Nov. 21, 1939. E. W. GRAHAM 2,180,411

AIR CLEANER

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Fig. 1.

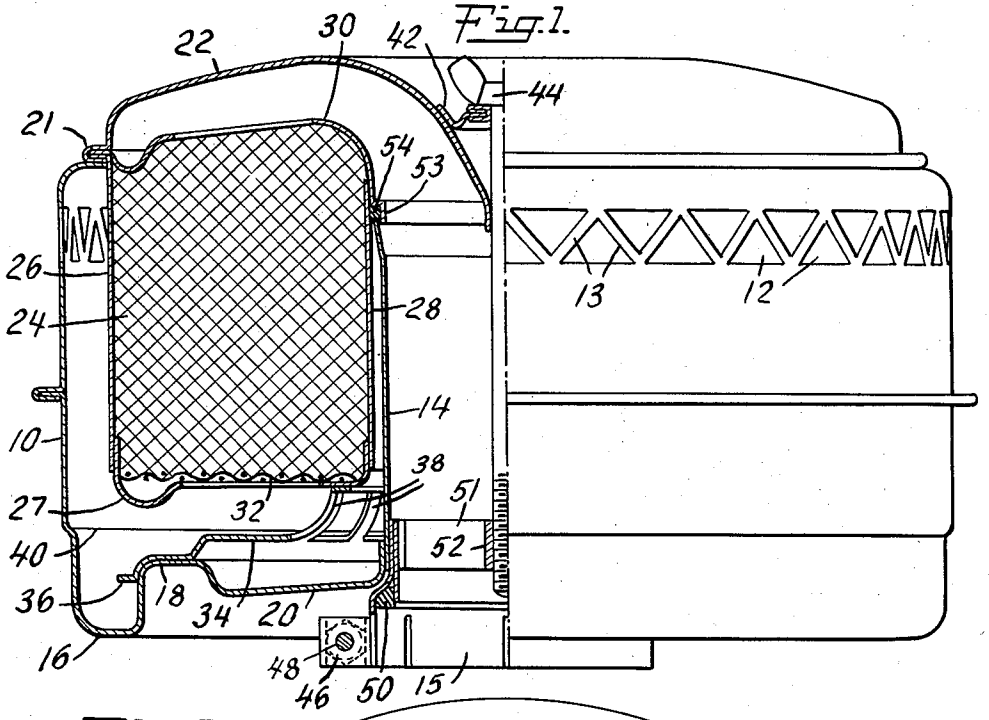
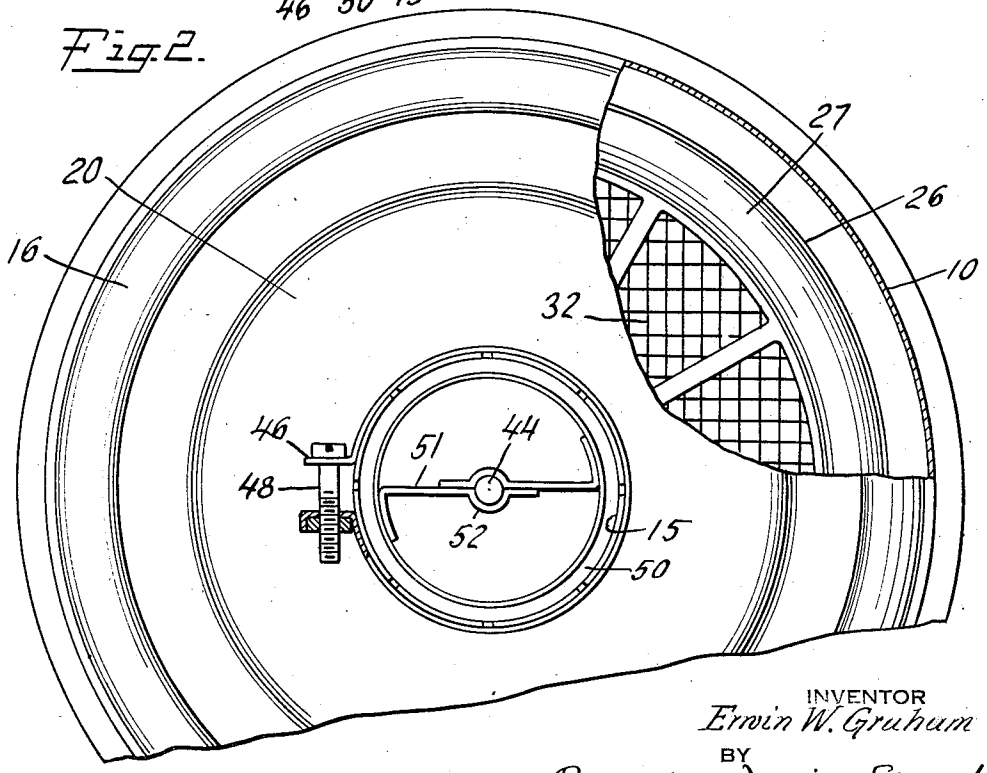


