# United States Patent

**Everroad**

[15] **3,688,780**

[45] **Sept. 5, 1972**


[54] **AIR FILTER CLEANING METHOD**


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[22] Filed: **March 19, 1971**

[21] Appl. No.: **126,171**

**Related U.S. Application Data**

[62] Division of Ser. No. 839,400, July 7, 1969, Pat. No. 3,620,234.

[52] **U.S. Cl.** .....**134/21,** 134/36, 134/37

[51] **Int. Cl.**.....**B08b 3/02,** B08b 5/02

[58] **Field of Search**.....134/21, 30, 37, 36, 166 R, 134/167 R, 168 R, 169 A, 88, 89, 102, 170, 171, 179, 180, 200; 15/302, 320



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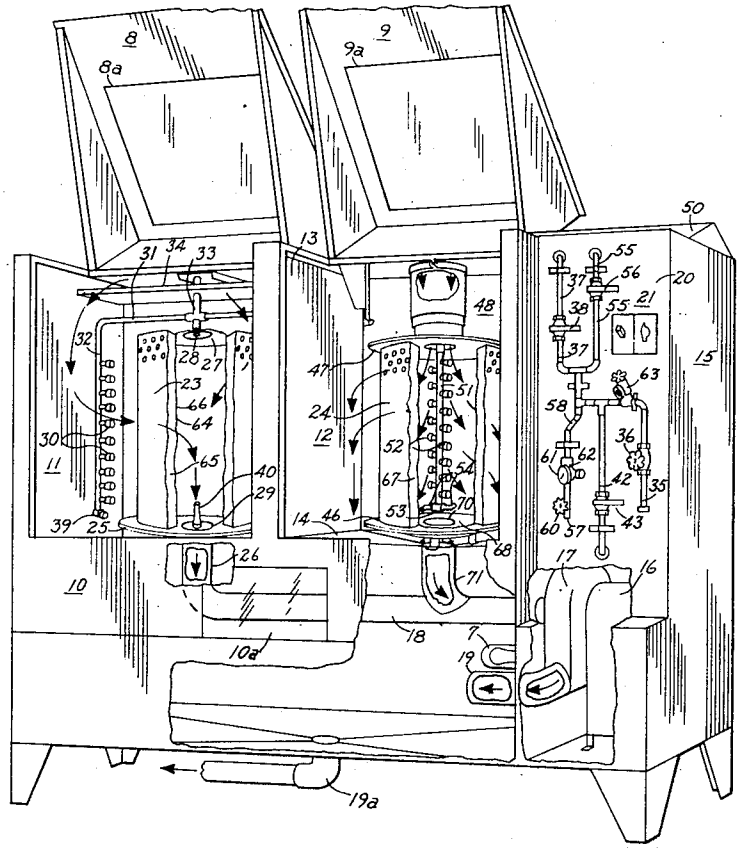
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[57] **ABSTRACT**

A method for cleaning air filters of the accordion folded paper type comprises spraying liquid over the filter wall on the side opposite the collected residue, concurrently passing air through the filter in the same direction, then discontinuing the flow when the discharged liquid is clear and similarly producing flows of liquid and air through the filter in the opposite direction and discontinuing when the liquid is clear.


