

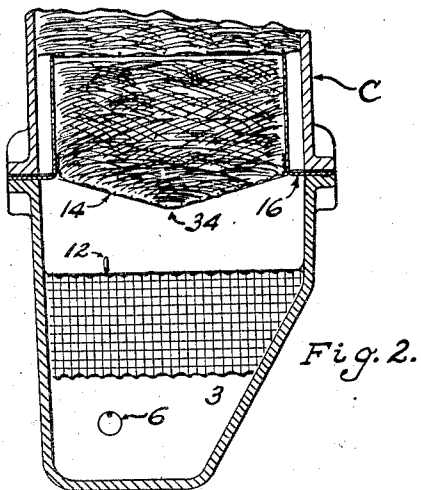
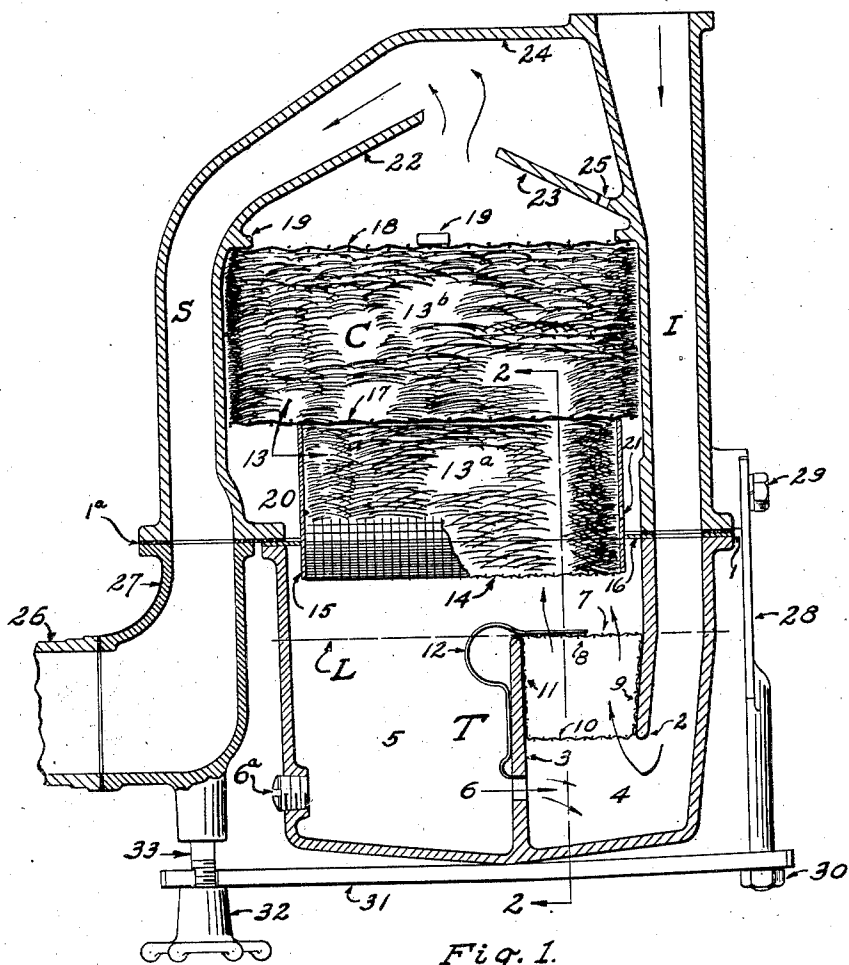
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AIR CLEANER

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AIR CLEANER

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The present invention relates to air cleaners for internal combustion engines and the like and an object of the invention is to generally improve the construction and operation of devices of this class.

A further object is to provide such a device which will be highly efficient under low load or idling conditions as well as under medium and heavy load conditions.