Fig. 2.



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Fig. 4.

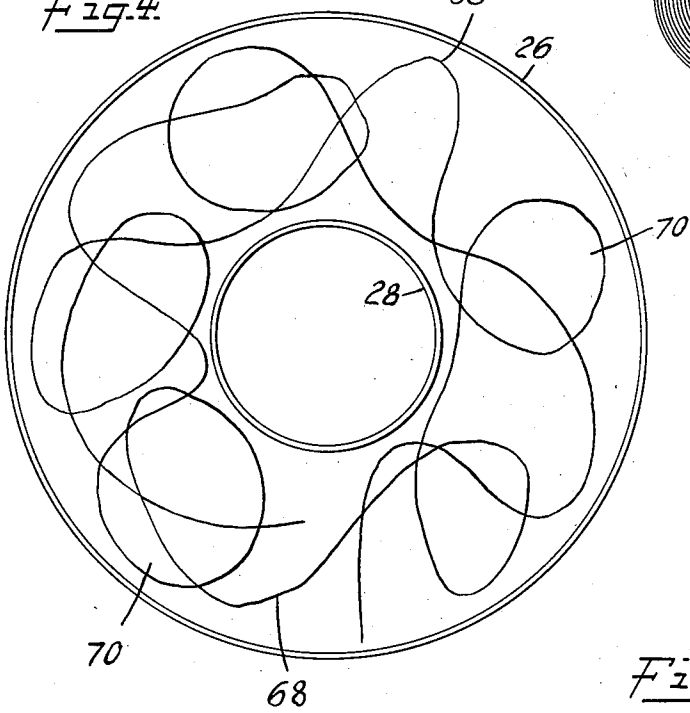
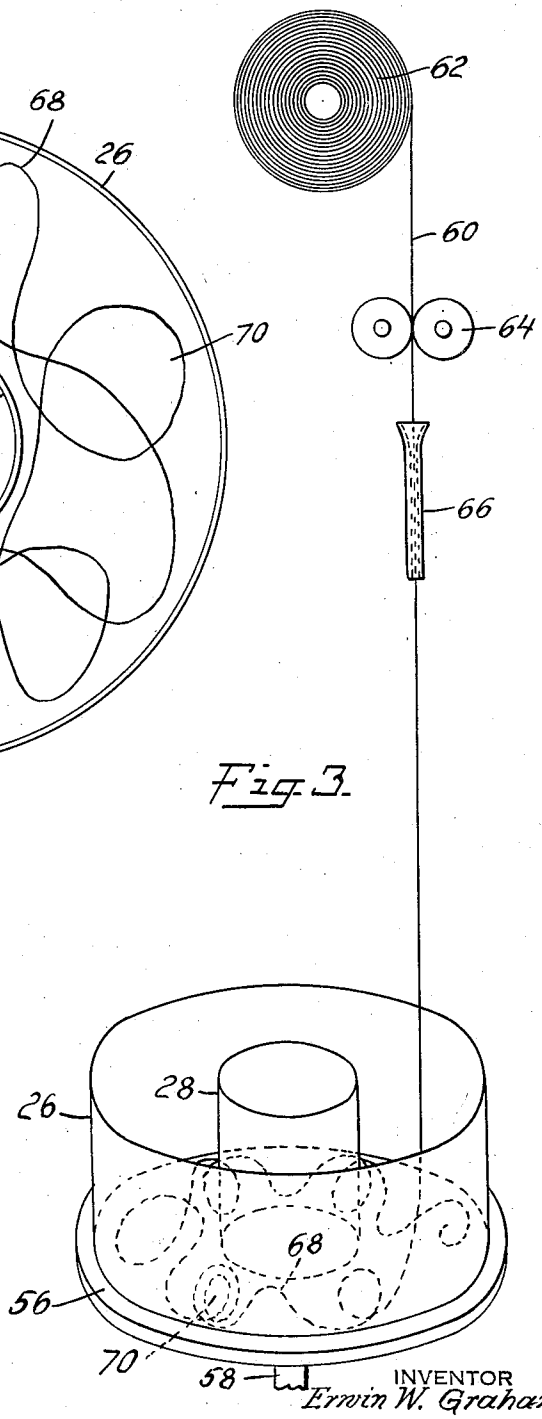


