

Description

Title of Invention : Venturi Effect Permanent Air Filter

Technical Field

[0001] This invention is in the field of fluid and solid mechanics and can be used in automobile air filters.

Background Art

[0002] Air filters have a long history. In the past, metal filters and greased fabric filters were used for this purpose, whereas today, filter papers are used in automobile engines and other industries. Such filters expire when fully saturated and have to be replaced.

[0003] The term “filter” draws the mind toward fabric or paper meshes. This constraint has limited innovations in this field. Considering the high viscosity of different liquids, various water filters are available nowadays; but they all suffer from two common drawbacks. To better understand their problems, it must be noted that according to fluid dynamics, in a water tube, the section area is inversely proportional to fluid velocity; i.e. reducing the section area shall result in reduced fluid pressure and remarkably increased fluid velocity.

[0004] Consequently, a major problem of the existing water filters is the fluid movement in the airflow direction. Some attempts have been made to address this problem by lowering the air velocity or increasing the tube section area. Therefore, most water filters are too large to be placed in a vehicle. Moreover, small water filters are only suited to low velocities. If they are to be used in home vacuum cleaners, water also moves in the same direction as the air due to the high velocity of airflow. Therefore, it requires an additional fabric filter beside waterproof electromotor and parts. However, this is not feasible in vehicles, and the old technologies cannot be used to filter the air used in vehicles. Fortunately, the proposed filter solves the said problems due to its unique technology and innovative features. It can be installed and operated in vehicle engines with no problems in any conditions. The precise component design of the filter is another critical performance parameter.

[0005] The previous inventions in this field are as follows:

<https://www.kaercher.com/my/home-garden/vacuum-cleaners/water-filter-vacuum-cleaners/ds-6-waterfilter-11952200.html>

Title: WATER FILTER VACUUM CLEANER DS 6 WATERFILTER

Multi-stage filter system consisting of innovative water filter, washable intermediate filter and HEPA 12 filter (EN 1822:1998)

The water filter vacuum cleaner invented by Kaercher does not use ejector technology. It uses multi-stage filters; i.e. in stage one, water absorbs the dust; but, due to high air velocity in the vacuum cleaner, water droplets flow in the airflow direction. Two sponge filters filter the air to prevent the water movement. The electric motor of said vacuum cleaner is waterproof.

[0006] <http://leisure.prior-it.co.uk/diy-build-pond-venturi.shtml>

Title: venturi effect air injection system

This device is used to inject gas into liquids for water disinfection. Structure and performance of this device are different from those of the invented filter.

It has a simple pipe structure and implements a restrictor inside and an air tube that extends above water level. Water is pumped through the venturi, and the restrictor creates a vacuum that sucks air in from the tube above water level and then mixes with water inside the venturi to cause bubbles that aerate the pond water. It is used to improve pond aeration and movement of water in the pond and increase the oxygen level in the water.

[0007] https://patentscope.wipo.int/search/en/detail.jsf?docId=CN159128781&tab=NATIONALBIBLIO&_cid=P22-KHUTPP-84041-1

Patent No.: CN204447607

Title: Venturi-tube pulse filter cartridge dust collector

The utility model discloses a venturi-tube pulse filter cartridge dust collector, which comprises a filtering chamber and an air purifying chamber, which are partitioned by virtue of a partition plate, wherein a blowing system comprises a blowing conduit, a round filter cartridge, a pulsed electromagnetic valve, a triangular filter cartridge support frame and a venturi blowing pipe; the triangular filter cartridge support frame is arranged in the filter cartridge; the venturi blowing pipe is arranged at the center position for mounting the filter cartridge; the filter cartridge is arranged in the filtering chamber in a manner of forming a constant

slope together with the horizontal direction; the blowing conduit is arranged in the air purifying chamber and is close to the venturi blowing pipe; an air inlet of the pulsed electromagnetic valve is connected with an air package pipeline through a movable joint; and an air outlet of the pulsed electromagnetic valve is connected with the blowing pipe through a hose. The filter cartridge dust collector disclosed by the utility model is reasonable in structure; the operation for mounting and repairing the pulsed electromagnetic valve is simple and feasible.

[0008] https://patentscope.wipo.int/search/en/detail.jsf?docId=US37179875&_cid=P22-KHUTRZ-84686-1

Patent No.: US4289511

Title: Bag-type filter apparatus with venturi-supported air diffuser

The invention is directed to the more effective cleaning of filter bags in a filter apparatus of the type having tubular venturis extending into the outlet ends of tubular supporting cages for the respective filter bags. Generally, such filter bags are cleaned by a periodic reverse flow of a jet of air into each venturi and thus through the filter bag. To enhance the cleaning of each filter bag, the present invention provides a hollow, perforated air diffuser tube communicatively connected to, supported by and extending from each venturi and longitudinally within the respective tubular cage and its surrounding filter bag so that, when a reverse flow of a jet of air is directed into the filter bag via the venturi, the diffuser tube diffuses and distributes the air throughout the filter bag so as to dislodge filtered particles along the length of the filter bag.

