July 20, 1943. R. A. KELSEY ET AL 2,324,629

ROTARY AIR CLEANER

Filed July 5, 1940 2 Sheets-Sheet 1

Fig. 1.

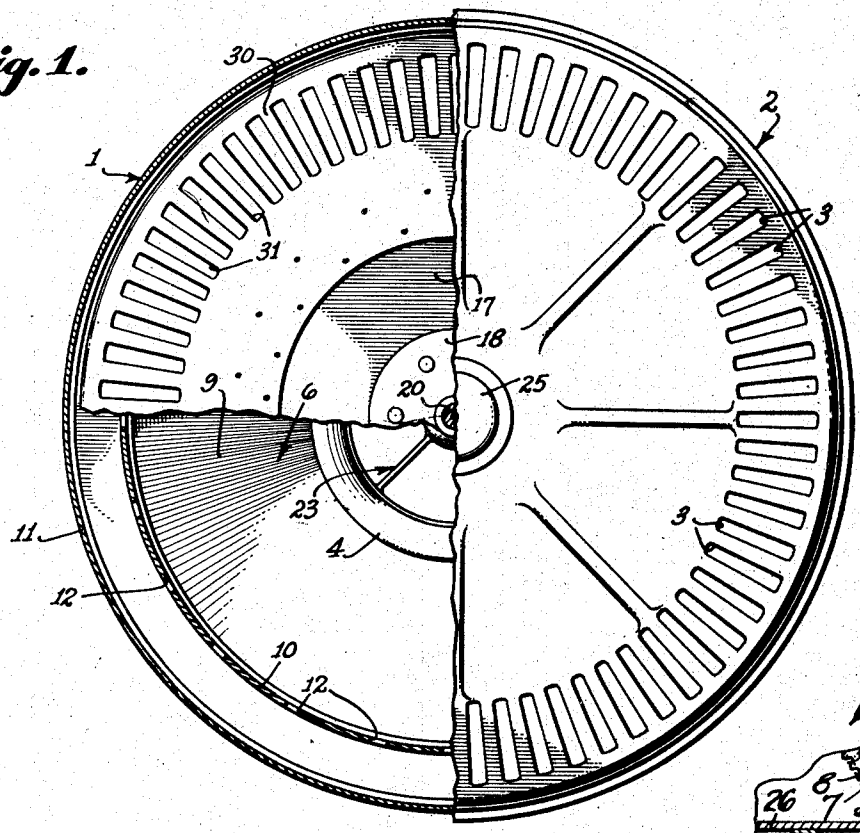


Fig. 2.A.

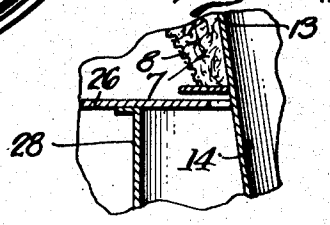
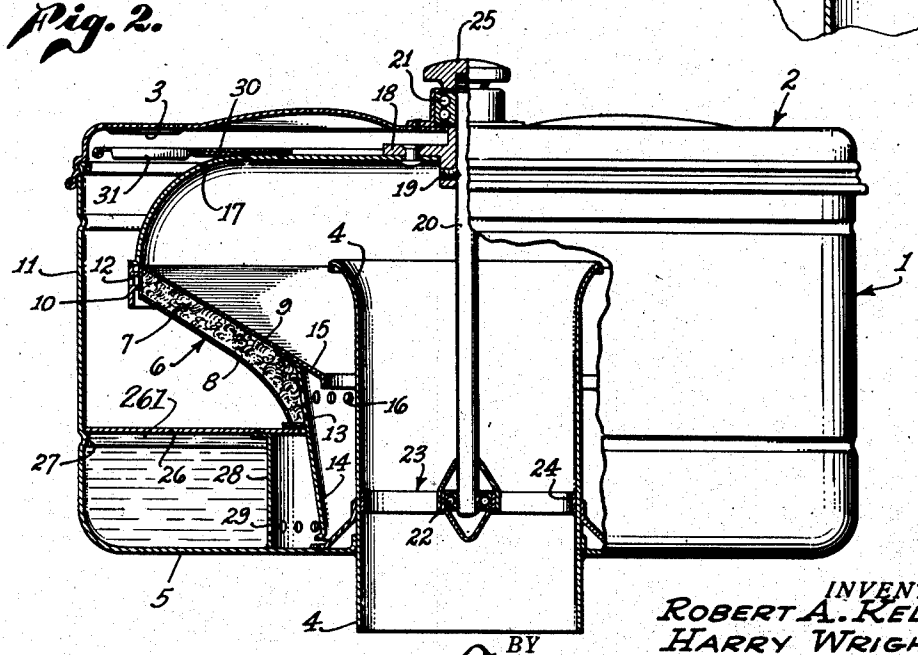


Fig. 2.