Fig. 3.



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AIR CLEANER

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Application July 14, 1936, Serial No. 90,452

3 Claims. (Cl. 183—15)

This invention relates to air cleaners for internal combustion engines, air compressors and the like, and particularly to the type of air cleaner which contains a bath of liquid, usually oil, arranged to be mixed with the incoming air in such manner that the contained dust and dirt is washed out of the air.

In air cleaners of said type, it is difficult to obtain uniformly satisfactory air cleaning action at the different speeds at which the engine is operated. This is particularly true where the air cleaners are applied to automobile engines which are operated at widely varying speeds. Furthermore, at high engine speeds the air passes through the air cleaner at high velocities and tends to carry the liquid out of the cleaner. To prevent this action most of the present air cleaners have baffles arranged across the path of the air.

It is the object of the invention to provide an air cleaner of the liquid bath type which is simple and economical of construction and which provides highly efficient air cleaning action.

It is a further object of the invention to provide a liquid bath air cleaner which provides highly efficient air cleaning action over a wide range of engine speeds and which retains the air cleaning liquid therein under conditions of high air velocities.

It is a further object of the invention to provide an interstitial air filtering mass for liquid bath air cleaners which is particularly effective for preventing the liquid from being carried out of the air cleaner by air passing therethrough at high velocity.

In the drawings:

Fig. 1 is a side view, partly in section, of the air cleaner;

Fig. 2 is a bottom view;

Fig. 3 is a diagrammatic view of a mechanism for forming the interstitial filtering means; and

Fig. 4 is a top sectional view of the interstitial filtering unit of my air cleaner at an intermediate stage in production.

The air cleaner comprises an exterior casing 10 which is generally cylindrical in shape and has a series of air entrance openings 12 extending around the upper portion of the side wall. The casing is further provided with a substantially central opening in the bottom wall through which an air discharge conduit 14 extends. The portions of the casing above and below openings 12 are connected by diagonal webs 13. The bottom wall of the casing 10 has an annular depression 16 formed around the outer border thereof to form a sump for the oil. Along the inner edge of the sump 16, the casing bottom is deformed upwardly to form the sump wall 18. Inwardly of the sump wall 18, the casing bottom is deformed downwardly to form a second sump 20. Since the normal oil level is above wall 18 it may be regarded that there is but a single sump in the casing. The total sump capacity is such that when the casing is filled to the proper level it contains the desired amount of oil.