[0009] <https://patentscope.wipo.int/search/en/detail.jsf?docPN=EP0280430>

Patent No.: EP0280430

Title: Integrated engine air cleaner and venturi resonator

An integral air cleaner-noise silencer assembly includes a filter element (22) dividing the assembly into lower and upper parts (14,16), the upper part (16) constituting a lid or cover for the filter and including a funnel-like clean air outlet (44) containing a venturi (38) with as small a throat (40) as practical to provide a maximum restriction of noise with a minimum restriction to air flow, the air outlet and venturi being overlaid by a resonator chamber (28) having an annular inlet (50) surrounding and concentric with the venturi diffuser outlet (44) for

dampening the acoustical energy of engine sound waves, the venturi diffuser walls also reflecting the waves back toward the engine.

[0010] <https://patents.google.com/patent/US6261333B1/en>

Patent No.: United States Patent 6261333

Title: Air filter for an internal combustion engine having a primary air region and a secondary air region.

The invention relates to an air filter having a primary air region and a secondary air region separated by a barrier. The primary air region contains a filter element for filtering out particles in the primary air. The secondary air region is designed to receive crankcase emissions sent from an engine's crankcase. Crankcase emissions are a result of gas escaping past the piston rings and into the crankcase due to high pressures in the cylinder during compression and combustion. To aid in removing these gasses from the crankcase, a venturi is enclosed within the housing to increase the negative pressure within the housing and in the secondary air region. This increase in negative pressure draws crankcase emissions out of the crankcase and thus reduces oil and crankcase gas bleeding from the crankcase. In addition, because this venturi is enclosed within this housing, this invention can be used as a compact air filter and crankcase ventilator thus reducing the amount of space and materials needed for these two components.

[0011] <https://patents.google.com/patent/CN206823423U/en?q=CN206823423U>

Patent No.: CN206823423U

Title: Venture air filter

The utility model provides a kind of venture air filter, housing and the gas-liquid separation tower for being arranged on the case top; the top side wall of the gas-liquid separation tower is provided with gas outlet, and the sidewall bottom of the gas-liquid separation tower is provided with air inlet; the air inlet is connected with two-stage Venturi tube by the first pipeline, and the two-stage Venturi tube includes the first Venturi tube and the second Venturi tube, and the contraction section of the expansion segment and the second Venturi tube of first Venturi tube welds together; the gas outlet is connected by second pipe with being arranged on the negative-pressure air fan of the enclosure interior, and the negative-pressure air fan is connected with being arranged on the outlet pipe of

case top; fuel water tank is additionally provided with the housing, the foul water tank is located at the bottom of gas-liquid separation tower; hole for water spraying is provided with the top of first Venturi tube and the second Venturi tube, the hole for water spraying is connected by supply line with foul water tank. The utility model uses two-stage Venturi tube, to the filter efficiency of air up to 99%.

[0012] <https://patents.google.com/patent/KR100239672B1/en?q=KR100239672B1>
Patent No.: KR100239672B1

Title: Air filter

The air filter includes an inlet 1 for compressed air; A pre-filtration chamber (2) into which air is introduced from the inlet; Porous filter means (3) for passing air from the pre-filtration chamber to filter particulate matter from the air; A plurality of venturis 4 through which air passes from the porous filter means; An expansion chamber (5) in which air from the venturi expands and cools so that droplets of oil and water condense and accumulate at the bottom; Air outlet 6 from the expansion chamber

Disclosure of the Invention

[0013] To describe the proposed filter, the venturi (i.e., ejector) effect must be explained. In the ejector, primary fluid enters a nozzle and due to the reduced section area, gains a much higher velocity. Therefore, the primary fluid enthalpy turns into kinetic energy which results in dramatically reduced pressure. This creates a vacuum, after which the secondary fluid is dragged into the mixing chamber, where it mixes with the primary fluid and the resulting compound is ejected through the diffuser.

[0014] The distinctive and innovative aspect of this filter is the altered ejector system. In this filter, the mixing chamber is designed like a dome, and its outlet is embedded in the wall. The diffuser is at a 90-degree angle relative to the mixing chamber. Therefore, a large volume of liquid is trapped in the mixing chamber; that is, a large volume of liquid only circulates in the mixing tube while only a small amount enters the diffuser, where the remaining liquid returns to the storage tank through outlet conduits. Although the liquid can return to the storage tank easily, static electricity technology can be used to guide the liquid to the storage tank more. Therefore, the liquid cannot eject with the airflow, even at high

velocities and with strong shocks to the filter device. About 80 percent of the fluid constantly circulates in the mixing chamber, and only 20 percent entering the diffuser. The tapered shape of the diffuser significantly reduces fluid velocity, and due to the gravitational force and the static electricity technology, the liquid returns to the first tank near the nozzle through the outlets, thus reentering the ejector cycle.

[0015] The liquid absorbs dust particles in the mixing chamber; therefore, clear dust-free air flows through the diffuser toward the outlet. Moreover, a partition in front of the diffuser outlet stops the droplets.