**4 Claims, 11 Drawing Figures**



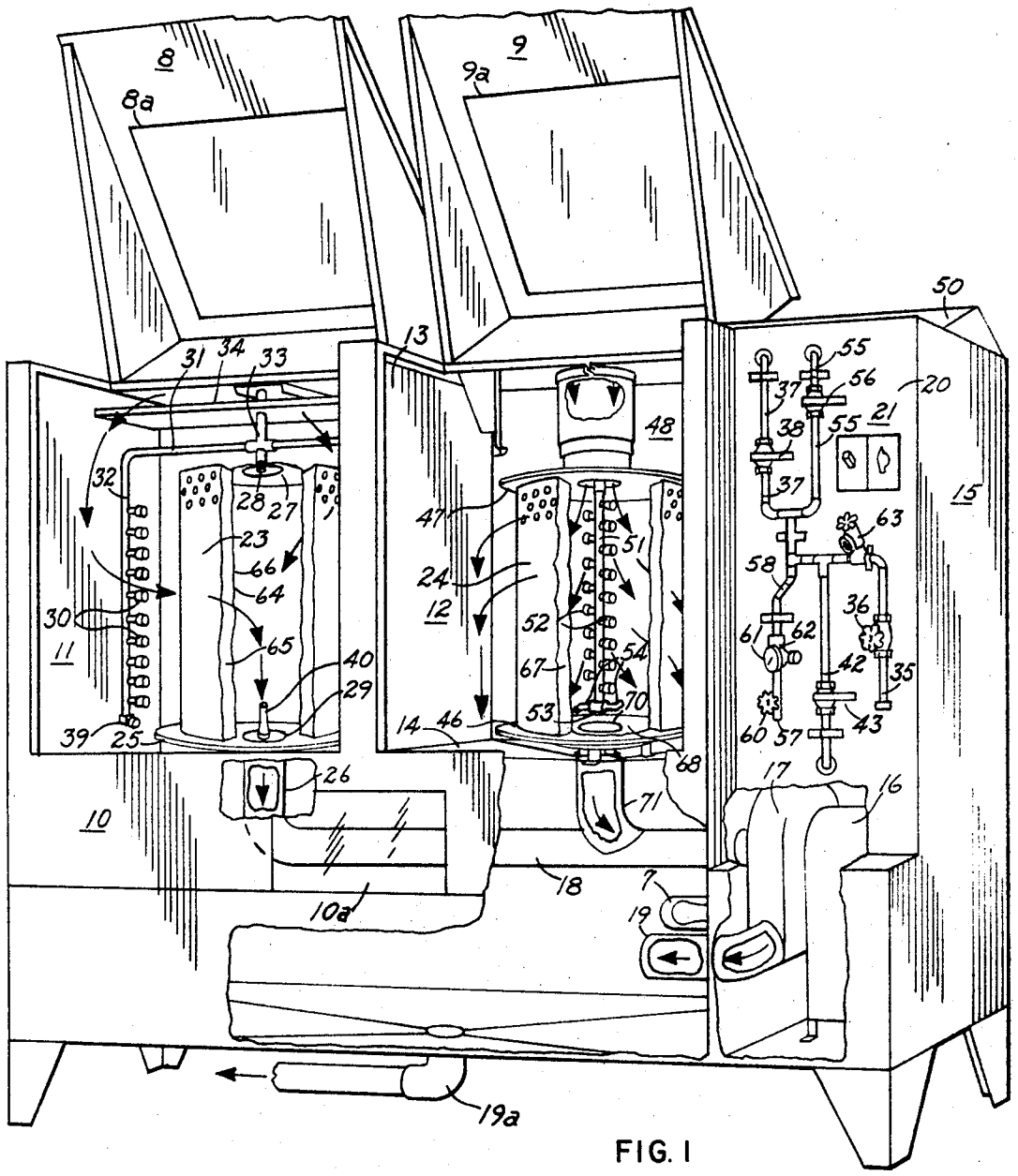



FIG. 1

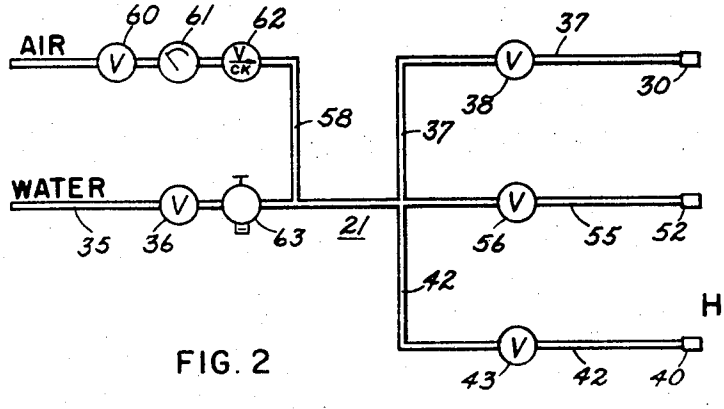



FIG. 2

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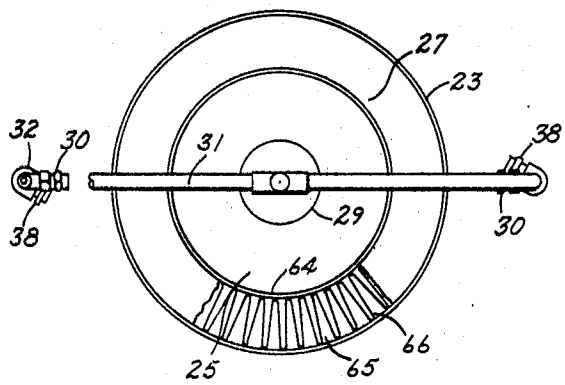



