caused by the fact that, since the mixture of correcting liquid and the recovered exhaust fumes depends on the degree of depression occuring in the engine. it will not be possible to obtain a stoichiometrically constant mixture for each speed-rate of the engine. In fact, the amount of exhaust fumes sucked out of the manifold is a function of the cylinder depression and, therefore, of the number of revolutions of the engine. This makes it impossible to optimize the combustion at the different speed rates of the engine.

Another inconvenience of said systems arises from the fact that they cannot be applied to compression-ignition engines, wherein the piston in its down-stroke creates no suction in the feeding ducts.

It is the object of the present invention to eliminate the above-listed inconveniences.

The main object of the invention is a device to recover and enrich the partially burnt fumes of interal combustion engines, so as to allow their re-combustion, with the purpose of significantly reducing the percentage of unburnt particles and CO (carbon-oxide) contained in the exhaust fumes.

Another object of the invention is a device wherein the enrichment of the partially burnt fumes is controlled by compressed air, so as to optimize the stoichiometric ratio in the mixture and, as a consequence, the combustion at every speed rate of the engine.

Yet another object of this invention is to improve the thermodynamic performance of the engine by obtaining, at the same time, a marked reduction of fuel consumption. the power performance remaining unaltered.

Not the least object of the invention is an endothermic engine letting out fumes with very highly decreased polluting components.

The above-mentioned objects and others, which will be better described hereafter are obtained by a device for the recovery and the enrichment of partially burnt fumes of endothermic engines which, in accordance with the claims, comprises a tank containing a combustion fluid for the combustion improvent, a tank containing air under pressure and connecting ducts departing from the exhaust manifold and from a compressed-air tank and leading to said combustion-fluid tank and from said combustion-fluid tank to the fuel manifold of an endothermic engine, characterized in that the tank which supplies the fuel for the enrichment of the exhaust fumes is kept under a constant pressure by the compressed air let into said tank and supplied by another auxiliary tank in the vehicle.

The tank containing the enriching fuel supplies to the exhaust fumes vapors derived from the enriching fuel, so as to create a constant stoichiometric ratio, and it presents on its upper side two throug- going coupling sleeves connecting the duct coming from the compressed-air tank and an L shaped coupling connecting it both with the duct connected with the exhaust manifold and with the duct connected with the fuel manifold of the endothermic engine, wherein the L shaped coupling is connected with the ducts by means of a valve, which mixes the partially burnt fumes with the enriching fuel.

There are suitable means for the interception and the adjustment of the deliveries and pressures of the fluids, as well as checking and safety devices.

Advantageously, in the device according to the

invention the tank containing the enriching fuel is held at a constant pressure, so that the stoichiometric ratio between the enriching fuel and the exhaust fumes is also kept constant.

The application of the device of the invention to an endothermic engine, entails an increase in the thermodynamic performance of the engine and a marked decrease in fuel consumption.

The device according to the invention becomes particularly advantages and useful, when applied on compression-ignition engines, which, as it is known, often produce a large amounts of exhaust fumes with the consequence of a high rate of fuel consumption and a high degree of environmental pollution, especially if the engines in question have a large cubic capacity.

Another advantage of the device according to the invention consists in that, thanks to the remarkable decrease of the pollution factor, it makes it possible to use propelled vehicles with diesel engines even within enclosed areas such as, for instance, factories, warehouses and others, thereby avoiding the use of costly catalytic mufflers.

Not the least advantage obtained with the device of the invention is that the efficiency equals and sometimes exceeds the efficiency of a turbo-engine, the cost of which is enormously higher than that of an engine equipped with the device according to the invention.

Other characteristics and construction details will be better understood from the description of a preferred embodiment of the invention, which is given by way of example only but which is not meant to limit the scope of the invention, such as it is illustrated in the enclosed table of drawing, wherein:

- Fig. 1 represents the device according to the invention.
- Fig. 2 shows a different embodiment of the device of the invention.

The device according to the invention, which is indicated as a whole with 1 in Fig. 1, consists of a tank 2, made of metal sheet, containing an enriching fuel, such as ethyl alcohol, for instance, the free surface of which is indicated with 3. With reference to tank 2, it can be noticed that it is provided in its rear side with tabs 4 with holes 5 for the assembly on the vehicle, with a bottom plug 6 for the drainage and a filler 7 for the fill-up. Tank 2 has praticalley a symmetrical parallelepiped shape with the recesses 8 in its upper end section. Said recesses 8, which are also symmetrical, act as breakwaters, since they dampen the surges of the fluid free surface 3, when the vehicle is moving along a bumpy road or is turning around bends.