[0016] This cycle iterates while the car engine keeps running. The moment the engine stops, the airflow halt stops the ejector, and mixing stops.

[0017] The filter features a liquid trap and a secondary storage tank. Therefore, if the driver suddenly brakes and the car stops, the liquid momentarily moves into the secondary storage tank due to the propulsion force and acceleration. Moreover, if the car moves downward in a sloped path, the said tank contains the excess liquid and prevents the fluid launch. As this secondary tank is sloped, the liquid quickly returns to the primary tank to return to the cycle.

[0018] When the car moves upwards on a sloped path, all of the fluid moves over the nozzle. This has no adverse effect on filter performance. When moving downwards, if the liquid level is adequately charged, the filter performs as desired. Note that the primary storage tank is designed to store a sufficient amount of liquid.

[0019] When the car is moving on a bumpy path with large obstacles, fluid droplets launch upward. At such times, a liquid trap and the static electricity technology over the filter holds the liquid. The ejector clamp is sloped, and during strong upward shocks, this clamp prevents liquid launch.

[0020] Venturi effect liquid pumping or suction greatly depends on airflow velocity. The filter tests indicate that fluid suction is relatively slow when starting a car, and therefore, filtering is slightly disrupted. However, as the engine speed increases, airflow also speeds up, and filtering performs well. This occurs when the liquid level in the primary storage tank is lower than the nozzle; therefore, it is proposed

to charge the filtering liquid such that it stands 0.5cm above the nozzle for proper mixing when starting the engine.

[0021] If the liquid level is 0.5 cm above the nozzle, when the engine is off, this 0.5cm volume enters the nozzle without affecting it; that is, if the engine is started, the liquid returns to the mixing chamber.

[0022] All filter components are made of hard rubber. Only the partition can be alternatively made of a fabric sponge. For the secondary fluid, motor oil with a viscosity of 5 or antifreeze liquid can be used, as they do not freeze in winter and provide high viscosity. If the filter is fabricated according to the dimensions and data in the blueprints, dust particles are entirely absorbed by the ejector fluid. The other advantage of this filter is washability and reusability. With a high dust absorption, this invention improves engine performance. Another advantage of the proposed filter in comparison with the similar products is the non-ejection of fluid due to smaller dimensions and usability in automobiles.

Technical Problem

[0023] The technology used in previous filters mentioned in the Background Art section only allows them to be used in large scales, as smaller scales reduce surface area of some points which increases airflow velocity and makes the liquid flow with the airflow; therefore the liquid exits the filter. Moreover, all similar filters must be mounted at a fixed point; that is, even a minor displacement launches liquid toward the outlet.

[0024] Another motivation for proposing this innovative air filter is the flaws in existing water and paper filters, that is:

- 1) No absorption of particles smaller than 20 micrometers, which increases fuel usage, air pollution, and global warming;
- 2) High consumption of paper despite its shortage;
- 3) Single-usage and non-reusability;
- 4) No absorption of particles when the filter is saturated;
- 5) Strong pressure drop when saturated, leading to low efficiency;
- 6) Human error in deciding the filter replacement time;
- 7) Water ejection at high velocities and inability to make filter smaller;

- 8) Multi-stage filter design and high saturation rate;
- 9) Water freezing or boiling.

[0025] Note that the invented filter rectifies the flaws of similar products despite its smaller size.

Some of the problems and flaws in similar filters are as follows:

[0026] <https://www.kaercher.com/my/home-garden/vacuum-cleaners/water-filter-vacuum-cleaners/ds-6-waterfilter-11952200.html>

Title: WATER FILTER VACUUM CLEANER DS 6 WATERFILTER

Multi-stage filter system consisting of innovative water filter, washable intermediate filter, and HEPA 12 filter (EN 1822:1998)

With a different system and functioning, this is a multi-stage filter that does not use ejector technology. That is, dust is first absorbed by water; however, due to the high air velocity in the vacuum cleaner, water droplets move in the direction of airflow. To prevent water movement, two sponge filters are placed in the path of air. Moreover, the electric motors in said vacuums are waterproof. Almost all water vacuum cleaners have the said problems. However, the proposed filter eliminates the flaws of Kaercher filter. It filters the air in a single stage, and fluid droplets do not move in the airflow path. Moreover, the proposed filter is smaller due to its innovative and precise design.

[0027] <http://leisure.prior-it.co.uk/diy-build-pond-venturi.shtml>

Title: Venturi effect air injection system

This device is used to inject liquids with gas for disinfection purposes. It has a different structure and design compared to the proposed filter. It does not control water volume and liquid discharge and cannot be manufactured in smaller scales. It also must be installed in a fixed place.

[0028] https://patentscope.wipo.int/search/en/detail.jsf?docId=CN159128781&tab=NATIONALBIBLIO&_cid=P22-KHUTPP-84041-1

Patent No.: CN204447607

Title: Venturi-tube pulse filter cartridge dust collector

This product has a different structure and performance, using a cartridge for filtering, and cannot be built in smaller scales.