Above the air entrance openings 12, the side wall of the casing 10 is turned inwardly a short distance to a point 21 where it is turned upwardly again and is formed into a dome-shaped top 22. Within the casing and surrounding the air discharge tube 14, an annular filter body 24 is arranged. The filter body comprises an interstitial mass of strand material which will be described more in detail hereinafter. It is confined between solid frame side walls 26 and 28, which extend over and cover the marginal portions of the bottom end of interstitial body 24. The bottom end portion 27 of frame wall 26 is curved in substantially semi-circular form. The middle portion of the bottom end of the interstitial body 24 is confined by an open mesh screen 32. The top end of the body 24 is confined by a cover 30 which may be joined to side wall 28 by welding and to side wall 26 by the crimping of top 22 as shown at the point 21. The marginal portions of cover 30 are solid while the middle portion is largely open to permit the ready flow of air. A substantially horizontal baffle 34 is arranged between the bottom wall of casing 10 and the bottom end of the interstitial body 24. The outer marginal portion of baffle 34 rests upon the wall 18 and an edge portion 36 projects outwardly into the sump 16. Spaced lugs 38 are formed integrally with the inner marginal portions of baffle 34 and are turned upwardly. These lugs are adapted to press against the bottom of interstitial body 24. Baffle 34 is held firmly in place by pressure and need not be attached to other parts of the air cleaner. The bottom end of discharge conduit 14 is provided with an adapter 15 for connecting the air cleaner to the intake of an internal combustion engine carburetor. The casing 10 is filled with oil to the level indicated by the numeral 40.

In operation, air enters at openings 12 and is directed downwardly toward the sump 16 by the wall 26. The air encounters the oil in the sump and then turns inwardly and upwardly and passes upwardly through the interstitial body 24. The air, after leaving this body, reverses its direction

again and passes downwardly through the discharge conduit 14 into the carburetor intake. A considerable proportion of the dust and dirt particles which are contained in the air do not follow the first reversal of direction and drop into the outer oil sump 16 where they settle upon the bottom and are retained. The wall 18 confines these particles to the outer sump and they settle to the bottom quickly and remain there. The curved surface 27 and the broad top of sump wall 18 provide a smooth flow of air and prevent eddy-currents from being set up in the bottom portion of the casing 10. The area between surface 27 and wall 18 is constricted and the air flow is relatively rapid. The oil is picked up from the sump by the air and is mixed with the air and carried upwardly into the interstitial body 24. The oil level 40 is arranged in sufficiently close proximity to the surface 27 to cause the entrapment of considerable quantities of oil.

The moving air causes the body of oil to pile up in the inner portion of the casing in the form of a sloping column. This column does not reach an equilibrium but undergoes an alternating rising and falling action. First it builds up to a maximum and then falls back to a minimum after which it again builds up to a maximum. A sort of oscillating action takes place. During the time that the column is falling, the oil flows back into the constricted area and when the column has fallen low there is more oil in this space than there would be at any time if a steady equilibrium were reached and maintained. The entrapped oil washes the air both in the space below the interstitial body 24 and in the lower portion of the body itself. As a result of the oscillating action described, more oil mixes with the air and the washing of the air is more thorough than it would be if a steady equilibrium of the oil column were maintained. This action takes place at low speeds as well as high, and the beneficial effect at low speeds is most valuable because it usually is difficult to secure thorough cleaning at low speeds. The air cleaner of this invention is uniformly effective over a wide range of engine speeds.

The oil is separated from the air in the interstitial body and travels back downwardly into the sump carrying the dirt and dust with it. The solid coverings for the marginal portions on the bottom and top ends of the interstitial body 24, cause the main body of the air to flow through the middle portion of the interstitial body. This promotes the thoroughness of the air washing operation and in addition provides a relatively quiet zone along the borders of the body within which the oil returns relatively freely to the sump. There is a continuous movement of oil outwardly from the middle portion of the body toward the borders and then downwardly to the sump. This movement assists in preventing the oil from being carried out of the interstitial body and into the discharge conduit and the engine. The main portion of baffle 34 is located a short distance below the oil level. This baffle has a retarding effect upon the action of the air stream upon the oil. The projecting portion 36 has a definite retarding effect upon the movement of the oil and the main portion of the baffle holds the oil in inner sump 20. Baffle 34 is needed only when the engine is operated at extremely high speeds when the air, rushing through the air cleaner at high velocities, would otherwise carry a portion of the oil through the filtering unit 24 and into the discharge conduit and the engine. For all speeds below the extremely high range the baffle 34 is not needed. It is contemplated that the baffle be omitted from automobile air cleaners except in those cases where it is expected that the automobile is going to be driven at abnormally high speeds.