Further objects are to provide, in a liquid washed type of air cleaner, improved means for distributing the liquid, particularly under low load conditions; improved preliminary cleaning and liquid atomizing means; improved labyrinth means for receiving the liquid; improved means for mixing the liquid with the incoming air and for limiting the amount of liquid carried into the labyrinth; storage means for liquid in the vicinity of the labyrinth; means for returning stored liquid to the labyrinth; means for preventing bypassing of dirt-laden air past the labyrinth; means for trapping particles of liquid about to be carried out of the cleaner and various expedients for the realization of the above objects.

Other objects and advantages will appear from the following specification and accompanying drawing in which:

Figure 1 is a substantially axial sectional view of a cleaner illustrative of the invention.

Fig. 2 is a reduced vertical sectional view taken on the line 2—2 of Fig. 1.

Like reference characters have been applied to the same parts throughout the drawing and specification.

As seen in Fig. 1 the device comprises a labyrinth or cleaner chamber C, a liquid sump or tank T, an air inlet passageway I, and a suction passageway S, all related as hereinafter described in detail.

Cleaner chamber C and tank T are for convenience in the present instance made as castings fitted together at the joint 1, a gasket 1a being interposed if desired, whereby the device may be very readily opened for cleaning, but other arrangements for facilitating this are contemplated as equivalent. Intake passageway I extends downwardly to a point well below the liquid level as represented by the line L, terminating in a lip 2 beneath which all the air entering the device must pass through the liquid chamber, the depth of liquid when at rest at the lip being quite substantial, although it is to be understood that the invention is not to be taken as limited to this depth or in fact in any manner except as defined in the claims.

A dam 3 in the present instance extends across the sump having its top approximately at the level of the liquid when at rest, and so disposed as to define a chamber 4 of relatively limited volume about the lip 2 and a second chamber 5. During heavy load conditions or when there is a large flow of air in inlet I a large part or nearly all of the liquid in the chamber 4 will be swept out of the chamber by the air stream and carried upwardly into the cleaner chamber. By virtue of the dam 3 the remainder of the volume of the tank, namely chamber 5, is not affected by the air stream, and the volume of liquid so carried up by the air is thus limited to the contents of chamber 4.

A passageway 6 is provided, in the present instance through the dam although it might be otherwise located within the contemplation of the invention, the capacity thereof being so chosen as to allow sufficient liquid to flow from chamber 5 to promptly replenish chamber 4 upon sudden reduction in the flow of air in passageway I, such as would result upon a sudden change from heavy to light load conditions. Thus the lip 2 is maintained deeply immersed in liquid substantially at all times during light load operation, assuring the best possible atomization of the liquid and the carrying up of a relatively large quantity into the cleaning chamber C. The passageway may be formed in any desired manner, but in the present instance it is made by a tool introduced through an opening subsequently closed by a plug 8a.

Passageway 6 also feeds a metered quantity of liquid into chamber 4 during heavy load conditions to insure the presence of sufficient liquid in the vicinity of lip 2 for efficient atomization, but insufficient to exceed the capacity of the cleaning chamber to separate the liquid from the air and return it to the tank.

To further facilitate such atomization a screen or reticulated element generally designated as 7 and in the present instance for convenience composed of a box-like member having sides 8, 9, 10, 11, is fitted into the space between lip 2 and dam 3 and held in place by any convenient means such for example as a spring hook or the like 12, which may conveniently engage passageway 6, although other expedients for fastening the hook or screen are contemplated as within the scope of the invention.

Upper and lower sides 8 and 10 are active in screening the in-coming material, side 10 being submerged in liquid, and side 8 being located approximately at the surface of the liquid when quiet. These screens assist materially in the

breaking up of the liquid and mixing it with air, and they serve to intercept coarse material such, for example, as chaff, before it can be carried up into the cleaning chamber C.

Another important function of the screen box 7 is to break up the bubbles of air passing through the liquid at light loads to prevent their being large enough to carry any substantial amount of "dry" dust in their centers, as will happen if the bubbles are large.

