

Feb. 11, 1958

J. B. SEBOK ET AL

2,822,885

AIR CLEANER AND INTAKE SILENCER ASSEMBLY

Filed Feb. 23, 1954

5 Sheets-Sheet 1

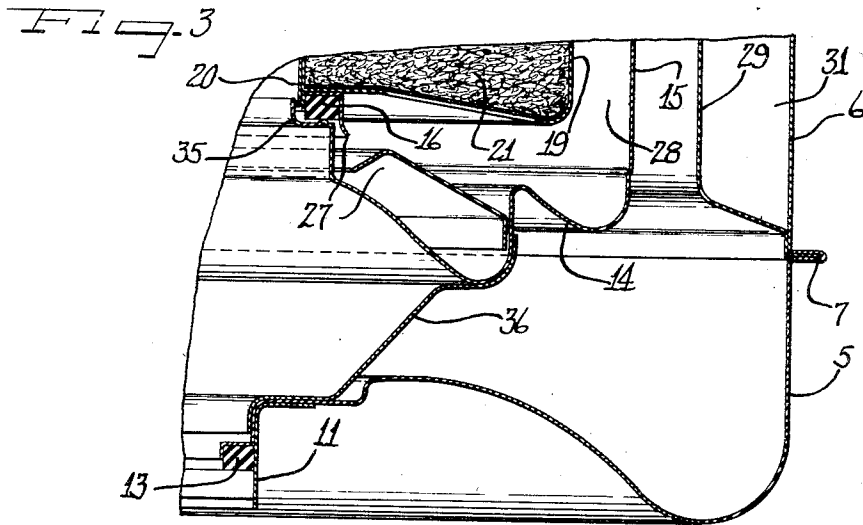
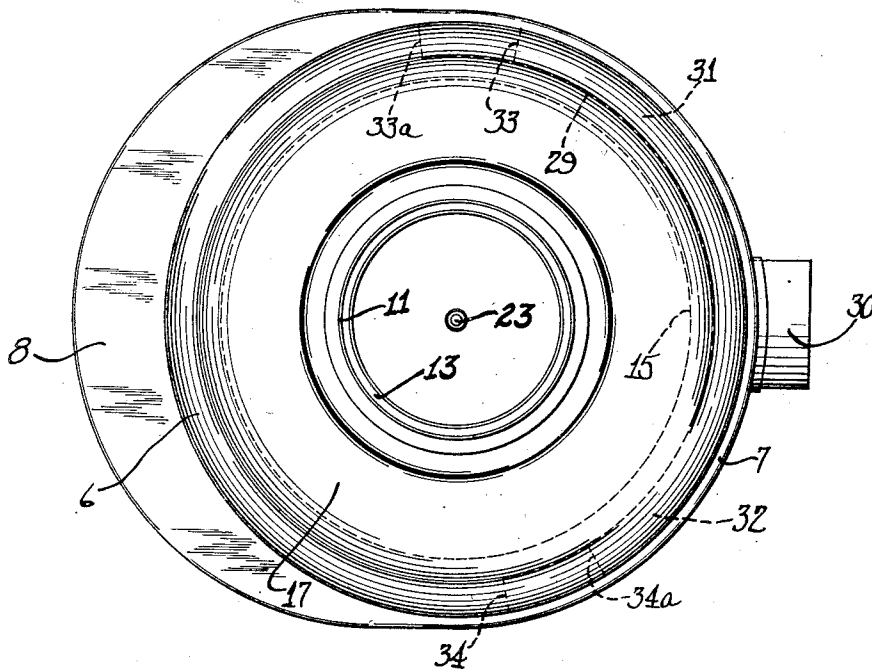