The dome-shaped top 22 of the casing is curved downwardly toward the center in order to impart a directing effect upon the emerging air so that its reversal of direction and movement into the discharge conduit 14 is accomplished smoothly and with a minimum amount of eddy-currents and resistance to flow.

The air entrance openings 12 are arranged in such a manner as to provide substantially uniform air flow throughout the periphery of the casing. The webs of metal 13 between the openings are narrow and the openings are of triangular shape and each alternate opening is oppositely oriented. The result is that the vertical length of total opening is substantially the same at any point, and the total opening area is substantially the same for any equal length about the perimeter of the casing. The webs 13 extend in diagonal directions and substantially the same result may be obtained by different diagonal arrangements from that shown in Fig. 1. For instance, they may all extend in the same diagonal direction. However, such an arrangement provides somewhat less structural strength in the connection between the upper and lower portions of the casing than that provided by the arrangement shown. If the webs extend vertically the effect of the obstruction to air flow by the webs is present at the points where the air stream encounters the bath of oil and also where it encounters the filtering unit. At the areas directly rearwardly of the webs there is turbulence and reduced air flow. These portions of the oil bath and the interstitial body are not utilized as fully as the other portions.

The air cleaner is so constructed that it is separable into several parts for convenience in manufacturing, installing and cleaning after it has been in use. The top 22 and the interstitial body 24 are permanently joined together at the point 21. The side and bottom walls of casing 10 are integral and discharge conduit 14 is permanently joined to the bottom wall. The baffle 34 and the adapter 15 are separate parts. For uniting the parts and installing the air cleaner the top 22 is provided with a part 42 spaced upwardly from the central portion of top 22. The central portion of top 22 and part 42 are provided with aligned openings through which a bolt 44 may be inserted. The adapter 15 fits over the end of the intake pipe (not shown) with which the engine carburetor is commonly provided. A collar 46 is provided about the lower end of the adapter 15 and is adapted to be tightened upon the carburetor intake by means of the threaded bolt 48. The adapter is provided with a flexible gasket 50 for the purpose of preventing leaks between the air cleaner and the carburetor intake. A bracket 51 extends diametrically across the adapter and has a tapped opening 52 at the center to receive the threaded end of bolt 44. The upper part of the inner wall 28 of the air filter unit 24 is provided with an inwardly extending flange 53 which is provided with a gasket 54.

For assembling the air cleaner, baffle 34 may be placed in the open casing shell 10 and the top 22, carrying filter unit 24, may be placed upon the casing shell. The upper end of discharge conduit 14 fits against gasket 54. Adapter 15 may

be fitted into the lower end of discharge conduit 14. Bolt 44 is inserted through the aligned openings in the top of the casing and the end is threaded into opening 52 in bracket 51 and all of the parts are drawn tightly together in this manner. Baffle 34 is held in place under pressure between filter unit 24 and the bottom wall of the casing 10. The adapter may then be fitted over the end of the engine carburetor intake and tightened in place by tightening bolt 48 on collar 46

It may be inconvenient to manipulate bolt 48 while the air cleaner is in place because of limitations of space. In such case the adapter 15 may be tightened upon the carburetor first, and then the air cleaner assembly may be fitted upon the adapter and finally bolt 44 may be threaded into place to draw the air cleaner assembly tightly into place upon the adapter.

When it is desired to wash the accumulated dust and dirt from the air cleaner, bolt 44 is unscrewed and the air cleaner removed. The filtering unit and the casing shell may be taken apart and washed separately. Clean oil may then be placed in the casing shell and the parts reassembled and tightened upon the adapter by means of the bolt 44. The fact that the air cleaner is constructed of separable parts as described results in simplicity and economy of manufacture.