Cleaning chamber C contains a mat or pad of fibrous or like material generally designated as 13, for example crimped, tangled or matted wire providing a labyrinth of fine passageways therebetween into which the mixture of air, liquid and dirt is carried from chamber 4, the liquid particles being intercepted along with the dirt by means of the labyrinth material, the air passing upwardly and the liquid and dirt working back down against the air flow and dropping into the sump or tank.

The mat or labyrinth 13 is, for convenience, divided into portions 13^a and 13^b (although it might constitute a single body of material without departing from the invention) the former being supported on a screen or reticulated element 14 forming the lower element of a box-like chamber or casing 15 carried in a diaphragm 16 interposed between cleaner chamber C and tank T so as to completely prevent the passage of air into the cleaner chamber except through the casing 15.

The bottom of the casing formed by the screen 14 is advantageously made in the form of an inverted gable or wedge as particularly shown in Fig. 2, the gable in the present instance projecting below the diaphragm, although other arrangements are contemplated as within the scope of the invention. The top of the box is open and the labyrinth material or pad 13^a may fill the box substantially to a screen 17 which projects over the edge thereof and into contact with the walls of chamber C as shown, the remainder of the chamber being filled by means of pad 13^b to the level of a screen or reticulated element 18 engaging lugs or the like 19—19 for holding the cleaner element against displacement by the suction of the engine.

Pad 13^b may be firm enough to be self-supporting and screen 17 may be omitted, within the contemplation of the invention.

The projecting of the labyrinth material 13^b past the upper edge of box 15 provides a space or reservoir 20 between the walls of the casing and the cleaner chamber and above diaphragm 16 into which part of the liquid returning downwardly from the labyrinth material will drain. This furnishes a body of liquid, in contact with screen 17 under many conditions of operation, some of which liquid may be drawn up into any gaps or cracks that may exist between the labyrinth material 13^b and the walls of chamber C to seal them with liquid, and positively prevent the passage of any dirt-laden air past the pad and directly to the engine. Furthermore, reservoir 20 is sealed against upward flow of air except at a hereinafter described passageway 21 by diaphragm 16 and the walls of box 15, passageway 21 being sealed by the hydrostatic head of liquid thereabove against the relatively low pressure differential existing at this point, and, accordingly, under ordinary conditions no air has access to reservoir 20, so that all the air passing through pad 13^b must necessarily enter the pad through the box or casing 15, and at points substantially

spaced from the edges or points of contact of the pad with the walls of casing C. Therefore no air can reach the said walls without first passing through at least a portion of pad 13^b. It is therefore virtually impossible for any air to get through the cleaner without first passing through at least part of one of the cleaning pads or labyrinths—a common source of trouble in known forms of air cleaners being the passing of uncleaned air between the pads and walls.

Passageway 21 leads from reservoir 20 into the body of labyrinth material in box 15, in the present instance above screen 7, and acts to supply a relatively large quantity of liquid to the labyrinth material for a considerable length of time after the flow of air through the device is reduced upon a change from heavy to light load conditions, the flow through this passageway 21 being largely or entirely prevented during heavy loads by the strong upward draft of air and the resulting reduction of pressure in the neighborhood of screen 17 below that at passageway 21. Thus in the event that this reduced flow of air is insufficient to carry any substantial quantity of liquid upwardly from chamber 4 more liquid will be supplied from reservoir 20 to prevent drying out of the labyrinth material. Under certain conditions of load it is possible for liquid to flow constantly from passageway 21, reservoir 20 being constantly replenished by liquid carried up by the air stream. It is also possible for chamber 4 to be replenished by liquid flowing over the top of the dam under certain conditions.

Under usual conditions of operation the period of light load or idling will be terminated before the liquid in reservoir 20 is exhausted, but in the event that the idling period is continued beyond this time sufficient liquid will have reached chamber 5 and found its way into chamber 4 to fill the latter substantially to the line L so that lip 2 will be submerged in liquid to its maximum depth, whereupon the passage of a relatively small volume of air will suffice to carry a sufficiently large volume of liquid into the labyrinth material to insure thorough saturation thereof. Under these conditions the thorough mixing and breaking up of the air caused by the screen 7 is particularly beneficial.