FIG. 3

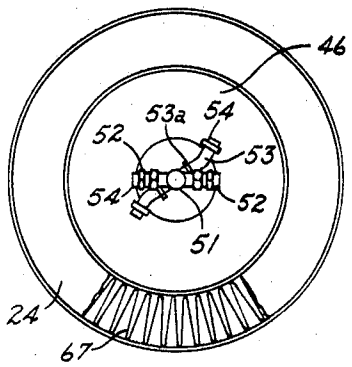



FIG. 4

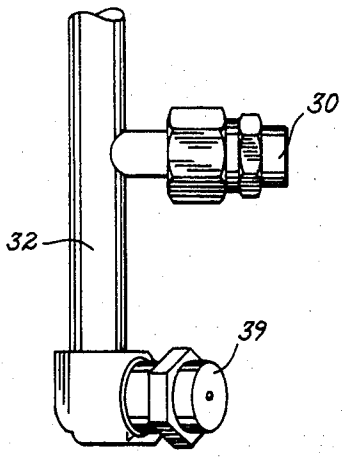



FIG. 5

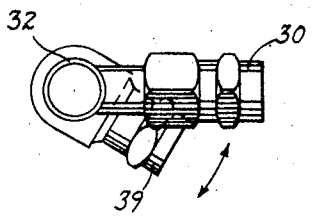



FIG. 6

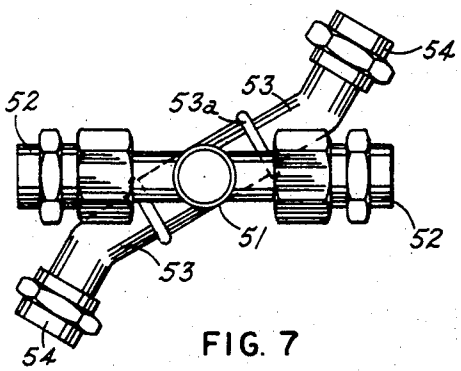



FIG. 7

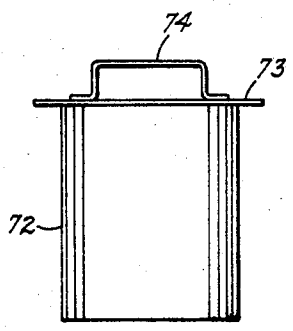



FIG. 8

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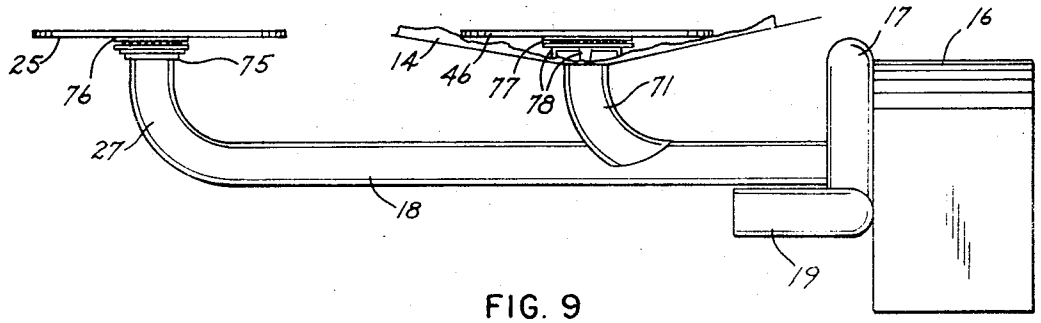