[0029] https://patentscope.wipo.int/search/en/detail.jsf?docId=US37179875&_cid=P22-KHUTRZ-84686-1

Patent No.: US4289511

Title: Bag-type filter apparatus with venturi-supported air diffuser

This device employs a different structure and performance, using a bag filter.

[0030] <https://patentscope.wipo.int/search/en/detail.jsf?docPN=EP0280430>

Patent No.: EP0280430

Title: Integrated engine air cleaner and venturi resonator

This device has a different structure and performance, using elements for filtering.

[0031] <https://patents.google.com/patent/US6261333B1/en>

Patent No.: United States Patent 6261333

Title: Air filter for an internal combustion engine having a primary air region and a secondary air region

This device features a different structure and performance. It utilizes multi-stage filtering where separate filters the air in the first stage.

[0032] <https://patents.google.com/patent/CN206823423U/en?q=CN206823423U>

Patent No.: CN206823423U

Title: Venture air filter

This device features a different structure, performance, and dimensions, with multi-stage filtering.

[0033] <https://patents.google.com/patent/KR100239672B1/en?q=KR100239672B1>

Patent No.: KR100239672B1

Title: Air filter

This device has an entirely different structure and performance.

Solution to Problem

[0034] A new filter with better efficiency and newer technology is invented to solve the above problems. It uses a high-viscosity, bipolar intermediary liquid. However, one of the problems of liquid fluids is their movement with airflow. To tackle this problem, the venturi effect (or ejector) technology is utilized.

[0035] To trap the liquid fluid and prevent its exit, the ejector is modified, marking one of the distinctions and innovations of the proposed filter. In this filter, the mixing chamber is designed like a dome, and its outlet is embedded in the wall. The

diffuser is angled 90 degrees relative to the mixing chamber. This modified structure allows to trap a large volume of liquid fluid in the mixing chamber; that is, a large volume of liquid fluid only circulates within the mixing tube, and a small amount enters the diffuser. Thereafter, the remaining the liquid returns to the storage tank through the outlet conduits. Therefore, the liquid cannot eject with the airflow, even in the case of high velocities and displacements of the filter.

[0036] Utilizing antifreeze or motor oil with a viscosity grade of 5 prevents the liquid fluid from freezing or boiling.

[0037] The filter is designed such that filtering is performed in a single stage, with a negligible pressure drop in the path. If the liquid fluid saturates, the liquid becomes slightly stiff but still has a much lower pressure drop compared to its peers.

Advantageous Effects of Invention

- [0038] 1) High dust absorption power (even particles smaller than 20 micrometers);
2) No pressure drop in the air path;
3) Reduced fuel usage and pollution due to the higher absorption and much lower pressure drop in the path of airflow;
4) Washable and reusable;
5) Enhanced efficiency and strength ;
6- Being economical and cost-effective;
7) No paper usage and eco-friendliness;
8) Simpler repair and maintenance;
9) Single-stage air filtering;
10) Smaller scales compared to counterparts.

Brief Description of Drawings

[0039] [Fig.1] Front view of ejector schematics (venturi effect);

[0040] [Fig.2] Front and side views of ejector modifications;

[0041] [Fig.3] Filter cross section (through line B) for a better representation of the interior. [Table1] lists the parts.

[Table1]

No.	Description
1	Unclean air inlet
2	Nozzle
3	Fluid charge cap
4	Mixing chamber
5	Ejector clamp
6	Filtered air outlet
7	Filter cap gasket
8	Filter cap
9	Damper
10	Liquid trap
11	Separating partition
12	Diffuser
13	Storage tank #2
14	Fluid outlet
15	Storage tank #1
16	Fluid discharge cap
B	Section line
N	North direction

[0042] [Fig.4] Filter dimensions in centimeters.

[0043] [Fig.5] 3D filter schematics.

[0044] [Fig.6] Schematics of the function cycle and liquid flow with the static electricity technology.

Detailed Description

[0045] Venturi effect air filter comprises the following parts:

Nozzle, Fluid charge cap, mixing chamber, ejector clamp, filter cap gasket, filter cap, damper, liquid trap, fabric-made separating partition, diffuser, storage tanks, and the filler and fluid ejector cap.

[0046] Unclean air enters through the inlet (#1) and then gains velocity via the nozzle (#2). The liquid fluid in the tank (#15) is sucked by the unclean air into the mixing chamber (#4). There, the liquid fluid mixes with air and absorbs dust particles. After that, a small part of the liquid fluid enters the diffuser and is directed to the tank (#15) through the outlet conduits (#14). The tapered shape of the diffuser significantly reduces fluid velocity, and due to the gravitational force and the static electricity plates, the liquid returns to the first tank (#15) near the nozzle through the outlet conduits, thus reentering the ejector cycle.

[0047] The filtered air moves from the upper part of the diffuser (#12) to the outlet (#6). The filter includes a liquid trap (#10) and a secondary storage tank (#13). If the driver suddenly brakes and the car stops, the liquid fluid moves into the secondary tanks due to the acceleration force. Moreover, if the vehicle moves downwards on a slope, this tank collects the excess liquid fluid, thus preventing it from leaking. The cap (#16) is used to drain the liquid fluid when washing the filter, whereas the cap (#3) is used to recharge the fluid liquid.