Above screen 18 is arranged a baffle 22, a second baffle 23 extending toward baffle 22 so as to direct the outgoing air from a point substantially over the center of pad 13^b, the air in the present instance passing somewhat to the right as seen in Fig. 1 and then turning to the left as indicated by the arrows in order to pass down the suction passageway S. Any particles of liquid which may have escaped the labyrinth material will have a tendency to continue through the space between the baffles in a substantially straight line to be precipitated approximately at 24 against the upper surface of the suction passageway S, the liquid then running back down the walls of the passageway. Any of the liquid which accumulates above baffle 23 may drain back into the labyrinth through a port 25.

The various parts may be held together in any suitable manner but in the present instance cleaner chamber C is permanently attached and supported on the engine (not shown) and passageway S is connected with the carburetor inlet 26 by means of an elbow 27 permanently connected between chamber C and the inlet. Tank T is removably maintained in air tight manner against diaphragm 16 as for example by a tension rod 28 fixed with chamber C as by

a screw 29 and supporting, through a nut or the like 30, a strap 31 engaged beneath the tank and pressed upwardly thereagainst by means of a hand nut 32 or similar expedient, threaded on a stud 33 in the present instance fixed with elbow 27, the strap having a slotted engagement with stud 33.

The tank may thus be readily removed by loosening nut 32 and swinging strap 31 to one side. The used liquid and accumulated dirt may be removed and the tank recharged with fresh liquid and replaced by reversing the above process. With the tank removed screen 7 may be taken out and cleaned by disengaging spring 12 from passageway 6.

The operation of this embodiment should be apparent from the above description, it being noted that lip 2 may be deeply submerged in liquid so as to obtain highly efficient cleaning of the air under low load conditions without the disadvantage of carrying over of liquid into the engine under heavy loads such as has been the experience in prior structures, although it is to be understood that numerous features of the invention are useful apart from their association with the deeply submerged lip.

This freedom from carrying over of liquid is brought about by the relatively limited capacity of the chamber 4 and also by the fact that the reservoir 20 accumulates and holds a substantial portion of the liquid which is swept out of the chamber 4 under heavy load operation. The labyrinth is accordingly not overloaded under these conditions and the liquid charge stays in the cleaner.

On the other hand upon sudden change from heavy to light load operation the depleted liquid in chamber 4 is almost instantly replaced by liquid from chamber 5 through passageway 6, and by the substantial amount of liquid that is fed into the labyrinth through the passageway 21 from reservoir 20, the cleaning being far superior under low and varying loads to that which has been done in known forms of cleaners.

The inverted gable or wedge shape of the screen 14 aids in concentrating the returning liquid in the neighborhood of the ridge 34 to assist in its return to the sump T.

The above being a complete description of an illustrative embodiment of the invention, what is claimed as new and desired to be secured by Letters Patent of the United States is:

1. In an air cleaner a labyrinth chamber, a liquid sump below said labyrinth chamber, a labyrinth in said chamber, a suction passageway leading from the chamber, an air inlet for the chamber opening into the sump beneath the liquid level therein, means for regulating the amount of liquid that will be carried up by the air flow into the labyrinth, a reservoir associated with the labyrinth removed from communication with said sump and disposed to receive liquid draining from said labyrinth and arranged for holding a quantity of liquid during heavy load conditions and means leading to the labyrinth for conducting the stored liquid thereinto during light load conditions to supplement the supply of liquid in said labyrinth carried thereinto by the reduced flow of air from said air inlet.