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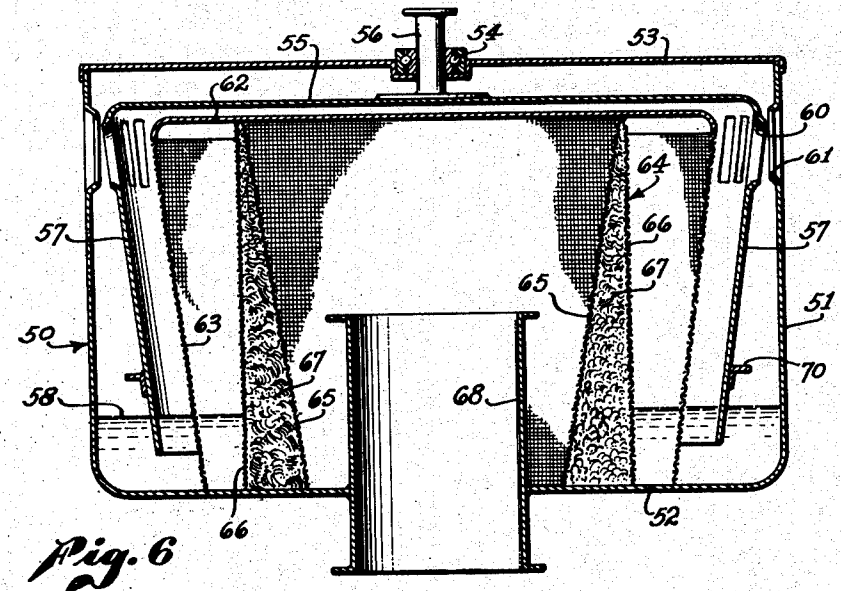


Fig. 6

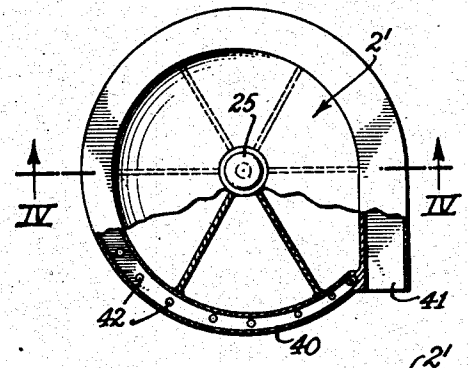
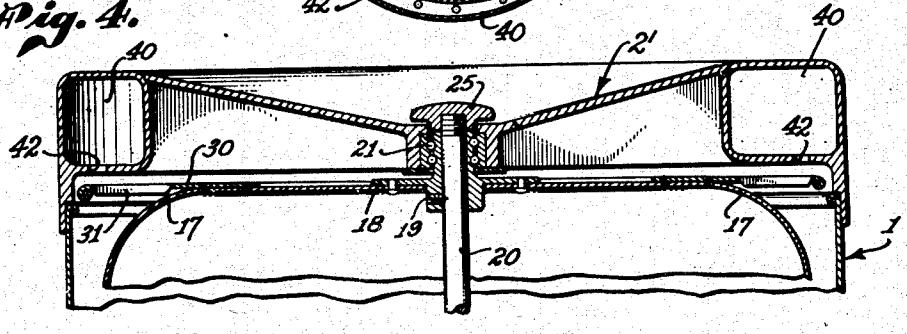


Fig. 3.

Fig. 4.



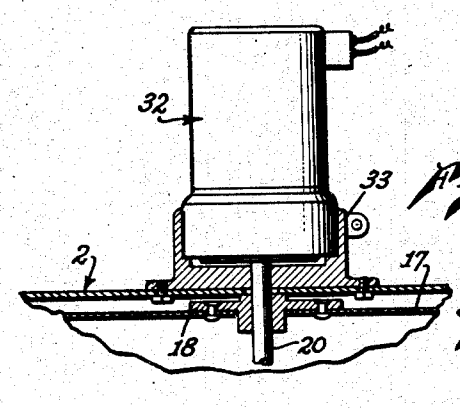


Fig. 5.