Industrial Applicability

[0048] The proposed filter is designed for automotive industries; however, it can also be used in other industries requiring dust absorption. This air filter is designed for Pride branded automobiles, with its dimensions suited to this car. It is made of hard rubber and a mold created for the filter according to the drawings allows for mass production via rubber injection. Nevertheless, for manufacturing, the filter components are built separately, a mold for ejector parts and another mold for the filter shell. As such, the filter can be disassembled and reassembled, or washed, by the user. All surfaces of the filter must be flat, and the part dimensions and spacings must be fabricated in proportional scale to the drawings not to disrupt performance. The filter cap must be sealed with a rubber gasket

and screw. The level of liquid fluid must cover 0.5 cm above the ejector nozzle at maximum.

Claims

[Claim 1] | The design and fabrication of a permanent air filtering device based on venturi effect, which is washable and functions by the absorption of dust particles via a liquid fluid.

The filter components are housed in a plastic shell and can be separated for utilization. These parts consist of:

Nozzle;

Fluid charge cap;

Mixing chamber;

Ejector clam;

Filter cap gasket;

Filter cap;

Damper;

Liquid trap;

Non-paper partition;

Diffuser;

Two storage tanks;

Fluid discharge cap;

[Claim 2] According to Claim 1, the design and configuration of the liquid trap and storage tank prevent the leaking of liquid in the direction of airflow during strong shocks and displacements of the filter.

[Claim 3] According to Claim 1, the proposed filter combines a venturi effect system, liquid trap, and storage tank in a configuration that reduces the scales. However, despite this smaller scale, the liquid fluid does not move with airflow at high velocities.

[Claim 4] According to Claim 3, the end of the mixing chamber is shaped like a dome, and its outlet is embedded in the wall. The diffuser is angled 90 degrees relative to the nozzle and the mixing tube. This modification/innovation in the ejector causes about 80 percent of the liquid in the mixing chamber to constantly circulate (with centrifugal force), and therefore only 20 percent moves toward the diffuser. Considering this modification in the ejector, this filter benefits from an innovation.

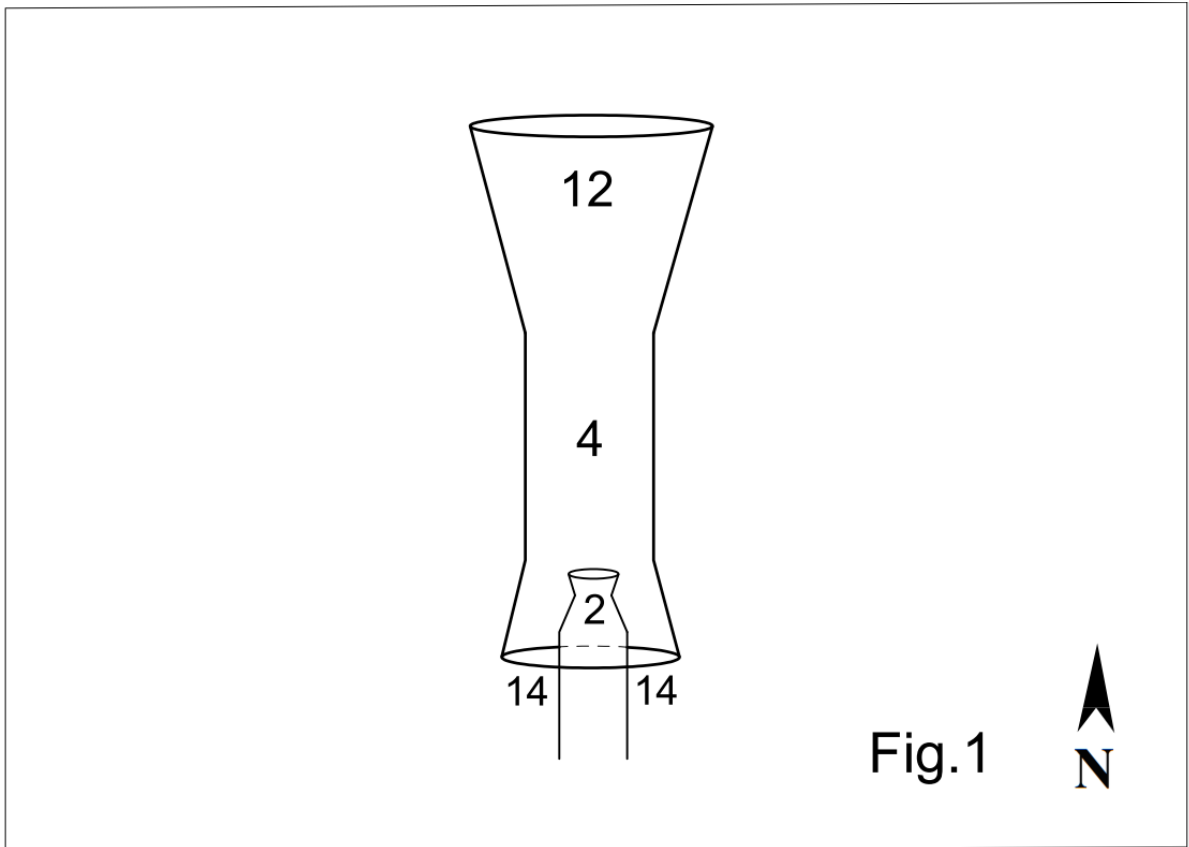
[Claim 5] According to Claim 4, the symmetrical tapered design of the diffuser and the implementation of 3 dampers increases the section area, thus significantly reducing fluid velocity. This in turn separates the remaining liquid fluid from the air due to its heavier weight, returning it to the cycle. Therefore, this invention claims to have a cyclic process. |