FIG. 9

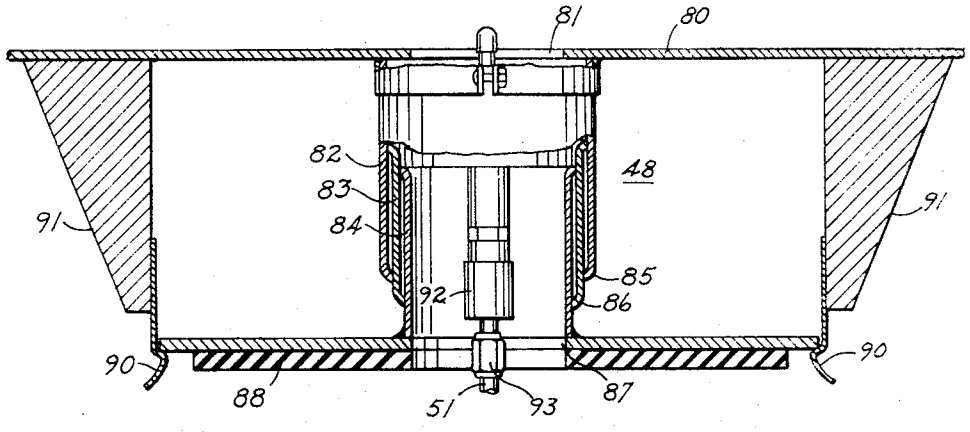



FIG. 10

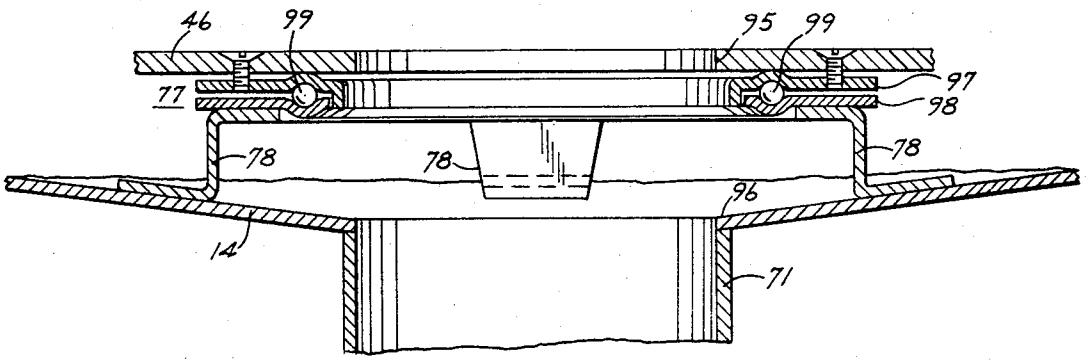



FIG. 11

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# AIR FILTER CLEANING METHOD

This application is a division of my copending application Ser. No. 839,400 filed July 7, 1969, now U.S. Pat. No. 3,620,234.

This invention relates to the cleaning of air filters for internal combustion engines and the like and particularly to an improved method for more effectively cleaning such filters.

The accordion folded paper filters commonly employed for cleaning air supplied to internal combustion engines and the like were originally intended to be discarded after they had been rendered ineffective by use. It was, however, found to be possible to clean such filters for reuse and various methods and apparatus have been employed for this purpose. U.S. Pat. Nos. 3,021,972 granted Feb. 20, 1962 and 3,236,249 granted Feb. 22, 1966, both issued to Herbert L. Everroad, are examples of such filter cleaning apparatus. It has become desirable to increase the speed and effectiveness of cleaning and also the average number of times each filter may be cleaned, and accordingly, it is an object of the present invention to provide an improved method for cleaning air filters of the type employed with internal combustion engines.

It is another object of this invention to provide an improved method for cleaning air filters for internal combustion engines and the like with more effective and more complete removal of the residue accumulated on the filter material.

Briefly, in carrying out the objects of this invention when utilizing the cleaning method thereof for cleaning air filters such as the hollow cylindrical filters utilizing accordion-pleated paper and employed for internal combustion engines for heavy equipment the filter is arranged for circulation of water in a direction opposite to that under which the filter has been operated, thus the water is directed from the leaving side of the filter toward the side on which the residue has been accumulated. At the same time a flow of air is directed through the filter paper in the same direction as the water so that the entire area of the filter is subjected to both water and air passing therethrough. When the water leaving the filter is clear the flow of water and air is reversed and continued until the water is clear after leaving the filter. Preferably the filter before being subjected to the passage of air and water is soaked in a chemical solution to dissolve or loosen the residue accumulated thereon, this tends to free the residue and speeds the cleaning of the filter by the foregoing method.