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ROTARY AIR CLEANER

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Application July 5, 1940, Serial No. 344,090

9 Claims. (Cl. 183—9)

This invention relates broadly to devices for cleaning gases, particularly air. A chief field of use of the invention is in cleaning the air supply of internal combustion engines, although it is in no sense limited to this particular use, as will appear hereinafter.

A general object of the invention is to provide a gas cleaner of the wetted screen type, that is simple and inexpensive, while having a high cleaning efficiency and being reliable in operation.

A more specific object is to provide a gas cleaner of the wetted screen type having a particularly simple and effective mechanism for circulating the wetting liquid over the screen.

A feature of the invention is a gas cleaner of the wetted screen type, in which the wetting liquid is circulated over the screen in response to centrifugal force developed by a rotating element.

Other specific objects and features of the invention will appear from the following detailed description of certain specific embodiments of the invention, as illustrated in the accompanying drawings, in which

Fig. 1 is a plan view, with parts broken away, of one embodiment of the invention, in which the rotary element is driven by the air to be cleaned;

Fig. 2 is an elevation view, partly in section, of the cleaner shown in Fig. 1;

Fig. 2A is an enlarged detail sectional view of a portion of the structure shown in Fig. 2;

Fig. 3 is a plan view, with parts broken away, of the upper portion of a modification of the cleaner shown in Figs. 1 and 2, adapted for cleaning air supplied to the cleaner under pressure;

Fig. 4 is a sectional view in the plane IV—IV of Fig. 3;

Fig. 5 is a detail elevational view, partly in section, showing a modification of the structure shown in Figs. 1 and 2; and

Fig. 6 is a schematic vertical sectional view showing still another modification of the invention.

Referring first to Figs. 1 and 2, the cleaner therein disclosed comprises a stationary casing 1 of approximately cylindrical shape, adapted to be closed at the top by a detachable cover 2, the casing and the cover defining a chamber into which air enters through an annular row of louvers 3 in the cover 2, and from which it discharges through a central discharge pipe 4 which extends downwardly through the center of the bottom wall 5 of the casing 1.

Positioned within the casing 1 is a rotating element including a filter element 6, through which the air is drawn. This filter element 6 consists of a mass of metal turnings 7, or similar material, supported between a lower screen 8 and an upper screen 9. In addition to the lower and upper walls 8 and 9, respectively, the filter element 6 has an outer peripheral wall 10 which is spaced inwardly from the peripheral wall 11 of the casing 1, but has a circumferential row of holes 12 therein. The filter element 6 also has an inner edge wall 13 which extends downwardly and inwardly to form a converging skirt 14, extending almost to the bottom wall 5 of the case. The upper wall 9 extends inwardly a short distance past the upper edge of the wall 13 to form an overhang 15. The inner wall 13 has a circumferential row of holes 16 therein.

The whole screen or filter structure so far described is attached at its outer edge to the lower edge of a dome member 17 which is secured to a central hub 18, the latter being in turn secured, as by a set screw 19, to a central shaft 20, the latter being rotatably supported by upper and lower ball bearings 21 and 22, respectively. The upper ball bearing 21 is mounted in the cover 2 and the lower bearing member 22 is mounted in a spider 23 having a rim 24 slidably fitted within the discharge pipe 4.

It will be apparent from the foregoing description, that the entire filter element, together with the dome 17, is freely rotatable as a unit within the casing 1. A knob 25 may be mounted on the upper end of the central shaft 20, exterior of the bearing 21, to give a visual indication of the rotation of the rotatable member and permit manual testing to determine if the member is freely rotatable.

The lower portion of the chamber within the casing 1 constitutes a cleansing liquid (which will be hereinafter referred to as "oil") reservoir. The oil reservoir is separated from the upper, outer portion of the chamber by a horizontal annular partition wall 26 which is supported at its outer edge by a bead 27 pressed into the peripheral wall 11 of the casing. The wall 26 is also supported adjacent its inner edge by a cylindrical baffle plate 28 which is secured at its upper edge to the wall 26, the lower edge of baffle 28 resting on the bottom wall 5. The baffle 28 is provided with a circumferential row of holes 29 near its lower edge for the flow of oil therethrough. The oil level will normally be adjacent the partition wall 26, as indicated at 26'.