The interstitial body 24 is designed to provide maximum air cleaning efficiency and maximum retarding effect upon the tendency of the air to carry the oil out of the air cleaner and into the engine. The filtering material is of the metallic ribbon-like strand type in which one or more strands are coiled in helical fashion about a straight, flexible carrier strand. Such strand material is called a gimped strand and is described and illustrated in Norris United States application Serial No. 752,246, filed November 9, 1934 (now Patent No. 2,122,582, granted July 5, 1938). This gimped strand material is particularly effective for retarding the movement of the oil out of the air cleaner, much more so than the straight or the wavy strand materials that have been used heretofore. A unique method of arranging the strand material is used in order to secure the optimum porosity characteristics and uniformity of distribution throughout the volume of the interstitial body. The annular enclosing frame for the body, without the cover 30, is arranged on a support which is adapted to revolve the frame about its vertical axis. One or more of the gimped strands are fed by a suitable feeding device and allowed to fall freely into the open topped frame while the latter is being revolved. The rate of movement of the frame is considerably slower than the rate of feed of the strand material. As a result the strand material is not carried away upon the support as fast as it is deposited and there is an accumulation. The accumulation causes swinging of the strand around to form loops and back and forth and sidewise to form zigzags. Fig. 3 illustrates in diagrammatic fashion the deposition of the strands in the air filter frame. The frame is carried upon a platform 56 which is adapted to be rotated upon a support 58. The strand material 60 is supplied from a reel 62 and is fed at a predetermined speed by means of a pair of cooperating rolls 64. It has been found that for the gimped strand material satisfactory feeding of the strand is obtained by having one roll surfaced with a soft material, such as soft rubber and the other roll provided with teeth or other spaced projections which engage the coils of the strand. The strand may then proceed through a guide 66 located a suitable distance above the frame and then drops freely into the annular frame. The swinging back and forth illustrated at 68 and the curling into loops 70 is the result of the natural movement of the strand as it accumulates in the relatively slowly revolving frame.

Fig. 4 illustrates further the arrangement of the strand material. To simplify the illustration, the bottom construction of the frame is omitted and only the enclosing side walls 26 and 28 are shown. Furthermore, since it is difficult to trace the arrangement of the individual strands after a body of them has been built up, a single strand is shown after only two layers have been deposited. The weaving of the strand from side to side and the formation of the loops are shown. The relative speeds at which the strand is fed and the frame is rotated determine the frequency and the size and character of the loops and the weaving from side to side. Considerable latitude is permissible in this respect. The strand should be fed from a height sufficient to permit the ready formation of the loops and other irregularities. A height of about two feet above the bottom of the frame has been found to be satisfactory. The amount of material for each filtering unit is usually determined by weight and after this amount has been fed into the frame, it is compressed sufficiently so that the cover 30 may be attached.

The successive layers of the strands cross and re-cross each other in a heterogeneous but orderly manner. Such crosswise arrangement of gimped strands results in an open interstitial mass which is more suited for an oil bath air cleaner than the more closed mass which results when a simple circular arrangement of gimped strands is used. In addition, the porosity characteristics and the distribution of strand material is substantially uniform throughout the volume of the mass. When the proper character of gimped strand is used the mass possesses elasticity and resists packing down with use. An automobile air cleaner is subjected to vibration which tends to pack down the mass of strands.

The gimped strands are composed of metal, preferably copper, rolled or drawn, into ribbon form. There is an optimum size for best results, with respect to both the transverse dimensions of the strands and the diameter of the helical coils. Both of these factors affect the size of the pores, which should be maintained within a more or less limited range for best results. If the pores are too large the air passes through the mass without undergoing a thorough cleaning action and if they are too small the oil travels too readily from one strand to another with the ascending air stream, with the result that the oil is carried out of the air cleaner. It has been found that if the dimensions of the strands are too large the distribution is not uniform and the mass possesses insufficient elasticity to resist packing down with use. If the dimensions are too small the strands do not possess sufficient strength and the mass lacks the elasticity necessary to maintain the porosity uniform and prevent packing down.