The features of novelty which characterize this invention are pointed out with particularity in the claims annexed to and forming a part of this specification. The invention itself, however, both as to its organization and the method employed together with further objects and advantages thereof will best be understood upon reference to the following description taken in connection with the accompanying drawings in which:

FIG. 1 is a perspective view of an apparatus suitable for practicing the method of the invention shown open for access to the filter retaining assemblies;

FIG. 2 is a piping diagram of the air and water supply system for the apparatus of FIG. 1;

FIG. 3 is a top plan view of the filter mounting and spray assembly of the left-hand compartment of FIG. 1;



FIG. 4 is a top plan view of the filter mounting and spray assembly in the right-hand compartment of FIG. 1;

FIG. 5 is an enlarged elevation view of the lower end of one of the spray nozzle branches of the assembly of FIG. 3;

FIG. 6 is a top plan view of the portion of the assembly shown in FIG. 5;

FIG. 7 is a top plan view of the central spray member of the lefthand filter compartment as shown in FIG. 4;

FIG. 8 is a side elevation view of a closure element for the discharge openings at the bottom of the filter retaining assemblies of FIGS. 1, 3, and 4;

FIG. 9 is a side elevation view of the suction pump and fluid discharge connections of the apparatus of FIG. 1;

FIG. 10 is an enlarged view, partly in section, of the top air connection and filter closure assembly of righthand compartment of the apparatus of FIG. 1; and

FIG. 11 is an enlarged sectional elevation view of the bottom filter mounting assembly of the righthand filter compartment of FIG. 1.

Referring now to the drawings, the filter cleaning or rinsing unit illustrated in FIG. 1, comprises a main housing 10 having a lefthand compartment 11 and a righthand compartment 12 separated by an upright partition 13 and a horizontal floor or partition 14 in the compartment 12. At the righthand end of the housing 10 there is provided an extension or enclosure 15 in the lower portion of which is mounted a motor driven blower unit comprising a motor 16 and a centrifugal blower 17 which is employed as a vacuum pump to draw air from the compartments 11 and 12 through a duct 18 and to deliver the air together with entrained water through a discharge outlet 19 into the lower portion of the housing 10 which comprises a chamber in direct communication with the chamber 11 and extending the full width of the housing. On a rearwardly offset front wall 20 of the housing extension 15 there are mounted piping connections for water and high pressure air indicated generally at 21. Water discharged from the outlet 19 is removed from the housing through a drain connection 19a. The compartments 11 and 12 are provided with hinged doors 8 and 9, respectively, shown resting in their open positions. When pivoted downwardly these doors close the compartments; windows 8a and 9a are provided in the doors to afford a view of the interiors of the compartments. The water flowing to the outlet 19a may be observed through a window 10a in the lower front wall of the housing, a lamp 7 being provided for better visibility.

The two compartments 11 and 12 are provided with retaining assemblies for holding filter units indicated at 23 and 24, respectively. These filter units are of the hollow cylindrical type comprising inner and outer spaced perforated walls the space being provided with a suitable filtering material such as accordion-pleated filter paper arranged with the pleats running longitudinally of the filters and lying in zigzag configuration in generally radial positions. This is the type of filter commonly employed with diesel engines and other internal combustion engines used with heavy equipment.

As shown in FIGS. 1 and 3, the filter retaining assembly in the compartment 11 comprises a circular

bottom plate 25 rotatably mounted on an upturned portion 26 of the air duct 18 which in turn is braced by a bracket securely attached to the housing 10 but not shown in the drawing. The filter 23 is positioned on the plate 25, and, as is a common practice with these filters, has a gasket about its open end which provides a seal with the plate. The upper end of the filter 23 is provided with a closed sheet metal end 27 which may have a small central opening 28 for receiving the anchoring bolt for attaching the filter when installed on an engine. Air is removed from the interior of the filter unit 23 by connecting it to the conduit 18 through a central opening 29 in the plate 25 and a low pressure or vacuum is thus maintained in the interior of the unit. The hole 28 is sufficiently small that it does not constitute a significant bypass for the air so that there is substantially no impairment of the vacuum maintained within the interior of the filter.