Abstract

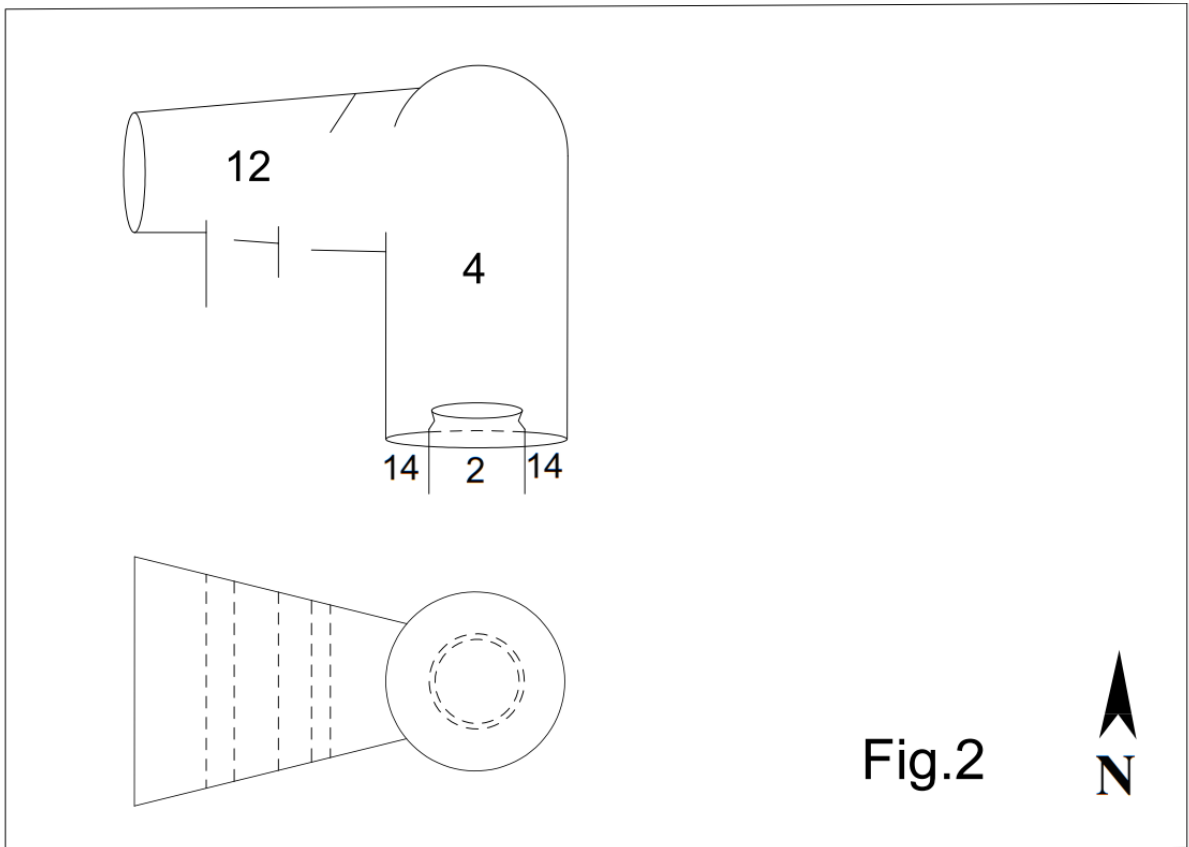
The venturi effect permanent air filter modifies the ejector to absorb the unclean air via a liquid fluid (antifreeze or motor oil). The invention includes a 90-degree dome-shaped ejector, a liquid trap with the static electricity plates, and storage tanks. This filter can solve automobile problems such as:

- 1) Non-absorption of particles smaller than 20 micrometers, which increases fuel consumption, pollution, and global warming;
- 2) High consumption of paper despite its shortage;
- 3) being single-use and non-reusability;
- 4) Incomplete absorption of dust particles;
- 5) Strong pressure drop when saturated and the resulting low efficiency;
- 6) Water leakage at high velocities and inability to reduce filter size. |