The strand material which I have found to be suited to the purpose is composed of copper and comprises one helically coiled strand wound about one straight carrier strand. The coils are, on the average, about three-sixteenths inch in diameter,

there being about eighteen coils to the lineal inch of carrier strand. Both strands are approximately 0.0025 inch by .010 inch in transverse dimensions. One pound of the material described extends for a length of approximately four hundred yards. Some variation may be made in the dimensions of either the coiled strand or the carrier strand or of both of them and various combinations have been used successfully. If the transverse dimensions of the strand are too small, the resilience of the strand is lessened and the elasticity of the filtering mass reduced to the extent that it packs down with use. The diameter of the helical coils may be varied, one-eighth inch coils having been used successfully.

A body of the filtering material described possesses elasticity and expands to a normal volume when the pressure is released after it has been compressed below such normal value. It is arranged in the frame at substantially this volume or at a volume which is slightly less and it maintains such volume without packing down when it is in use. This arrangement results in porosity characteristics which combine maximum filtering efficiency and maximum retarding effect against carrying of the oil out of the air cleaner by air at high velocity. In prior oil bath air cleaners, it has been necessary to interpose mechanical baffles across the path of the air stream to prevent the escape of oil. In the air cleaner of this invention such a baffle ordinarily is not required, the baffle **34** being used only under condition where such high speeds are encountered as may be considered abnormal.

The invention is not limited to the construction described herein. A single operative example is described and illustrated and the invention embraces such variations, both in the general structural features and the character of the strand material, as may be made by those skilled in the art.

I claim:

1. In an air cleaner, a casing having air inlet and discharge openings therein and having a liquid sump in the bottom thereof, an interstitial mass of filtering material arranged above said liquid sump, said casing having an air passage therethrough leading from said inlet opening downwardly toward and adjacent said sump and upwardly from said sump and through said filter to said outlet opening, a baffle member spaced from the bottom wall of said sump, and a partition connecting intermediate portions of said baffle and the bottom wall of said sump, said partition extending transversely of the path of air travel, said baffle member being constructed and arranged to provide a passageway to the liquid below said baffle on each side of the partition.

2. In an air cleaner, a casing having air inlet and outlet openings therein and having a liquid sump in the bottom thereof, an interstitial mass of filtering material arranged above said liquid sump, said casing having an air passage therethrough leading from said inlet opening downwardly toward and adjacent said sump and upwardly from said sump and through said filter to said outlet opening, a generally horizontal baffle below the initial level of said sump and spaced from the bottom wall of said sump, and a partition projecting upwardly from an intermediate portion of the bottom wall of said sump and engaging an intermediate portion of said baffle to separate the bodies of liquid on the opposite sides of said partition, said partition extending transversely of the path of air travel, said baffle being constructed and arranged to provide a passageway to the liquid below said baffle on each side of said partition, said baffle having a bend therein to provide an enlargement of said air passage in advance of said filter.

3. In an air cleaner, a casing having a substantially cylindrical side wall, said side wall having a peripheral air inlet opening therein, a substantially central discharge conduit extending through the bottom wall of said casing, an intermediate substantially cylindrical wall spaced inwardly from said side wall and arranged to form an air passage extending downwardly from said inlet opening toward the bottom of said casing and upwardly to said discharge conduit, an annular filter mass within said upward air passage between said discharge conduit and said intermediate wall, a liquid sump in the bottom of said casing in spaced relation to the bottom of said filter, and adjacent said air passage, a generally horizontal baffle spaced from the bottom wall of said sump, and a partition extending transversely of the path of air travel and connecting intermediate portions of said baffle and the bottom wall of said sump to separate the bodies of liquid on opposite sides of said partition, said baffle member being constructed and arranged to provide a passageway to the liquid below said baffle on each side of said partition.

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