Water is sprayed over the external surface of the filter 23 from a plurality of spray nozzles or jets 30 carried on a yoke comprising a cross conduit 31 and two upright conduits 32, the nozzles 30 being arranged in straight lines at spaced intervals along the upright conduits 32 and being directed radially against the outer surface of the filter 23. The yoke assembly is rotatable about the axis of an upright supply connection 33 which is rotatably mounted in a cross brace 34 attached to the partition 13 and the end wall of the housing 10. Water is supplied from a main water inlet connection 35 mounted on the offset wall 20 and provided with a manual valve 36. Water for the nozzle 30 is supplied to the connection 33 through a branch conduit 37 under control of a manual valve 38. The nozzle assembly is rotated by the reaction forces produced by nozzles 39 at the bottom ends of the conduits 32, these reaction nozzles being angularly adjustable for changing the rate of turning of the nozzle assembly. The arrangement of the nozzles 30 and 39 is shown in detail in FIGS. 5 and 6. An additional water spray may be supplied to the interior of the filter 23 from a spray nozzle 40 extending upwardly through the opening 29 in the plate 25. This nozzle is supplied with water from the main 35 through a branch conduit 42 having a valve 43 for adjusting the flow of water.

As illustrated in FIGS. 1 and 4, the filtering unit retaining assembly in the compartment 12 comprises a rotatable circular bottom plate 46 preferably provided with a rubber-like sealing surface and a vertically adjustable top plate 47 having a seal for engagement with the filter unit and which is mounted on a telescoping duct assembly 48 attached to the top wall of the compartment 12. Air is admitted to the duct assembly 48 from a duct 50 of triangular cross section which extends across the top of the housing 10 and is in open communication with the top of the compartment 11 and with the top of the duct assembly 48. The structural details of the duct assembly 48 and rotatable plate 46 are described below in connection with the descriptions of FIGS. 9 and 10.

It will now be apparent that air is circulated through both the filters of compartments 11 and 12 into the duct 18 and returns to the interior of the housing through the outlet duct 19 and is thus recirculated continuously during the operation of the apparatus.

A water spray is directed over the inner wall of the filter 24 from a vertical conduit 51 provided with radially positioned nozzles 52 arranged in oppositely facing straight rows on opposite sides of the conduit 51 with the nozzles in each row staggered with respect to the nozzles in the other. At the bottom of the conduit 51 there is a terminal cross conduit 53 having nozzles 54 at its ends. The conduit 53 is of generally S-shaped configuration so that the nozzles 54 are directed at slight angles to the radial and are effective to produce rotation of the conduit 51 so that the spray is applied about the entire interior wall of the filter 24. The arrangement of the nozzles 52 and 54 on the conduit 51, as shown in enlarged detail in FIG. 7, includes a fitting 53a in which the two arms of the conduit 53 may be adjusted independently to select the angles of the nozzles 54 and thereby adjust the speed of rotation of the spray. Water is supplied to the nozzles 52 through the conduit 51 from a branch connection 55 having a manual control valve 56 similar to the valves 38 and 43 in the branches 37 and 42. The water connections to the several jets are indicated diagrammatically in FIG. 2. The sprays are pressurized and for this purpose air under pressure from a suitable supply 57 is supplied to the several branch conduits through a connection 58 under control of a manual valve 60. A pressure gauge 61 is provided to indicate the pressure supplied to the system, and a check valve 62 is provided to prevent water from flowing into the air supply line. This arrangement of the air pressurized sprays assures uniform pressure of the water supplied to the sprays. Water for auxiliary use may be supplied through a flexible hose (not shown) which may be connected to a faucet 63 connected on the outlet side of the supply valve 36; such flexible hose may be employed, for example, to clean the inside walls of the apparatus after use, and it is particularly useful for checking the cleanliness of individual pleats of the paper filter to determine whether the cleaning operation has been completed.

As shown in FIGS. 1 and 3, the filter 23 comprises an inner perforated cylindrical metal wall or screen 64 and an outer cylindrical perforated metal wall or screen 65 spaced apart and retaining a paper filter of the accordion pleated type indicated at 66. During the operation of the filter to clean the combustion air for an internal combustion engine, for example, and depending upon the connections employed, the air may be circulated either from the outside in or from the inside out. In either case, the accumulated solids removed from the air are collected as a residue on the surface of the filter paper in the pleats on the intake side from which the air is received. By way of example, it can be assumed that in FIG. 3 the filter has been employed with the air flowing from the inside out and that the accumulation of residue is therefore on the inner faces of the pleats of the paper 66. When the vacuum pump 17 is in operation and is circulating air through the system while a pressurized water spray is being applied to the outer surface of the filter by operation of the nozzles 30 and the arm 31, which is rotated by the tangential component of the reaction force at the nozzles 38, both water and air are passed through the filter paper into the inside of the filter and thence out through the bottom outlet 29. This operation is continued until the water flowing through the filter is substantially clear. In

addition to the water sprayed over the outside of the filter 23 water may also be sprayed from the nozzle 40 and to rinse or flush the interior surfaces of the filter.