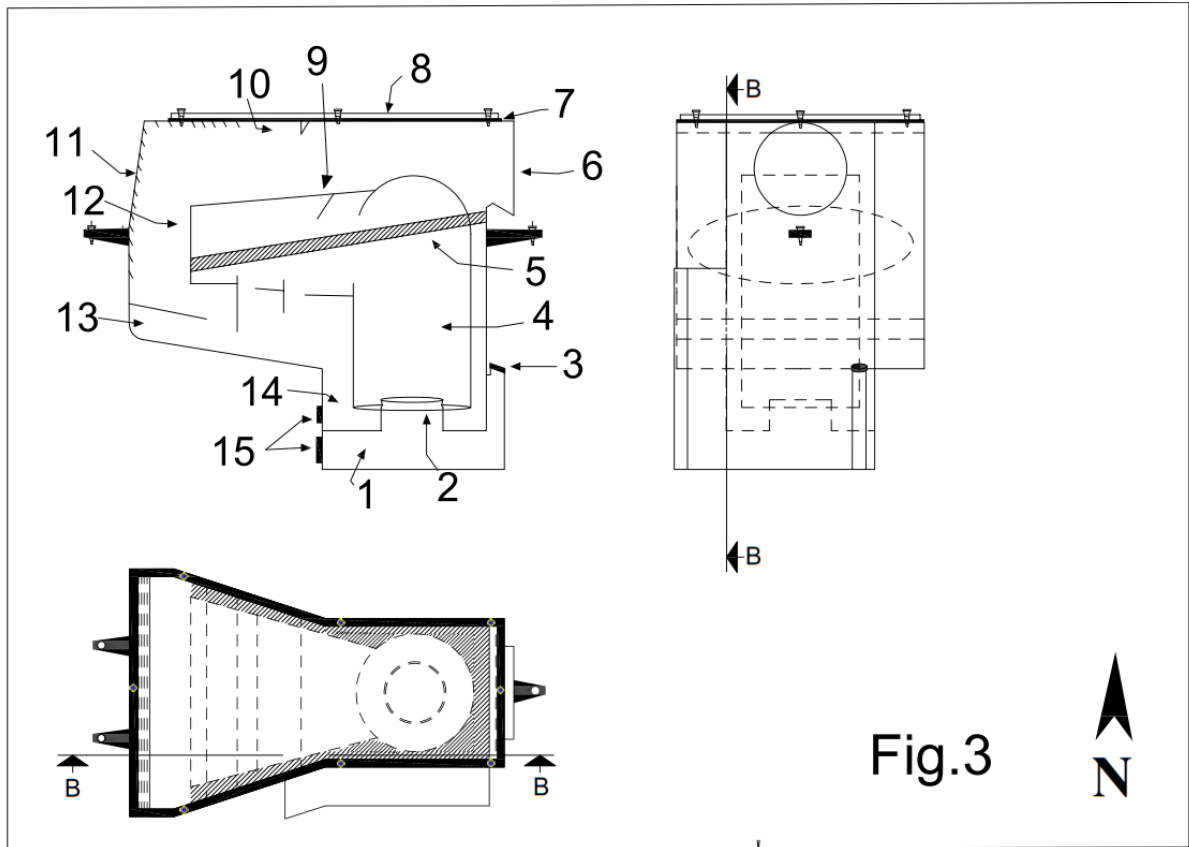
[Fig.1]



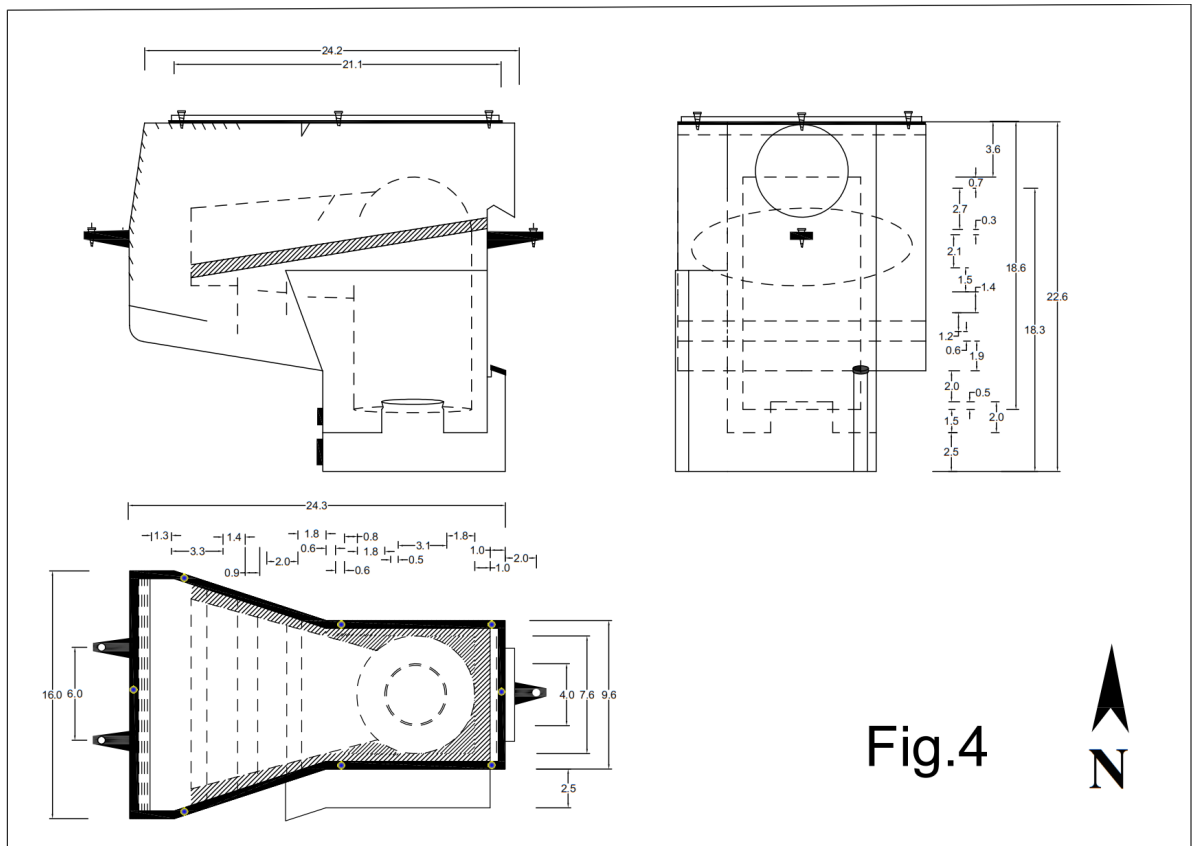
[Fig.2]