The coupling sleeves 11 and 12 which are connected together by duct 13, are inserted into the upper surface 10 of tank 2. Coupling sleeve 11 is a three-way coupling and it creates the connection of the interior of tank 2 with both duct 13 and with the pressure regulator 14 which lets in the compressed air coming through duct 15 from tank 16 holding the service compressed air of the vehicle. The pressure regulator 14 is adjusted for a pressure ranging from 0,2 to 0,3 bar, which is the value of the pressure, such as it is found within tank 2.

In Fig. 1 it can also be observed that the coupling sleeve 12 continues within the interior of tank 2 through duct 26 which lets in the compressed air on the bottom of tank 2, while the coupling sleeve 11, which has previously been mentioned, lets it in above the fluid free surface 3.

The pressure existing within tank 2 allows the fluid contained therein, for instance ethyl alcohol, to be changed into saturated vapor, so that the volume above the free surface 3 is completely saturated with alcohol vapor. The input of compressed air through the coupling sleeve 11 has, therefore, the task of creating a superior pressure front for the stabilization of the liquid surface 3 of the fluid and for the disintegration of the bubbles, constituting eventual fogs above the free surface 3.

On the upper surface 10 of tank 2, a L-shaped coupling 20 connects the interior of tank 2 both with duct 21 conveying the fumes recovered from the exhaust manifold, and with duct 22 delivering to the fuel manifold the exhaust fumes mixed with the enriching fuel contained in tank 2.

The device works as described hereafter.

By operating the general ignition switch of the vehicle, the electro-valve 30 is set into operation. It opens the connection between the compressed air tank 16 for the auxiliary services and the pressure regulator 14 of duct 15.

When the engine starts, the service compressor is immediately set into operation and it sets tank 16 under pressure, so that compressed air is sent through duct 15 and the pressure regulator 14 into tank 2 through the coupling sleeves 11 and 12.

Therefore, within a short period of time, a pressure comprised between 0,2 and 0,3 bar sets in within tank 2. This pressure changes the fluid contained therein into saturated vapor.

Through the couplings 31 and 32, which are connected with the exhaust manifold of the engine, approx. 60 to 70% of the exhaust fumes are recovered. Through the duct coils 33 and 34, the T-shaped coupling 35, whereby they are connected with duct 21 and the pressure regulator 70, they are conveyed inside the enriching mixer 37, which is connected through the L-shaped coupling 20 with the interior of tank 2. The mixer 37 is a Venturi-tube, wherein the exhaust fumes transform their pressure into speed, by sucking in through

the L-shaped coupling 20 some of the alcohol vapors contained within tank 2. Since said alcohol vapors are essentially made up of hydrogen, carbon and oxygen, they add to the mixture of partially burnt fumes, consisting essentially of CO (carbon oxide), some carbon and hydrogen molecules, which are combustible and some oxygen molecules, which have the task of further oxygenize the mass of partially burnt fumes. Thus, a new mixture is obtained, which, is conveyed through duct 22 and the couplings 38 and 39 into the fuel manifold, i.e. within the engine head, wherein it is burnt again, this time practically completely.

The pressure regulator 70, which is located in duct 21, upstream from the enriching mixer 37, has the task of adequately regulating the pressure of the exhaust fumes while they are conveyed into mixer 37. In fact, the engine gradually decreases its pressure as the number of kilometers driven increases, so that after a time it becomes necessary to adjust the degree of pressure of the exhaust fumes recovered from the exhaust manifold, so that the ratio between their pressure and the pressure which is present within tank 2 may remain constant in time. Thus a constant performance of the system for the enrichment of the partially burnt fumes is obtained.

In duct 22, immediately downstream from mixer 37, there is a manual regulator 40, which allows, by turning a screw 41, the most adequate dosage of the amount of partially burnt fumes to be recovered from the exhaust manifold, so as to obtain the optimum mixture for the re-combustion in the combustion chamber.