In operation, the rotary element is rotated or spun at sufficient speed (by means to be described later) to carry oil from the reservoir up-

wardly along the inner surface of the inclined walls 14 and 13 by centrifugal force through the hole 16 into the inner edge of the filter element 6. The oil is then urged outwardly through the filter element by the same centrifugal force which increases in magnitude from the inner edge to the outer edge of the filter element; since the centrifugal force, coupled with the force of gravity, acts outwardly and downwardly, whereas the filter element 6 is inclined upwardly and outwardly, part of the oil leaves the under-surface of the filter element and is thrown outwardly through the air stream which moves down through the inlet louvers 3 past the edge of the dome 17 and then flows inwardly and upwardly through the filter 6 and into the discharge pipe 4. Some of the finer particles of oil are carried back into the filter by the air current. Other, larger particles strike the peripheral wall 11 or the partition wall 26 and drain back into the reservoir across the inner edge of the partition wall 26.

Of course the flow of air through the filter 6 also tends to carry oil upwardly through the filter, counteracting to a certain extent, the tendency of the oil to be thrown out of the lower surface of the filter element by centrifugal force and gravity. As a result, some of the oil traverses the full length of the filter to the holes 12, from whence it is thrown directly across the air stream at the narrowest point of the latter, where the air is travelling at highest velocity. As a result, a substantial portion of this oil thrown out through the holes 12 is caught by the air stream and carried back into the filter element 6.

As a result of the oil particles being thrown into the air stream before it enters the filter 6, a substantial number of the particles of dust in the air are wetted by the oil particles so that they either drop out of the air stream by virtue of their weight, onto the partition wall 26, or are immediately deposited upon the wet surface of the filter element during passage of the air therethrough. Of course additional dust particles that were not wetted by the oil prior to the entry of the air into the filter element, are deposited on the wetted surface of the filter.

A few oil particles may be carried by the air completely through the filter element 6, but most of such particles will be thrown out of the air stream onto the dome 17 by virtue of the change in the direction of the air to get into the open, upper end of the discharge passage 4. Any oil particles deposited on any part of the undersurface of the dome 17 are thrown outward by centrifugal force to the lower edge of the dome, from whence they escape through the holes 12 along with oil that reaches the holes 12 directly through the filter 6.

By virtue of the relatively powerful centrifugal forces acting upon the oil permeating the filter element 6, a relative rapid flow of oil is produced through the filter, rapidly carrying away the accumulated dust deposits and preventing any clogging of the filter element. The dust and dirt collected by the oil accumulates in the bottom of the oil reservoir.

In the particular modification described in Figs. 1 and 2, rotation of the filter element is produced by the air entering the louvers 3 in response to suction applied to the discharge pipe 4. Thus the pipe 4 may be connected to the intake pipe of an internal combustion engine, the suction of which draws air through the cleaner. The motor element proper is a fan 30 secured to the dome 17 and having vanes or blades 31 positioned immediately below the louvers 3 and inclined in a direction opposite to the direction of inclination of the louvers 3. The inclination of the louvers deflects the entering air so that it moves in a helical path instead of straight down. This air, as it passes through the blades 31, produces a torque which spins the fan and the rotatable filter element secured thereto.

The energy for rotating the filter element is, of course, derived from the suction-producing device connected to the discharge pipe 4 and causes a pressure drop through the entire unit that may be objectionable in some instances. In this event, it may be desirable to rotate the filter element from an external source of power. Thus an electric motor 32 may be mounted on the cover plate 2, as shown in Fig. 5, and have its shaft directly connected to, or integral with, the shaft 20. The motor casing may be detachably supported in a clamp base 33 provided on the cover plate. In the particular construction shown in Fig. 5, the shaft 20 is journalled in a plain bearing in the base 33, instead of in a ball bearing as shown in Fig. 2. This is permissible because where an external source of power is employed for positively rotating the rotatable element, it is not so important to reduce friction to a low value. The motor 32 may supply only sufficient power to rotate the filter element and the fan 30 (Fig. 2), may be eliminated. On the other hand, the fan 30 may be retained even when the motor is used to produce a supercharging effect to actually produce a pressure increase in the air passing through the filter.