The filter 24 as illustrated in FIGS. 1 and 4 is of the same construction as the filter 23 and by way of example it may be assumed that the filter 24 has been employed in an air intake system wherein the flow through the filter is from the inside out. The accumulated residue of separated solids thus lies on the outer face of the filter paper indicated at 67. During the cleaning operation, the filter 24 is positioned, with its open end up, on the retaining assembly and the interior of the filter 24 is washed by sprays projected from the nozzles 52; the nozzle assembly is rotated about the axis of the spray conduit 51 which is rotatably suspended on a quick detachable coupling (not shown in FIG. 1) so that the tangential components of the reaction forces at the nozzles 54 produce rotation of the sprays. The closed end of the filter unit, indicated at 68, has a center hole 70 for receiving an attaching bolt; this hole is so small that it does not significantly affect the flow of air through the filter paper.

During the operation of the washing sprays and rotation of the nozzles 52 within the filter 24, air is admitted to the interior of the filter through the telescopic inlet assembly 48 and passes with the water through the perforated inner wall thence through the filter and out through the perforated outer wall of the filter. After passing through the filter, the air passes downwardly under the mounting plate 46 and into a branch duct 71 into the suction duct 18. This circulation of air is continuous during the filter washing operation and may be continued after the water sprays have been turned off in order to effect a partial drying of the filter.

In the event that it is desired to employ only one of the compartments 11 and 12 to wash a filter the respective air outlet duct 26 or 71 of the other compartment is closed by a closure cylinder illustrated in FIG. 8. This cylinder comprises an elongated hollow cylindrical portion 72, a top plate 73 extending over the walls of the cylinder 72 and providing a stop flange and a handle 74 for convenience in placing the plug in position and in removing it. The cylinder 72 is of sufficient length to fit over the nozzle 40 in the compartment 11 and to reach through the plate 46 in the compartment 12 and into the spaced opening of the duct 71. By closing the unused duct in this manner, the full effectiveness of the vacuum pump is available for drawing air through the filter in the other compartment and removing all liquid.

The arrangement of the vacuum duct 18 and the rotating plates 25 and 46 is illustrated in FIG. 9. The plate 25 is rotatably mounted on a collar 75 securely attached to the outlet duct 27 and also supported from the walls of the cabinet by a bracket (not shown). The plate 25 is rotatable on the supporting ring 75 on a ball bearing assembly 76 so that it may be turned easily when placing a filter in position in the compartment 11. The plate 46 is rotatably mounted on the wall 14 and the outlet duct 71 on a ball bearing assembly 77 spaced from the wall on legs 78 to provide passages for air under the edge of the plate 46 and into the duct 71.

The air inlet duct assembly 48 which carries the plate 47 is shown in detail in FIG. 10. The assembly 48 is mounted on the upper or top stationary wall of the compartment 12 as indicated at 80. The wall 80 is provided with a circular intake opening 81 for the passage of air into the assembly 48 from the triangular duct 50. The assembly comprises three telescoping cylindrical duct members 82, 83 and 84 spaced from one another and being closed to the outside by inturned flanges 85 and 86 on the members 82 and 83, respectively, which flanges slidably engage the cylinders 83 and 84, respectively. The cylinder 84 is securely bonded to the plate 47 about an opening 87 in the plate. It will now be apparent that the plate 47 may be raised and lowered while maintaining a sealed duct connection between the openings 81 and 87. A sealing gasket 88 may be secured to the underside of the plate 47 for facilitating the sealing of a filter unit in engagement therewith. Plate 47, as shown in FIG. 10, is in its upward or retracted position and is held on spring hooks 90 which are mounted on downwardly extending triangular brackets 91 attached to the underside of the top wall 80 of the compartment 12. When in use the duct assembly 48 is moved downwardly the spring catches 90 releasing the plate 47 whereupon the assembly is moved into position with the gasket 88 in sealing engagement with the top of a filter resting on the bottom plate 46. In order to facilitate the placing of a filter in position, the spray assembly 51 is made detachable as mentioned heretofore a quick detachable coupling 92 being provided for this purpose. This coupling is of the well known type wherein an axially sliding member is arranged to release ball detents (not shown) so that a detachable element 93 at the end of the spray conduit 51 may be placed in position and then locked by returning the slide member to its position locking the detents and holding the detaching element 93 and conduit 51 against axial movement while affording rotational movement with respect to the coupling 92.