FIG. 1



Inventors

Joseph B. Sebok

Ralph E. Sendelbach

By *Cliff Sherman, Moroni, Ohio* Attys

Feb. 11, 1958

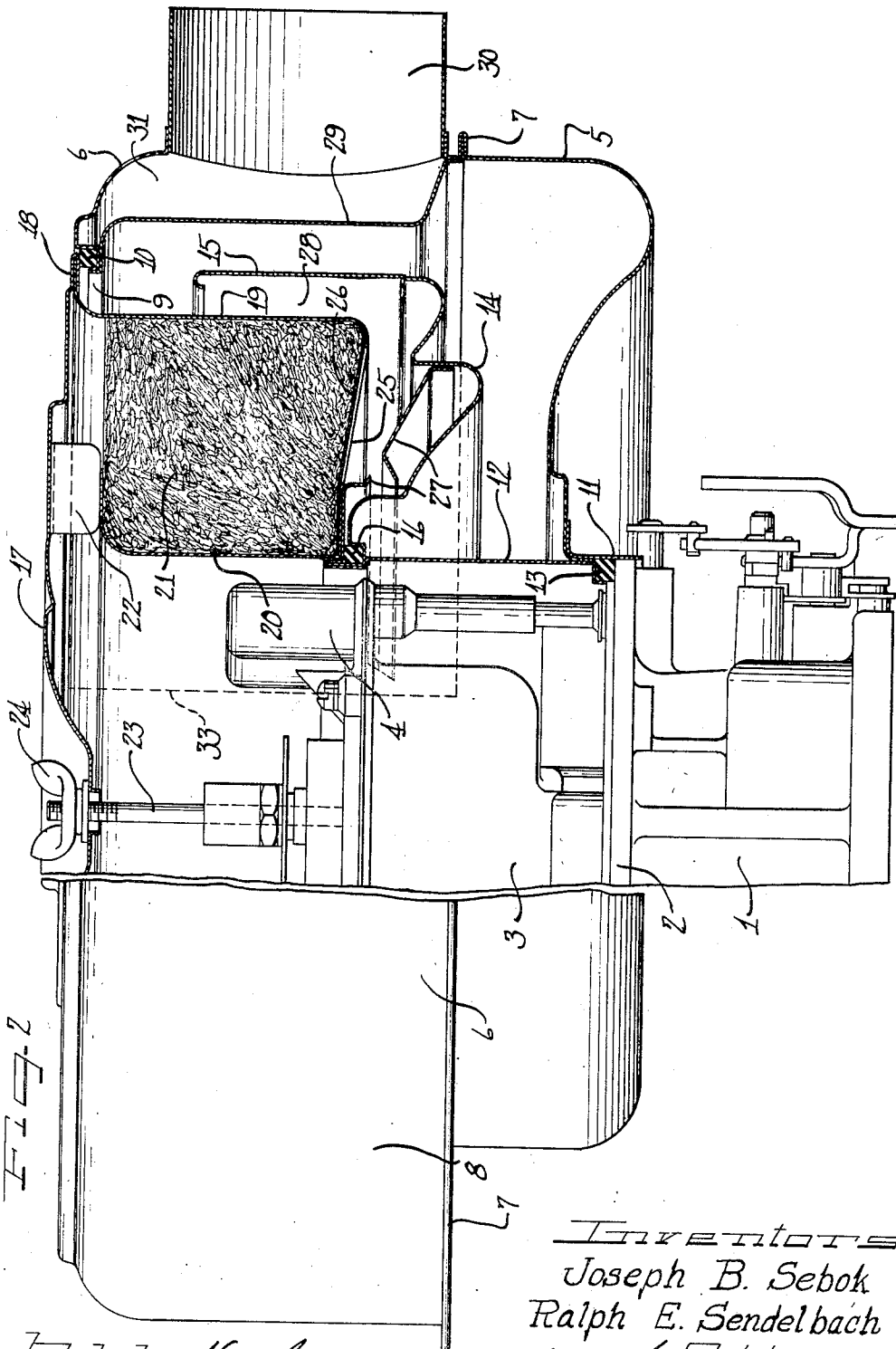
J. B. SEBOK ET AL

2,822,885

AIR CLEANER AND INTAKE SILENCER ASSEMBLY

Filed Feb. 23, 1954

5 Sheets-Sheet 2



Inventors
Joseph B. Sebok
Ralph E. Sendelbach

Attorney
H. Sherman McNeil & Co.