Since the pressure within tank 2 is higher than the atmospheric pressure, and in view of the high flammability of the fluid contained in tank 2, said tank must be made of highly resistant steel, having a thickness, such as to guarantee a high degree of safety. For this purpose, the device is also equipped with safety valves, which are indicated with 42 and 43 in Fig. 1. Valve 43 especially is calibrated for a pressure of approx 1,2 bar and it automatically shuts the connection of tank 16, containing air under pressure, with tank 2, should the pressure within duct 15 exceed the maximum value of 1,2 bar, thereby preventing the build-up of dangerous overpressures within tank 2.

Moreover, on the top surface 10 of tank 2 there is an overpressure valve 42, also calibrated for 1,2 bar, which allows the discharge into the atmosphere, if within tank 2 the maximum pressure, in this case 1,2 bar, is exceeded for whatever reason.

It can also be observed that the front side 50 of tank 2 has a groove 51, presenting a U-shaped section, containing a tube 52 made of transparent material, preferably nylon or plexiglass, which serves as a level indicator for the fluid contained in tank 2.

In order to avoid useless waste of the compressed air contained in tank 16, valve 30, which is of the normally closed type, only opens the passage between tank 16 and duct 15, when the general ignition key of the engine is turned, so that it is insured that tank 16 remains shut, when the engine is not running. If, because of maintenance operations, it becomes necessary to work on the electric system of the engine with the ignition key inserted, valve 30 is provided with a cock 60, which allows to manually interrupt the connection between tank 16 and duct 15, so as to avoid air losses from tank 16.

According to a different embodiment of the invention, such as it is shown in Fig. 2, the valve 30 of fig. 1, which interrupts the flow of compressed air when the engine is off, is replaced by an electrovalve 80, which is located between the safety valve 43 and the coupling sleeve 11, i.e. after the pressure regulator 14. Thus the electrovalve 80 works at a low pressure and, therefore, under improved conditions.

The embodiment represented in Fig. 2, shows another electrovalve 90, located before the L-shaped coupling 20 which is connected with the mixer 37, which is shut when the engine is off in order to prevent the fuel contained in tank 2 to leak into duct 22, thus allowing a further reduction of fuel consumption.

On the basis of the foregoing description, it can be understood, how the device according to the invention reaches all the proposed objects.

First of all, the object of drastically and almost completely reducing the percentage of unburnt particles, which are present in the exhaust fumes, has been reached. In fact, it has been understood how the recovery of one part of the exhaust fumes and their mixture with an enriching fuel, such as alcohol vapor, for instance, allows a re-combustion of the mixture thus obtained, so that the fumes, which had not completely burnt in the previous combustion, are totally burnt.

It is also obvious how the object of enriching the partially burnt fumes has been reached. The mixture thus obtained maintains a constant stoichiometric ratio at any speed rate of the engine. In fact, the device according to the invention creates the mixture by sucking the enriching fuel through a mixing valve 37, the delivery of which is optimized by means of a manually adjustable regulating valve 40. Moreover, the mixture with the enriching fuel is made at a strictly constant pressure, which is generated within tank 2, above the free surface 3, by the compressed air, which is let in by means of the pressure regulator 14.

The further object of increasing the thermody-

namic efficiency of the engine has also been reached. In fact, as it is well known to the experts of this branch that, other factors remaining unalterated, said efficiency improves proportionally in relation to the degree of combustion which can be obtained in the combustion chamber. At the same time, the device according to the invention causes a reduced fuel consumption.

The fact that all the above-mentioned objects have been reached, makes it possible to reach also the further object of obtaining exhaust fumes with a low polluting factor.

It can easily be understood that the just described device can be usefully applied on any kind of endothermic engine.

It is, however, obvious that it is most advantageous when applied on vehicles driven by powerful engines with compression ignition, such as, for instance, buses, trucks, earth-lifting and earth-moving equipment and the likes, which are characterized by high power and large cubic volumes, so that their fuel consumption and polluting factor are very high.

From the point of view of the efficiency, when the device according to the invention is installed and used on said engines, it also offers the advantages which are usually offered by turbocommpressors, at a highly reduced cost. In fact, various tests performed under different performance conditions have proved that the engines equipped with the instant device reach a better efficiency and performance, in some cases, than turbocompressed engines of equal power with a reduction of exhaust fumes, which, sometimes is up to 70%.