There are some applications in which it is desired to clean air under pressure. In such instances the cleaner structure shown in Fig. 2 may be employed with a manifold for delivering the air under pressure through the fan 30. Such a construction is shown in Figs. 3 and 4, in which the cover plate 2' is in the form of a casing having a curved input manifold 40 adapted to be connected at its input end 41 to a source of air under pressure. The air is discharged from the manifold 40 through apertures 42 immediately above the blades 31 of the fan. The remainder of the construction is identical with that of Fig. 2, and the rotating element is spun by the force of the entering air, exactly as in the case of the structure shown in Fig. 2.

One application of the modification shown in Fig. 4 is a cleaner for dirt-laden air from a vacuum cleaner, or the like, the device being substituted for the usual filter bag.

In all of the structures disclosed in the drawings, the cover and the rotating element are removable from the case 1 as a unit, to permit removal of dirt from the chamber in the bottom of the case 1. Thus the upper end of the shaft 20 of the rotatable element is rotatably supported from the cover, and the ring 24 on the spider 23, which radially supports the lower bearing, is freely slidable through the discharge pipe 4 so that when the cover is lifted straight up the rotatable element comes with it. Thereafter the partition plate 26 and the baffle plate 28 may be lifted out as a unit, leaving the bottom of the casing fully accessible for cleaning. The cover may be normally secured in place on the case 1 by any desired means. Thus it may be made to fit snugly by friction on the top of the casing or any well-known fastening expedients, such as interrupted screw threads, may be utilized.

The modification of the invention shown in

Fig. 6 differs from those previously described, chiefly in having a stationary filter element with a separate rotating element for elevating the oil and mixing it with the incoming air before it reaches the filter element proper. Thus referring to Fig. 6, the cleaner therein disclosed comprises a main casing **50** having a peripheral wall **51** and a bottom wall **52**, and adapted to be closed by a cover **53**. The cover **53** rotatably supports, by means of a ball bearing **54**, a short shaft **56**, on the lower end of which there is secured a disc **55** having formed integrally therewith and extending inwardly and downwardly from its outer edge, a skirt **57**. The lower end of this skirt dips in a pool of oil **58** in the bottom of the case **50**. The skirt **57** has adjacent its upper edge louvers **60** for the passage of the air to be cleaned and the peripheral wall **51** of the casing has louvers **61** therein, which are juxtaposed to the louvers **60** but angled in the opposite direction so that currents of air passing through the two sets of louvers, apply a torque to the rotating element sufficient to spin it.

In response to the spinning of the rotary member, oil from the pool **58** is carried by centrifugal force up along the inner surface of the skirt **57** to the louvers **60**, where the oil is caught in the air stream and carried inwardly with the air in the form of small droplets. Positioned inwardly of the rotary member is a stationary member having a closed top wall **62** spaced a short distance below the disc **55** and having a skirt **63** of fine mesh screen wire. The skirt **63** is positioned parallel to and a short distance within the rotating skirt **57** but unlike the latter, extends clear to the bottom wall **52** of the outer case. The droplets of oil carried by the air stream are impinged upon the screen **63** and are broken up and subdivided into finer form. A part of the oil is carried through the screen in finely divided form, and a portion of the oil may, of course, accumulate on the screen **63** and flow down along the screen into the pool **58**.

Positioned a short distance within the stationary screen **63** is an annular filter element **64** which extends clear from the bottom wall **52** of the case up to the wall **62**, so that all air passing through the annular screen **63** has to pass through the filter element. As clearly shown in the drawing, the filter element consists of two screen walls **65** and **66**, respectively, containing therebetween a mass of metal turnings, or the like, **67**. As shown, the filter element **64** is thicker at the bottom than at the top, as this is sometimes found desirable, although it is not essential.

As the air carrying an excess of liquid in the form of mist or droplets passes through the filter **64**, the liquid is trapped on the surfaces of the filter elements together with the dirt and dust present, whereas the clean air passes on through the filter element and into the top of a discharge pipe **68** which extends through the bottom wall **52** of the case. The oil accumulating in the filter element **67** works it way downwardly by gravity carrying the accumulated dust and dirt therewith so that the filter element is being continually cleaned by the addition of oil and the dirt trapped is washed down into the pool and accumulates in the bottom of the case.

The skirt **57** preferably has an outwardly extending ridge or flange **70** on its outer surface at a short distance above the oil level for preventing oil from creeping up along the outer surface of the skirt.