Feb. 11, 1958

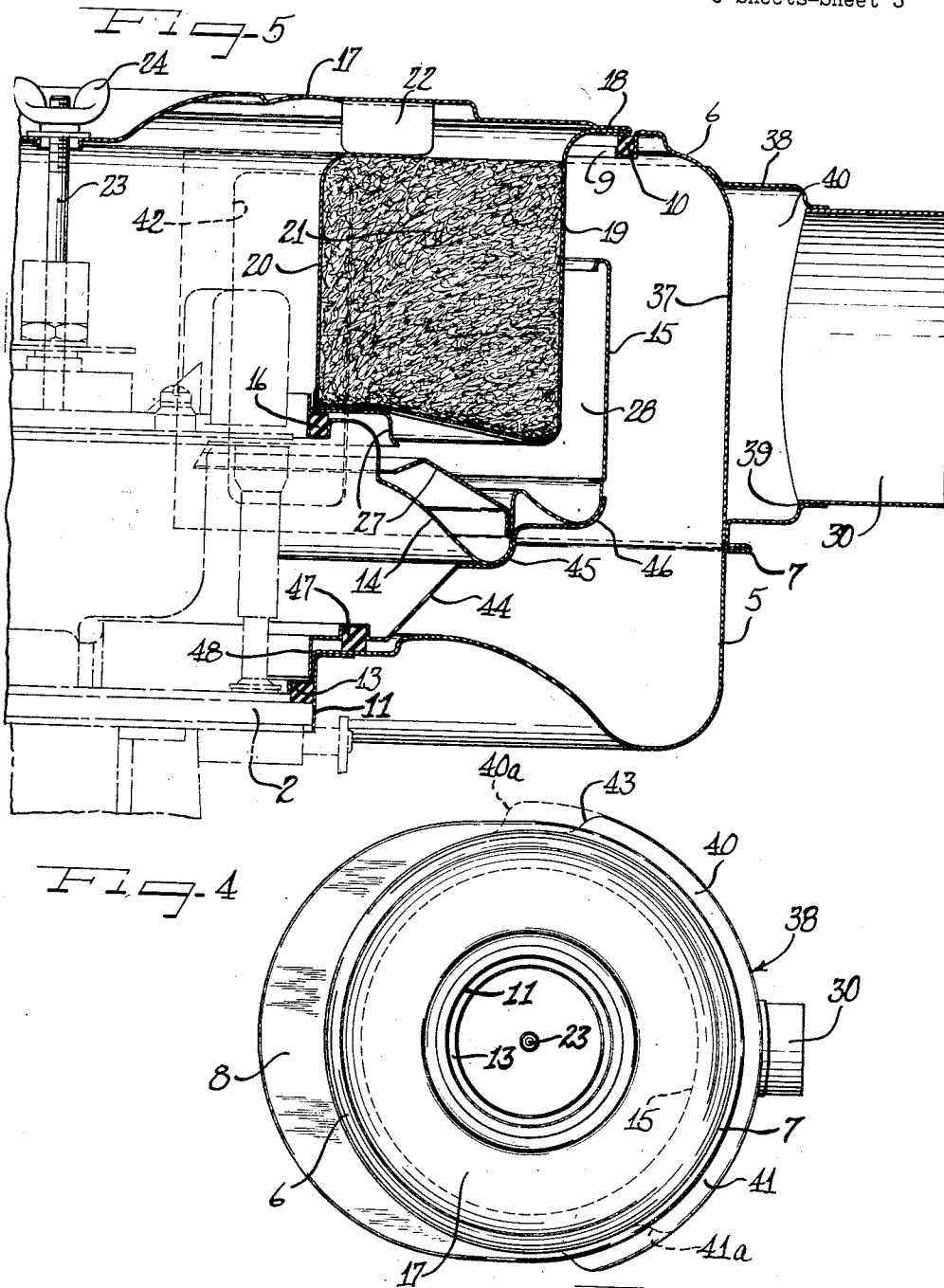
J. B. SEBOK ET AL

2,822,885

AIR CLEANER AND INTAKE SILENCER ASSEMBLY

Filed Feb. 23, 1954

5 Sheets-Sheet 3



Inventors

Joseph B. Sebok

Ralph E. Sendelbach

Attorneys
Shid, Sherman, Miami, Coral Gables, Florida

Feb. 11, 1958

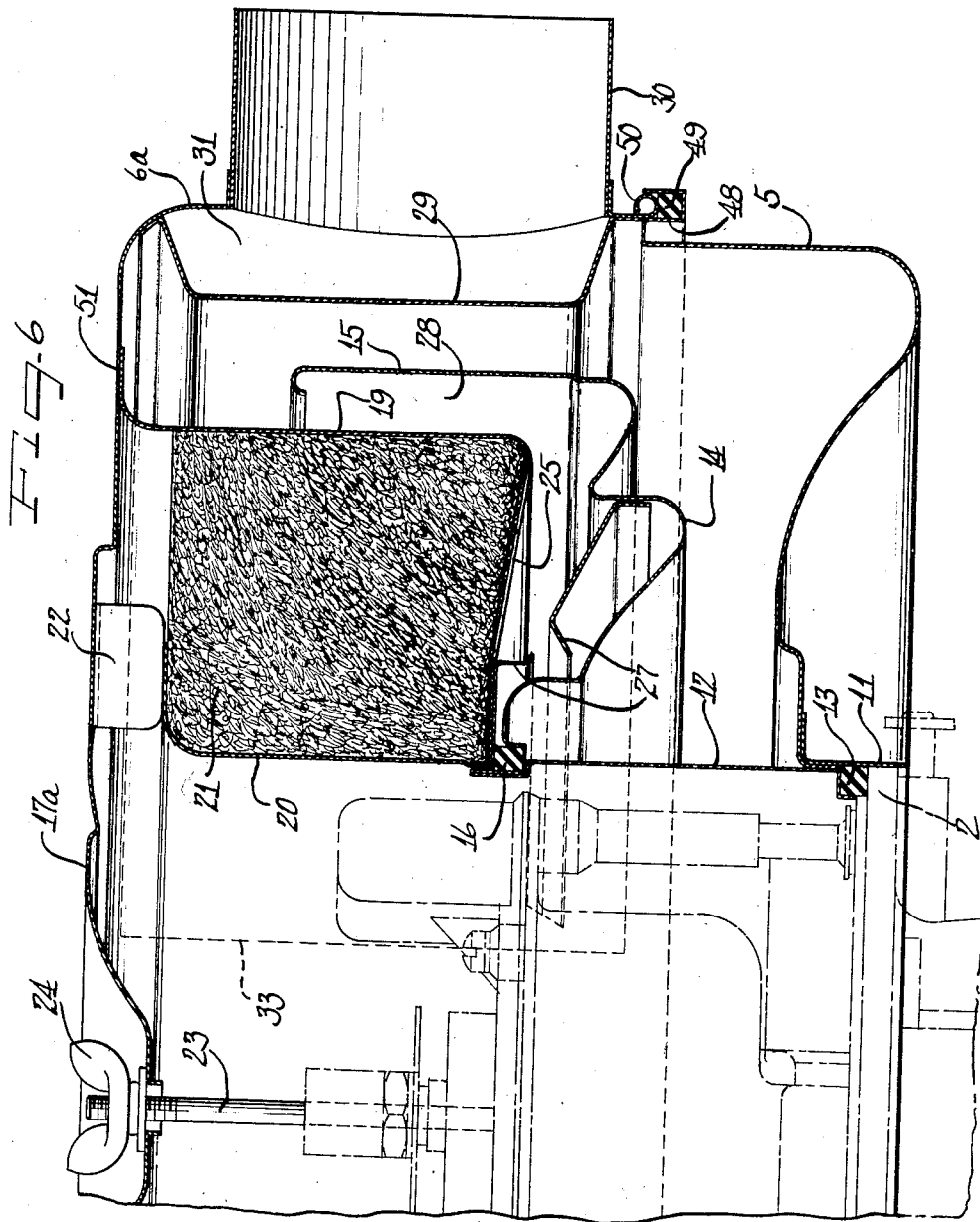
J. B. SEBOK ET AL

2,822,885

AIR CLEANER AND INTAKE SILENCER ASSEMBLY

Filed Feb. 23, 1954

5 Sheets-Sheet 4



Inventors

Joseph B. Sebok

Ralph E. Sendelbach

Attys
Shel, Sherman, Morris, Shaw & Lingen

Feb. 11, 1958

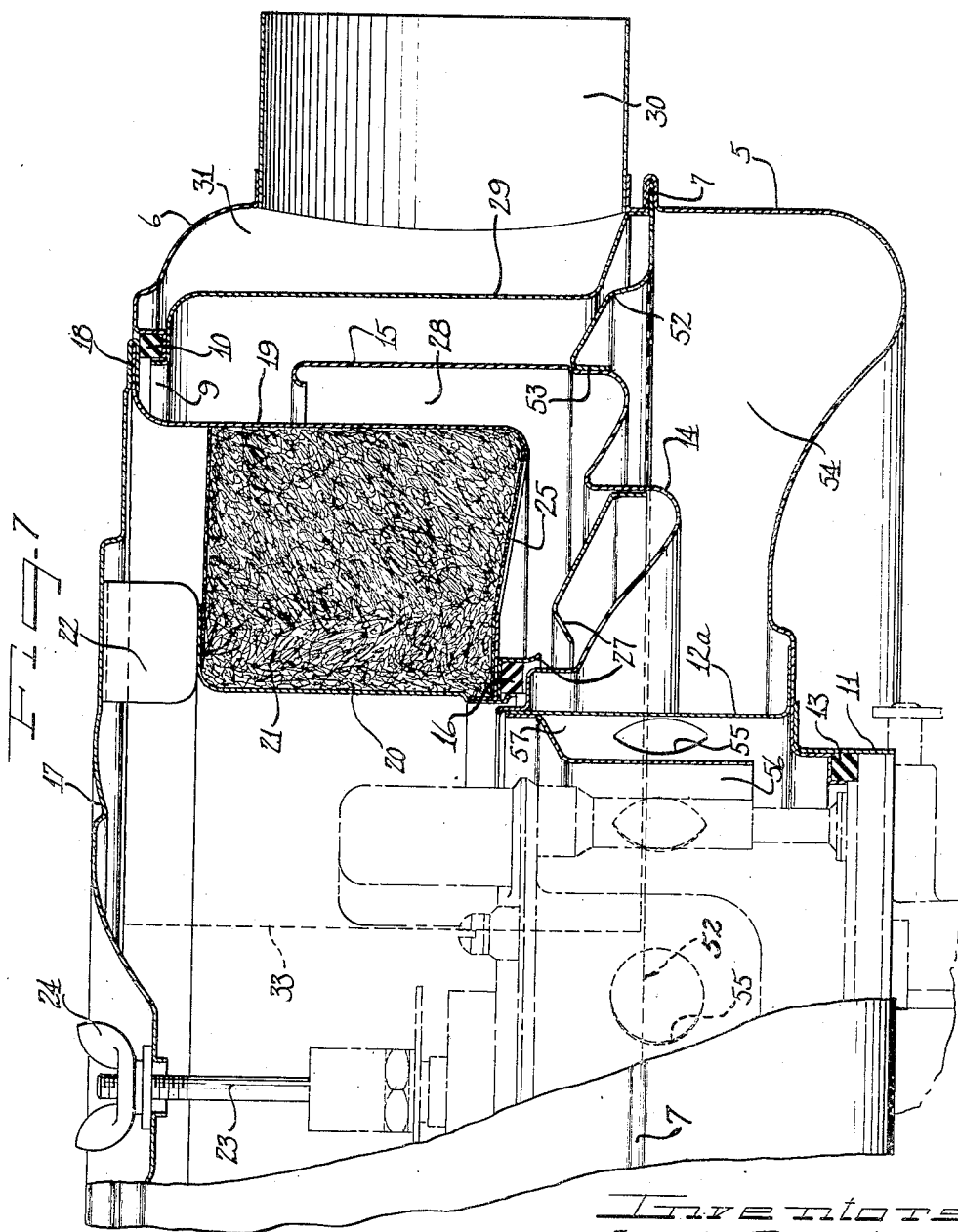
J. B. SEBOK ET AL

2,822,885

AIR CLEANER AND INTAKE SILENCER ASSEMBLY

Filed Feb. 23, 1954

5 Sheets-Sheet 5



Inventors
Joseph B. Sebok
Ralph E. Sendelbach

Attorneys
Hill, Sherman, Morris, Cross & Gage

1

2,822,885

AIR CLEANER AND INTAKE SILENCER ASSEMBLY

Joseph B. Sebok, Dearborn, and Ralph E. Sendelbach, Detroit, Mich., assignors, by mesne assignments, to Purolator Products, Inc., Rahway, N. J., a corporation of Delaware

Application February 23, 1954, Serial No. 411,612

22 Claims. (Cl. 183—15)

This invention relates to improvements in an air cleaner and intake silencer assembly, and more particularly to such an assembly highly desirable for use in connection with internal combustion engines of the automotive type, although the invention will have other uses and purposes for mechanisms requiring an adequate supply of clean air and also desirable silencing of intake noises or noises emanating from the intake, as will be apparent to one skilled in the art.

For purposes of clarity and adequate disclosure, the instant invention will be herein considered in connection with its use in association with a carburetor of an internal combustion engine, such as the commonly known automobile engine.