During its manufacturing stage, the invention may undergo variations of a constructive nature, which will, however, still be included within the scope of the invention.

Claims

1) A device for the recovery and the enrichment of the partially burnt fumes of endothermic engines, comprising a tank (2) containing a combustion fluid for combustion improvement, a tank (16) containing air under pressure and ducts (15, 21, 22) leading from the exhaust manifold and a compressed-air tank (16) to said tank (2) and from said tank (2) to the fuel manifold of an endothermic engine, characterized in that the tank (2) supplying the fuel for the enrichment of the exhaust fumes is kept at a constant for the pressure by means of compressed air let into said tank (2) and supplied from another service tank (16) of the motor-vehicle.

2) A device according to claim 1, characterized in that the tank (2) containing the fuel for the enrichment of the exhaust fumes, supplies combustion vapors to the exhaust fumes at a constant stoichiometric ratio, suitable means being present for the mixing of said vapors with said fumes.

3) A device according to claim 1, characterized in that the tank (2) presents on its upper surface (10) two trough- going coupling sleeves (11, 12) for its connection with the duct (15) coming from the compressed-air tank (16) and a L-shaped through-going coupling (20) for its connection both with the duct (21) connected with the exhaust manifold and with the duct (22) connected with the fuel manifold of the endothermic engine, whereby the L-shaped duct (20) connects itself to said ducts through a valve (37) for mixing the exhaust fumes with the enriching fuel, suitable means being provided for the interception of the deliveries and the regulation of the pressures of the fluids, as well as safety and control devices.

4) A device for the recovery and the enrichment of the partially burnt fumes of endothermic engines according to claim 1, characterized in that the tank (2) containing the enriching fluid is made of steel.

5) A device for the recovery and the enrichment of the partially burnt fumes of endothermic engines, according to claim 4, characterized in that the tank (2) presents in its upper side L-shaped breakwater-indentations (8).

6) A device for the recovery and the enrichment of the partially burnt fumes of endothermic engines according to claim 4, characterized in that the tank (2) presents on its front side (50) a groove (51) having a U-shaped cross-section suited to hold a level indicator (52).

7) A device for the recovery and the enrichment of the partially burnt fumes of endothermic engines according to claim 1, characterized in that a calibrated pressure regulator (14) lets into the tank (2) compressed air coming from a tank (16) containing air under pressure.

8) A device for the recovery and the enrichment of the partially burnt fumes of endothermic engines according to claim 7, characterized in that a coupling sleeve (11) downstream from the calibrated pressure regulator (14) lets compressed air into the tank (2) above the free surface (3) of the enriching fuel, while another coupling sleeve (12), connected with the former, lets compressed air into the same tank (2) at the bottom through a vertical duct (26) arranged within the tank (2).

9) A device for the recovery and the enrichment of the partially burnt fumes of endothermic engines according to claim 1, characterized in that between the compressed-air tank (16) and the pressure regulator (14) there is a normally-closed electrovalve (30) operated by the engine ignition key.

10) A device for the recovery and the enrichment of the partially burnt fumes of endothermic engines according to claim 9, characterized in that the electro-valve (30) presents a cock (60), which is operated manually and suited to shut off the compressed air.

11) A device for the recovery and the enrichment of the partially burnt fumes of endothermic engines according to claim 1, characterized in that the electrovalve (80), which is normally closed and is operated by the engine ignition key, is located between the pressure regulator (14), regulating the compressed air coming from tank (16), and the coupling sleeve (11) for the connection with the tank (2) containing the fuel.

12) A device for the recovery and the enrichment of the partially burnt fumes of endothermic engines according to claim 1, characterized in that the mixing valve (37) is a Venturi tube, the smallest section of which is connected with the L-shaped coupling (20) connected with the interior of the tank (2).

13) A device for the recovery and the enrichment of the partially burnt fumes of endothermic engines according to claim 1, characterized in that upstream of the mixing valve (37) there is a pressure regulator (70)

14) A device for the recovery and the enrichment of the partially burnt fumes of endothermic engines according to claim 1, characterized in that it presents an electrovalve (90), located before the L-shaped coupling (20), which is connected with the mixer (37).