Although for the purpose of explaining the invention certain specific embodiments thereof have been described in detail, it is to be understood that various changes from the particular construction shown can be made without departing from the invention, which is to be limited only as set forth in the appended claims.

We claim:

1. A gas cleaner comprising a stationary casing having a central gas conduit extending downwardly through the bottom wall thereof and defining therewith an annular chamber for containing a pool of liquid, a rotor in the form of an inverted cup having its edge dipping into said liquid and dividing the space in said casing above the liquid into inner and outer compartments, respectively, the inner compartment being in open communication with said gas conduit, means supporting said rotor for free rotation and means for rotating it, means defining passages in said rotor for the flow of gas therethrough, the portion of said rotor below said passages converging inwardly and downwardly into said liquid, whereby rotation of the rotor forces liquid upwardly therealong to said passages by centrifugal force, and means communicating with said outer compartment to complete a path for gas flow through said cleaner.

2. A gas cleaner as described in claim 1, in which said last-mentioned means comprises openings in said casing, and means associated with said openings and responsive to gas flow therethrough for applying a torque to said rotor to rotate it.

3. A gas cleaner as described in claim 1, with means exterior of said casing for rotating said rotor, and vanes on said rotor for inducing flow of gas through said casing in response to rotation of said rotor.

4. Apparatus as described in claim 1, in which said casing comprises a lower stationary member and detachable cover with said rotor rotatably supported from and removable with said cover.

5. A gas cleaner as described in claim 1, in which said stationary casing comprises a lower, open top member and a detachable cover member, and said rotor has a supporting shaft, upper bearing means on said cover member for rotatably supporting the upper end of said shaft, a lower bearing member for said shaft, and a spider freely slidable in said gas conduit for radially supporting said lower bearing.

6. A gas cleaner comprising a porous gas-filtering element adapted to be wetted with a cleaning liquid to make it effective, means defining a basin below said filtering element for containing a pool of said liquid, a rotor rotatable about a vertical axis and means for rotating it, said rotor having a downwardly converging annular wall member dipping into the liquid in said basin, whereby liquid is elevated in a thin film along the surface of said annular wall member by centrifugal force in response to rotation of said rotor, said annular wall member having an opening therein above the liquid level in said basin for passage of gas, and means for conducting a stream of gas to be cleaned first through said opening in said annular wall member to entrain liquid rising along the wall member to said opening, and then through said filtering element.

7. A gas cleaner comprising a casing having a basin therein for containing a pool of liquid, means for conducting a stream of gas to be cleaned through said casing above said pool, a rotor rotatable about a vertical axis and means

for rotating it, said rotor having a downwardly converging annular wall member dipping into the liquid in said basin, whereby liquid is elevated in a thin film along the surface of said annular wall member and discharged from the upper portion thereof by centrifugal force in response to rotation of said rotor, said liquid being discharged from said rotor into said gas stream, screen means in the path of said stream beyond the point of delivery into said stream of said liquid for subdividing liquid particles and intermixing said liquid and gas, said screen member being in the form of an annular wall positioned inwardly of said annular wall member, and means beyond said screen means for separating liquid particles from said gas stream and consisting of a relatively thick porous annular wall positioned inwardly of said screen.

8. A gas cleaner comprising a gas filter element adapted to be wetted with liquid to make it effective, means defining a basin below said filter element for containing a pool of liquid, a rotor rotatable about a vertical axis, said rotor having a downwardly converging annular wall member dipping into the liquid in said basin, said annular wall member having openings therein above the liquid level in said basin for passage of gas therethrough, vane means on said rotor responsive to gas flow through said openings for rotating said rotor, whereby liquid is elevated in a thin film along the surface of said annular wall member by centrifugal force, said openings being in that portion of said annular wall member carrying said liquid film, whereby said liquid is discharged into said openings and entrained into gas flowing therethrough, and means for conducting a stream of gas to be cleaned first through said openings in said rotor and then through said filter element.

9. A gas cleaner comprising means defining a basin for containing a pool of liquid, a rotor rotatable about a vertical axis, said rotor having a downwardly converging annular wall member dipping into the liquid in said basin and an annular porous section extending upwardly and outwardly from said annular wall member, and means for rotating said rotor whereby liquid is elevated in a thin film along the surface of said annular wall member and into the inner, lower edge of said porous section and thence outwardly through said porous section by centrifugal force, and means for conducting a stream of gas to be cleaned inwardly through said porous section.

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