Heretofore, the type of intake silencer commercially used with automobile engines has universally been a silencer operating upon resonator principle, and wherein a casing was arranged to provide a chamber of predetermined volume which communicated with a path through which sound waves might travel, but was otherwise closed. In many cases communication was established with the resonator chamber by way of a tube concentric with but spaced from an air duct, and in other cases by way of a tubular element having apertures therein. Of course, the resonator chamber was to attenuate a sound of predetermined frequency, this being in most cases the fundamental tone of the automobile engine. The tuning of a resonator chamber to a particular frequency depends upon the volume of the chamber and the character of the acoustical coupling by which communication is established with the path traveled by the sound waves. Most frequently the resultant tuning was accomplished by varying the size and length, or both, of the tube establishing communication with the chamber, and that tube was frequently referred to as a tuning tube. In some instances compound resonating chambers or resonating chambers connected in series were utilized, whereby a tuning tube established communication through a wall of the first resonating chamber and a second resonating chamber, the opening of that particular tube being too small to interfere with the attenuating potentialities of the first chamber. The provision of an adequate attenuating chamber, at least for the fundamental tone developed in an automotive engine, in an air cleaner and silencer assembly that sat upon the top of the intake horn of a downdraft carburetor has heretofore been accomplished with not too much difficulty. In such an instance it was rather a simple expedient to provide a tuning tube for connection with the carburetor intake horn, and terminate the clean air outlet tube inside that tuning tube, but spaced therefrom.

However, the difficulty of providing adequate silencing for an automobile engine has tremendously increased with the advent of higher horsepower engines, and lower hoods on automobile, thereby limiting the space in which attenuating chambers of adequate volume may be located. This tendency toward lower hoods and less space

2

in the engine compartment has now progressed to such an extent that in a number of cases the air cleaner and silencer assembly must actually seat down over and house the major portion of the carburetor, the former housing which was an integral part of the carburetor and to which the intake horn was attached having been eliminated. That required the central portion of the air cleaner, or in effect, the clean air outlet conduit, to be enlarged so that the upper part of the carburetor could be received inside the air cleaner-silencer assembly. In some cases, this enlargement was up to three times the previous diameter. In many instances it was also desired to reduce the overall height, from cleaners and silencers used theretofore. As a result, extreme difficulty was experienced in finding space for a resonator chamber of adequate volume to effect the desired silencing, and increase in engine size usually requires a greater volume in the attenuating chamber. Even greater difficulty has been experienced in endeavoring to tune such an attenuating chamber of the true resonator type to a predetermined frequency because of the greater chamber size, and more particularly because of the lack of room for an acoustical coupling to that chamber in the form of a tube which could be lengthened or shortened or varied in diameter.

Endeavors to solve that problem have resulted in complicated structures of highly expensive character, and in many cases prohibitively expensive for commercial production and acceptance.

The instant invention effectively and economically solves the foregoing problems.

Inasmuch as the theory or principle of operation of the instant invention has not as yet been fully determined, and it is not yet known whether or not the instant invention effects sound attenuation on the principle of operation of a true resonator attenuating chamber, the attenuating chamber will be herein referred to as a volume or silencing chamber, for purposes of accurate presentation, the actual efficiency and efficacy of the instant invention having been conclusively proven in practice.

With the foregoing in mind, it is an object of the instant invention to provide a new type of silencer embodying a tuned volume chamber.

Another object of the invention resides in the provision of an air cleaner-intake silencer assembly designed for disposition over the major portion of a carburetor, and the silencing means of which includes a volume chamber which is easily and economically tuned to a desired frequency.

A further object of the invention resides in the provision of a volume chamber type of silencer that can readily and economically be varied at the time of manufacture to be effective on several different automotive engines, without resort to expensive die changes, or provision of duplicate dies, or a reconstruction of the main part of the silencer.

It is also a feature of the invention to provide a volume chamber type silencer for internal combustion engines, so constructed as to provide a great range of tuning which may be accomplished with no change whatever in the overall dimensions of the silencer.

Another feature of the invention resides in the provision of an air cleaner-intake silencer assembly wherein the silencer involves a volume chamber, and the tuning tube for the volume chamber also functions as an air inlet to the air cleaner.

It is also a desideratum of the instant invention to provide a volume chamber type intake silencer with the tuning tube therefor located within the volume chamber.

Still another object of the invention resides in the provision of an air cleaner-intake silencer assembly in which

sound emanating from the internal combustion engine or other source is passed through the filter element of the air cleaner before reaching the volume chamber of the silencer, thus causing the filter element of the air cleaner to function as a hiss silencer and absorb the noise of suction.

Also an object of the invention resides in the provision of an intake silencer having a volume chamber, and which is capable of being tuned to separate frequencies of materially different value.

Still another feature of the invention resides in the provision of an intake silencer having a volume chamber so constructed as to be capable of neutralizing a wider range of frequencies at a single tuning than has been heretofore possible.

A further feature of the invention resides in the provision of an air cleaner-intake silencer assembly, in which the silencer involves a volume chamber readily tunable, and incoming air passing through the air cleaner also passes through the volume chamber of the silencer.

Still another object of the invention resides in the provision of an air cleaner-intake silencer assembly, wherein the filter element of the air cleaner may be separately removed, the cleansing liquid container of the air cleaner may be separately removed, and the silencer casing left in position.

Also a feature of the invention is the provision of an intake silencer of the volume chamber type wherein the overall height of the structure is reduced to a minimum.