2. In an air cleaner a cleaner chamber, a liquid sump, an air inlet for the cleaner, terminating in a position to cause liquid to be entrained in the air entering therein and carried up into the cleaner chamber, a labyrinth pad in the cleaner

chamber and arranged with the edges thereof in contact with the walls of the chamber, and a reservoir above said sump and removed from communication therewith said reservoir being arranged to receive liquid solely from said pad and to maintain a body of liquid, when said reservoir is substantially full, at the point of contact of the pad with the chamber whereby to provide, under conditions which will maintain said reservoir substantially full, a liquid seal for any space that may occur between said walls and pad.

3. In an air cleaner a diaphragm dividing the cleaner into upper and lower portions, a liquid sump in the lower portion, and the upper portion including a cleaner chamber, said diaphragm providing an opening, walls defining a casing supported from the diaphragm and communicating with the opening, said walls being spaced from the walls of the cleaner chamber to form a reservoir between said chamber and casing, a labyrinth pad in the casing, a second labyrinth pad above the casing and defining the upper limit of the reservoir, a passageway leading from the reservoir into the casing, and means for conducting air into the cleaner, entraining a liquid from the sump, and conducting cleaned air out of the cleaner chamber.

4. In an air cleaner, a liquid sump, an air inlet terminating below the liquid level in the sump, a dam in the sump arranged to divide the same into a chamber associated with the air inlet and a separate chamber removed therefrom, a metering opening in the dam and a reticulated element extended between the inlet and dam through which air must pass on its way from the inlet, said element having a spring hook adapted to engage in said opening for holding said element in place in said chamber.

5. In an air cleaner a cleaner chamber, a liquid sump, an air inlet for the cleaner, terminating in a position to cause liquid to be entrained in the air entering therein and carried up into the cleaner chamber, a labyrinth pad in the cleaner chamber, and means arranged to direct air with entrained liquid from the sump into the pad at points spaced from the edges thereof whereby to prevent air from being bypassed around the pad without being cleaned, and means including a reservoir adapted to be maintained substantially full of liquid under heavy load conditions and positioned for maintaining a body of liquid in contact with the pad and in position to seal any space inadvertently existing between the pad and the cleaner chamber.

6. In an air cleaner a cleaner chamber, a liquid sump, an air inlet for the cleaner, terminating in a position to cause liquid to be entrained in the air entering therein and carried up into the cleaner chamber, a labyrinth pad in the cleaner chamber and arranged with the edges thereof in contact with the walls of the chamber, means arranged to direct air with entrained liquid from the sump into the pad at points spaced from the points of contact of the edges thereof with the walls of the chamber, and means including a reservoir adapted to be maintained substantially full of liquid under heavy load conditions and positioned for maintaining a body of liquid in contact with the pad and in position to seal the joint between the pad and chamber, whereby to prevent dirt-laden air from passing through any spaces that may inadvertently be left between the pad and said walls without passing through the pad.

7. In an air cleaner a body portion constituting

a chamber, a wall within the chamber spaced from the body to form an air intake passageway, a liquid sump engageable with the chamber and having a wall portion constituting an extension of the above-mentioned wall, said walls defining an air inlet passageway extending beneath the level of liquid in said sump, a dam in the sump positioned to divide the same into first and second liquid chambers, said dam extending approximately to the surface of the liquid within the sump, a reticulated element within the first chamber and extending between the said extension wall portion and said dam, spring means for removably retaining said reticulated element in place within said chamber, a diaphragm interposed between said chamber and said liquid sump

and having an opening therein, a casing extending through said opening and upwardly into said chamber to form a liquid reservoir between itself and said chamber, a labyrinth pad in said casing, a passageway leading from said reservoir into said pad, a second pad in said chamber resting on the upper end of said casing and overhanging said reservoir, opposed inclined baffles positioned above said second pad and arranged to influence the flow of air from approximately the middle of the upper pad, a precipitating surface positioned to receive air directed by said baffles and a suction passageway leading from the vicinity of said precipitating surface at a sharp angle to the direction of movement of air past said baffles.

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