15) A device for the recovery and the enrichment of the partially burnt fumes of endothermic engines according to claim 1, characterized in that the valve (40) with the manual regulator (41) for the delivery of the partially burnt fumes recovered from the exhaust manifold is downstream from the mixing valve (37) and upstream of the duct (22) leading the enriched mixture to the fuel manifold.

16) A device for the recovery and the enrichment of the partially burnt fumes of endothermic engines according to claim 3, characterized in that the tank (2) presents on its upper surface (10) a calibrated safety valve (42).

17) A device for the recovery and the enrichment of the partially burnt fumes of endothermic engines according to claim 8, characterized in that upstream of the coupling sleeve (11) letting the compressed air into the tank (2) and downstream from the pressure regulator (14) there is a safety valve (43) which can be calibrated.

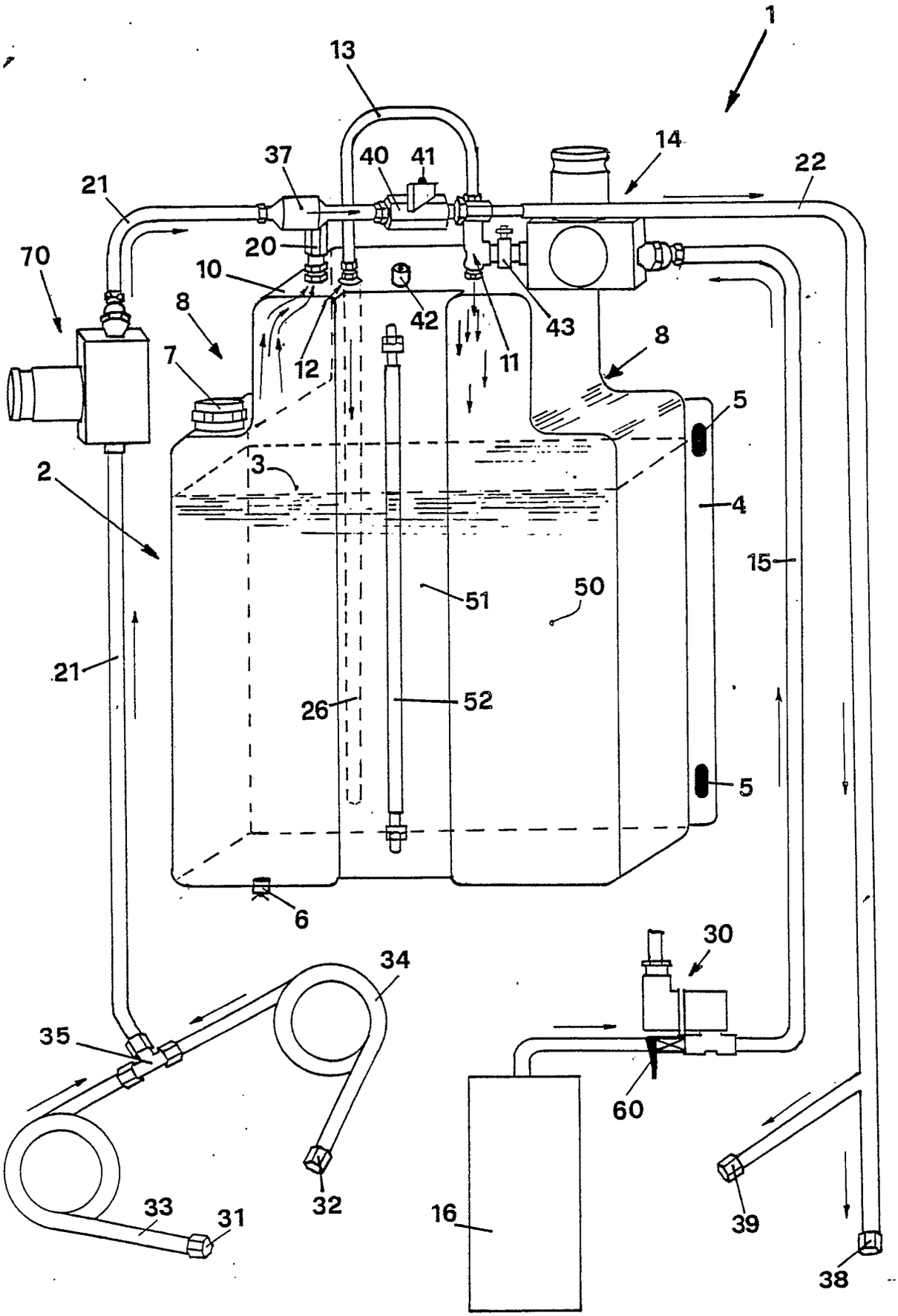
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FIG. 1