While some of the more salient features, characteristics and advantages of the instant invention have been above pointed out, others will become apparent from the following disclosures, taken in conjunction with the accompanying drawings, in which—

Figure 1 is a bottom plan view of an air cleaner-intake silencer assembly embodying principles of the instant invention;

Figure 2 is an enlarged fragmentary part central vertical sectional, part side elevational view of the structure of Fig. 1, showing the same in operative association with the carburetor of an internal combustion engine;

Figure 3 is a fragmentary central vertical sectional view showing a slightly different form of construction for the assembly of Figs. 1 and 2;

Figure 4 is a bottom plan view of an air cleaner-intake silencer assembly embodying principles of the instant invention but illustrating a different construction of the silencer portion;

Figure 5 is a fragmentary central vertical sectional view through the structure of Fig. 4;

Figure 6 is a fragmentary central vertical sectional view through an air cleaner-intake silencer assembly embodying a still different form of construction; and

Figure 7 is a part central vertical sectional, part side elevational view of a cleaner-silencer assembly embodying an extra true resonator chamber, in addition to the volume chamber disclosed in the above structures.

As shown on the drawings:

That illustrated embodiment of the instant invention seen in Figs. 1 and 2 is shown operatively associated with a carburetor of the so-called downdraft type. This carburetor in and of itself does not form a part of the instant invention and need not be of the particular structure illustrated. The carburetor itself includes a base portion 1 which may house the usual venturi and throttle valve and is the portion through which the combustible mixture passes. On top of this base portion is an annular flange or platform 2 which functions as a seat for the air cleaner-intake silencer assembly. The choke valve of the carburetor will usually be located substantially in the plane of the flange 2. Above that flange the carburetor includes the usual float chamber arrangement 3, an accelerating pump arrangement 4, and other parts com-

monly utilized in carburetors for internal combustion engines. It will be noted that the carburetor utilized with the instant invention does not include the customary cast housing over all the upper portion thereof and which housing terminates in an air intake horn. In this instance, incoming air surrounds all the portion of the carburetor above the flange 2, and that part of the carburetor is housed or enclosed by the air cleaner-silencer assembly. Obviously, the carburetor may be of the single or dual type, depending upon the character of engine it is to supply with fuel. In Figs. 5 to 7 I have indicated the same type of carburetor in dotted lines.

The air cleaner-intake silencer assembly includes an outer casing or shell, preferably fabricated from separate pieces to save cost in manufacture, and including a bottomed cylindrical lower portion 5 and an upper portion 6 lock seamed or otherwise secured to the lower portion as indicated at 7. While it is desirable for manufacturing economy to make as many casing portions of an air cleaner as possible of cylindrical contour, in the present instance the upper portion 6 of the shell is made somewhat eccentric, to project beyond the lower portion 5 at one side of the structure, as indicated at 8. This is done in order to increase the volume inside the casing without adding to the height of that casing. The top of the upper portion 6 is provided with a circular opening 9, and adjacent this opening the casing is formed to provide a seat for an annular gasket 10. A circuit opening is also provided in the bottom of the lower section 5, and is generally defined by a depending flange 11. Welded or equivalently secured to the casing bottom and the flange 11 is an inside upstanding cylindrical partition 12, shaped at its lower end to conjointly form a seat with the flange 11 for a gasket 13. The gasket rests upon the aforesaid carburetor flange 2, while the depending flange 11 circumscribes the carburetor flange, as clearly seen in Fig. 2, when the cleaner-silencer assembly is mounted in position over the upper portion of the carburetor.

Secured to the upper end of the partition 12 is an annular cup-like shell having a deviated bottom 14 and an outer cylindrical wall 15, forming a container for a cleansing liquid such as crankcase oil for the air cleaning part of the structure. The deviated bottom portion of this shell at its juncture with the partition 12 is also shaped to provide a seat for an annular gasket 16.

A cover 17 is provided for the top of the casing, and secured to the outer rim of this cover by a lock seam 18 or equivalently is a depending filter holding shell 19, the bottom of which is turned inwardly and joined to an inner shell 20, concentric with the shell 19 but spaced therefrom to define a compartment therebetween for a filter mass or element 21 of any suitable material, such as curled cattle tail hair. One or more depending feet 22 are secured to the underside of the cover and abut against the curvature upper end of the inner shell 20 to lend stability to the structure and to insure positive engagement of the filter holding means with the gasket 16 when the cover together with the entire filter element is positioned on the casing, the lock seam of the cover resting on the aforesaid gasket 10 at the top of the casing. The cover is held in position on the casing by means of a bolt 23 secured to the upper portion of the carburetor, and which extends through a suitable aperture in the cover to be engaged by a wing nut 24 externally of the cover.

The composite filter holding shell made up of the elements 19 and 20 has enlarged openings in the bottom thereof as indicated at 25, and over those openings an internal screen 26 may be located, if so desired. This filter holding shell also carries a baffle 27 secured to the bottom thereof, which baffle extends down into the liquid container to meter the amount of liquid carried into the filter mass by traveling air, during operation.

The inner element 20 of the filter holding shell conjointly with the partition 12 forms a housing for the upper portion of the carburetor above the flange 2, and also

acts, of course, as the outlet conduit for clean air. It will also be noted that there is an annular passage 28 between the outer element 19 in the filter holding shell and the vertical wall 15 of the liquid cup through which air descends toward the liquid in the bottom of the cup member.