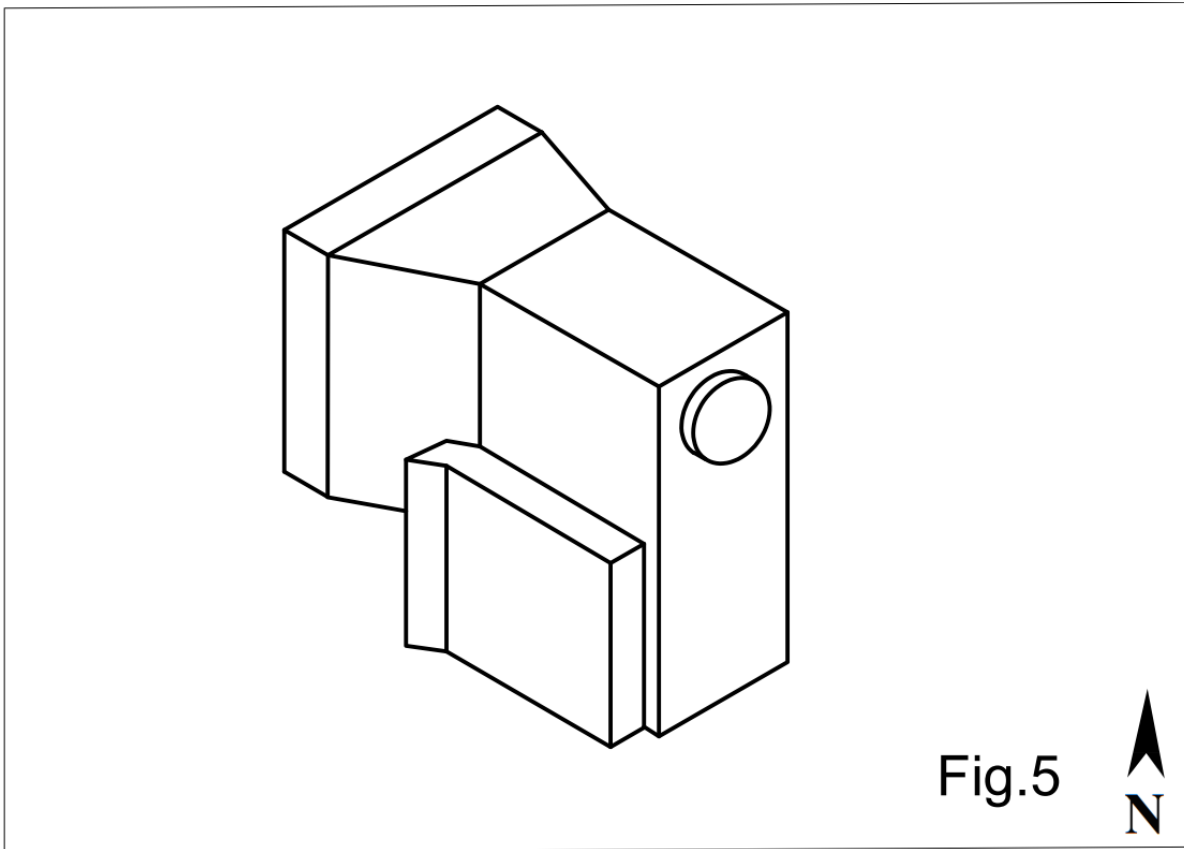
[Fig.3]



[Fig.4]



[Fig.5]



[Fig.6]