The arrangement of the bearing assemblies affording rotation of the plates 25 and 46 is illustrated generally in FIG. 11 which is an enlarged view of the mounting for the plate 46. As shown here, the plate 46 has a central round opening 95 which is in alinement with the opening at the top of the duct branch 71 indicated at 96. The bearing assembly 77 comprises upper and lower plates 97 and 98 formed with annular bearing races in which ball bearings 99 are free to rotate. The plug 72 of FIG. 8 is of sufficient length to pass through the opening 95 and into the opening 96 and thereby seals off the inlet to the duct 71. It will be noted that when the duct 71 is open air is free to pass through the spaces between the legs 78 directly from the compartment 11 into the suction conduit 18. The construction of the bearing assembly 76 is substantially the same with the omission of an air passage such as that provided by the legs 78 of FIG. 11.

The method of washing or cleaning filters which I have invented, and which can employ an apparatus such as that described above, comprises an initial washing or rinsing of the filter by concurrently passing water and air through the paper thereof in a direction opposite that in which the air has passed during use of the filter and has accumulated a residue on the filter. This washing action is continued until the outflow or discharge from the filter comprises substantially clear water. Thereafter, a second step comprises the passing of water and air in a similar manner through the filter in the reverse direction. I have found that the foregoing

procedure removes material lodged in the filter and which has not been removed by the initial step. The change in direction of fluid flow through the filter may be accomplished, for example, by placing the filter first in one compartment of the apparatus of FIG. 1 and then in the other compartment thereof.

I also prefer to employ a preparatory step in the cleaning process wherein the filter to be cleaned is first subjected to soaking in a quiet bath of filter cleaning fluid which tends to loosen the accumulation of deposited residue on the filter and to dissolve some components thereof. The water applied to the filter in the first and second stages is preferably applied as a spray under substantial velocity and the initial step of preparing the filter by soaking in a suitable filter cleaning solution greatly facilitates the release of the residue from the filter and shortens the time required for cleaning the filter under the spraying and air passage process steps. In both the washing and air passage steps, I have found it desirable to continue the passage of air after shutting off the water spray which effectively eliminates excess water from the filter unit. After the excess water has been removed the filter unit is preferably dried in a heated oven at a relatively slow rate. For example, the filter may be held in an oven at a controlled temperature normally not exceeding 160°F for a period of from one to four hours.

The method of this invention has been found highly effective in cleaning air filters for internal combustion engines and in maintaining the paper in useful filtering condition for as many as six or seven reuse cycles.

I claim:

1. The method of cleaning accumulated residue from air filters of the type employed for internal combustion engines and comprising inner and outer spaced perforated cylindrical walls and a filter element between the walls which comprises

spraying liquid over the perforated wall on the side of the filter opposite the side having the accumulation of residue,

concurrently producing a flow of air through the filter element from said opposite side whereby air and liquid pass through the filter element to remove residue therefrom and are discharged from the residue side,

discontinuing the flow of air and liquid from said opposite side when the discharged liquid appears free of residue,

spraying liquid over the other perforated wall,

concurrently producing a flow of air through the filter element from said other wall to said opposite side whereby air and liquid are discharged through said opposite side,

and discontinuing the flow of liquid when the discharged liquid is clear.

2. The method of claim 1 including the step of continuing the flow of air through the filter element toward said opposite side for a time sufficient to remove excess liquid from the element.

3. The method of claim 1 wherein the flow of air is effected by reducing the pressure of the air on the side of the filter element toward which the air and liquid are to flow.

4. The method of claim 1 including the initial step of soaking the filter in a cleaning solution capable of loosening the residue on the filter.

* * * * *

## Disclaimer

3,688,780.—*Herbert L. Everroad*, Denver, Colo. AIR FILTER CLEANING METHOD. Patent dated Sept. 5, 1972. Disclaimer filed July 24, 1972, by the inventor.

Hereby disclaims the portion of the term of the patent subsequent to Nov. 16, 1988.

[*Official Gazette September 11, 1973.*]