Now it will be noted that the entire interior of the casing comprising the portions 5 and 6, outside of the partition 12, the vertical wall 15 of the liquid cup, and in the upper portion outside the outer wall 19 of the filter holding shell, is all one volume chamber. This volume chamber is, as shown, preferably of a size sufficient for the attenuation of a wide band of sound waves of different wave lengths or frequencies. Of course, this volume chamber is in open communication with the annular air inlet passageway 28 leading toward the liquid in the bottom of the cup. In order to tune this large volume chamber to a predetermined frequency or narrower band of frequencies, we have provided a simple partition element 29 in the upper part of the casing, the lower end of the element being secured to the inside of the outer casing wall, and the upper end of the element being secured to the casing adjacent the top opening. The partition is arcuate in shape and its intermediate portion is disposed opposite an opening in the casing wall in which a dirty air inlet duct 30 is mounted. It is not essential that a conduit or duct 30 be utilized, but it is preferable in order to eliminate the possibility of debris lodging inside the casing, as might be the case if a bare opening were provided.

The partition 29 therefore forms a double branched tuning tube, or, in a manner of speaking, a pair of tuning tubes or channels extending in opposite directions but having a common junction with the inlet 30. As seen in Fig. 1, in the illustrated embodiment, the branches or separate tuning tubes 31 and 32 formed by the partition 29 are of equal length terminating at their open ends 33 and 34, respectively. It is not essential that the branches or tubes 31 and 32 be of equal length measuring from the center line of the inlet 30, because under certain circumstances it might be desirable to vary the lengths of these tubes in order to effect a desired tuning of the volume chamber. To that end, in Fig. 1, we have indicated other points of termination such as 33a for the tube 31, and 34a for the tube 32, in which event the tube 31 would be noticeably longer than the tube 32. The tubes or branches 31 and 32 may be shortened as much as desired, and lengthened substantially as much as desired, it being only necessary that there be room between the open ends 33 and 34 of the tubes to discharge the proper amount of incoming air and without interference or turbulence between the air streams. But only in rare cases will it be necessary for the tubes to pass beyond the diametral plane through the bolt 23 which is the center of the air cleaning structure since there is a tremendously wide variance of frequencies for the volume chamber that may be acquired with tubes of less length.

It should be especially noted that with the instant arrangement adequate tuning of a volume chamber incorporated in an air cleaner-intake silencer assembly of the character that fits over the upper portion of a carburetor, is provided by way of the tuning tubes or branches 31 and 32, and no increase in overall size of the casing is necessary, since these tubes are inside the volume chamber itself.

Now in operation, incoming dirty air enters the inlet 30, substantially divides itself into two streams passing through the tubes 31 and 32, and discharges directly into the volume chamber. The air descends through the annular passage 28, contacts liquid in the bottom 14 of the liquid cup member, passes upwardly through the filter mass 21, and enters in a clean and dry condition inside the enclosure formed by the inner wall 20 of the filter shell and the partition 12, whereupon the air may enter the carburetor directly in the region of the opening or openings controlled by a choke valve. Noises emanating from

the engine will exit through the opening or openings controlled by a choke valve, pass reversely through the filter element and the sound waves upon reaching the bottom of the passage 28 will be in communication with the tuned volume chamber. The structure of the instant invention is such that sound frequencies over a relatively wide range will be attenuated with the volume chamber tuned for a single frequency. For example, if the volume chamber is tuned to a frequency of 98 cycles per second, it has been found that it effectively silences any sound emanating from the engine and having a frequency between 103 and 135 cycles per second. Thus, it will readily be seen that the same cleaner-silencer assembly may be used on several different automotive engines, without even a minor change therein.

At present, one theory of operation of the instant invention is that the double-branched tuning tube or channel forms an acoustical short circuit for the volume chamber, in that the impedance to sound waves at the air inlet opening is far greater than the impedance to sound waves in a direction from one tube branch into the other. Tests have not definitely proven this theory correct, but conversely have indicated no real error in it.

In most cases the main sound to be attenuated is the fundamental engine tone, commonly referred to as power roar. With the volume chamber tuned to attenuate or neutralize that particular tone, it will automatically neutralize one or more harmonics thereof, as well as other tones within a reasonable range on either side of the frequency of that tone, and in the case of the instant invention, that range is definitely wider than with any resonator attenuating chamber heretofore known. That fundamental engine tone is to be distinguished from the rather sibilant hissing noise of suction in the engine, which hissing noise is effectively eliminated or absorbed by the filter element 21 itself which, in the case of the instant invention, accomplishes the same result as hiss pads heretofore used inside the cover of the casing. But with the instant invention, that hiss pad inside the cover may be eliminated since with the sound waves directed reversely through the filter element, the filter element performs that additional function.

By way of example, and not by way of limitation, it may be mentioned that with a cleaner-silencer assembly as seen in Figs. 1 and 2, and having an overall longer diameter of 16 inches, exclusive of the inlet duct 30, a tuning tube of a 25 inch length symmetrically mounted with respect to the inlet, that is to provide two oppositely disposed tubes 12½ inches each in length effectively tuned the entire volume chamber to a frequency of 98 cycles per second.