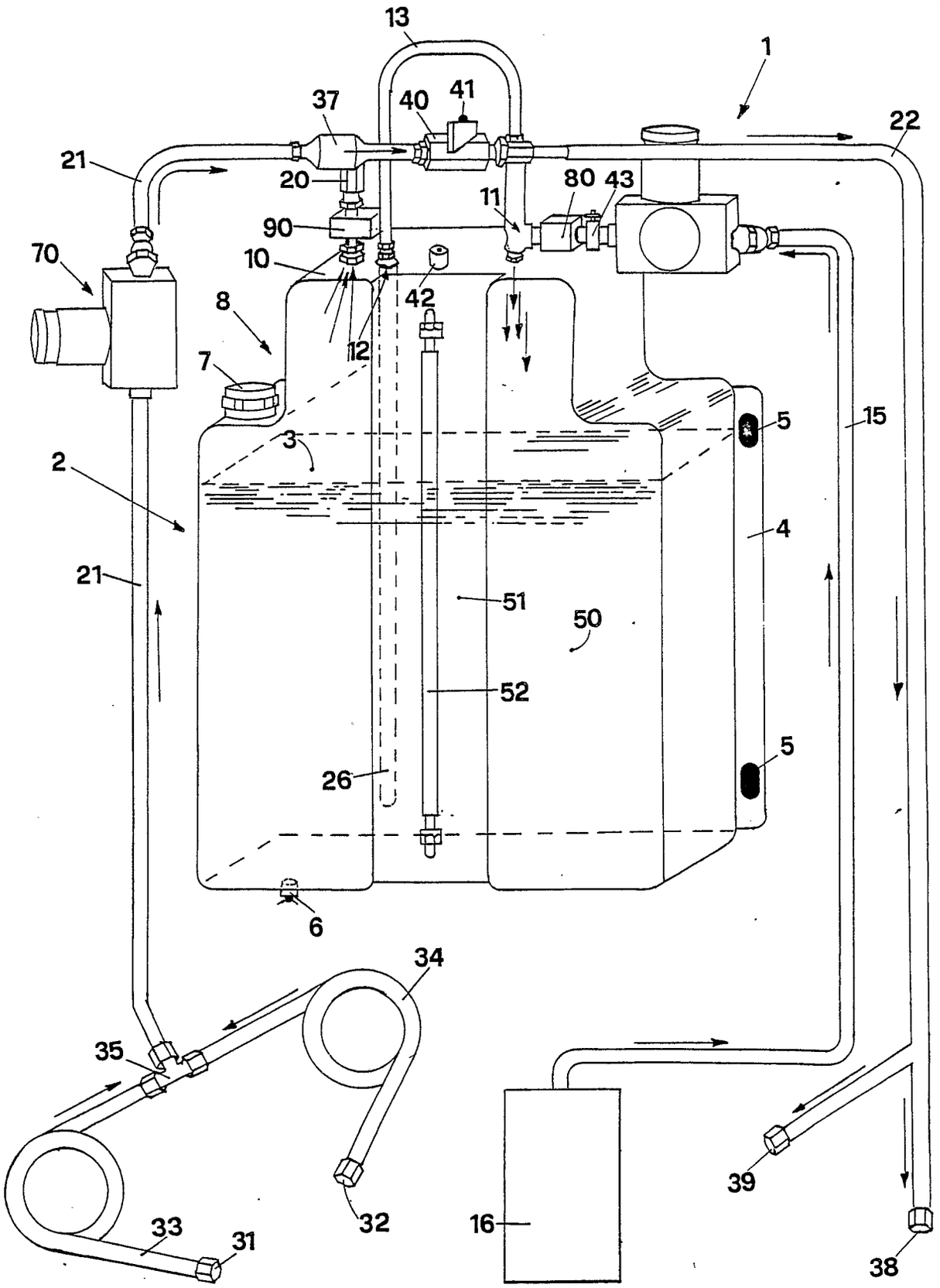
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FIG.2