Now the tuning of the volume chamber may also be effected by shifting the tuning channel or strictly speaking shifting the position of the partition 29 so as to render it unsymmetrical with respect to the inlet. In this regard, by way of example, for the same assembly a 25 inch channel was arranged unsymmetrically, and it tuned the volume chamber to a frequency of 107 cycles per second, so that by merely making the channel unsymmetrical, the frequency was varied from 98 to 107 cycles per second. There is another important feature that should be carefully noted in connection with the instant invention. That is that the volume chamber may be tuned to two widely different frequencies. Again, by way of example and not by way of limitation, it was noted that the 25 inch channel arranged unsymmetrically not only tuned the volume chamber to a frequency of 107 cycles per second, but also brought in an additional definite tuning to a frequency of 295 cycles per second. It was further found that with this particular size assembly complete removal of the partition 29 resulted in the chamber being tuned to 133 cycles per second and also to a second frequency of 310. When the channel was 18 inches in length, symmetrically arranged, thereby providing two tuning tubes of 9 inches each, the chamber was found to

be tuned to 99 cycles per second and a second frequency of 268; and a 12 inch channel symmetrically disposed tuned the chamber to 102 cycles per second and a second frequency of 260. A 6 inch channel symmetrically arranged and open at both ends, as were all the other tests, tuned the volume chamber to 112 cycles per second with a second frequency of 262 cycles per second.

It will therefore be especially noted that when necessary, and many engines give forth two relatively positive tones at widely spaced frequencies, the single volume chamber may be tuned to neutralize sound waves of two widely spaced frequencies at the same time. That is a very valuable attribute of the instant invention, because in the past difficulty has been experienced with some silencers having true resonator chambers, because where the resonator chamber was effective to attenuate the predominant engine tone, another secondary tone then became noticeable.

Now it will be noted that in order to effect adequate tuning of the volume chamber it is simply necessary to either vary the length or shift the position of the partition 29, a most economical procedure in the course of manufacture of the assembly.

Tests were also made with one end of the tuning channel blocked, and while this tuned the volume chamber properly to a desired frequency or frequencies, it tends to raise the restriction of the apparatus to entering air. This is indicative of the fact that a tuning channel with both ends open is more desirable, but not absolutely essential.

In Fig. 3 we have illustrated a slightly different form of construction which may be desirable where a little less volume in the attenuating chamber is desired, and a structure which is somewhat more economical than that seen in Figs. 1 and 2. In this instance, the structure is the same as above described except for two minor variations. The first variation is in the fact that the baffle 27 and lower part of the filter holding shell are arranged to carry the gasket 16, and the bottom 14 of the liquid cup is brought inwardly and curved upwardly as indicated at 35 to bear against that gasket. The second variation is the elimination of the partition 12, and the substitution of a sloping partition 36 which is spot welded or equivalently secured to an intermediate portion of the bottom 14 of the oil cup at its upper end, and at its lower end is secured to the overall casing bottom adjacent the point where that casing bottom is shaped to accommodate the gasket 13. The structure disclosed in Fig. 3 operates in all respects identical with the structure shown in Figs. 1 and 2, with the single exception that the volume of the attenuating chamber is slightly reduced owing to the different shape of the partition 36 from that of the partition 12.

In Figs 4 and 5 we have illustrated a form of construction that differs from that previously disclosed in that the tuning channels or tubes are disposed on the outside of the main casing, and also by the fact that in servicing the air cleaner, the top together with the filter element may first be removed, then the liquid cup lifted out of the main casing which may remain in position on the flange of the carburetor. In this instance, the upper portion 6 of the casing is solid opposite the inlet duct 30 as indicated at 37. A channel-shaped member 38 is secured to the outside of the casing wall to form the opposed tuning channels, and in an intermediate point that channel is provided with a flanged opening as indicated at 39 to receive the inlet duct 30. The ends of the side branches 40 and 41 of the tuning tube member 38 communicate with the interior of the casing by way of elongated slots 42 (Fig. 5) cut in the wall of the upper casing portion 6, both ends of the channel member 38 itself being externally closed as indicated at 43 in Fig. 4. As was the case with the embodiment described in connection with Figs. 1 and 2, it is not essential that the tubes or branches 40 and 41 be of the same length, but

they may terminate at different portions, as indicatively shown by dotted lines in Fig. 4 at points 40a and 41a, or at other points depending upon particular frequency desired for the volume chamber.

In this instance, also, the gasket 16 upon which the filter holding shell seats, is held by a formation in the upper portion of the bottom 14 of the liquid cup as described in connection with Fig. 2, but there is no vertical partition 12. In lieu thereof, there is a sloping partition 44 secured in two places to the bottom 14 of the liquid cup as indicated at 45 and 46 to insure adequate strength and rigidity. The lower portion of this partition is channeled inwardly to hold an external gasket 47 which seats against the bottom of the casing portion 5. The partition 44 terminates in a flange 48 extending downwardly toward the seat for the gasket 13 formed in the casing bottom, but is not secured to the casing bottom.

Accordingly, when the cleaner of Figs. 4 and 5 is to be serviced, it is a simple expedient to remove the wing nut 24, lift off the cover 17 carrying the filter unit therewith, then lift out the liquid cup 14—15 together with the partition 44 and gasket 47, leaving the casing proper seated on the flange 2 of the carburetor. With this arrangement it is simpler to empty the cleansing liquid and accumulated dirt from the liquid cup, refill it with new cleansing liquid, replace it, and set the cover with the filter unit in position, then tighten down the wing nut 24 to clamp all parts firmly in place and in sealing engagement with each other.

Otherwise, the structure of Figs. 4 and 5, insofar as sound attenuation is concerned, functions the same as structures previously described. It will be noted, also, that the disposition of the tuning tube on the outside of the casing, rather than inside, adds but a negligible amount to the overall size of the entire assembly.

In Fig. 6 we have illustrated a still different form of structure which may be more convenient for certain installations, but which functions insofar as air cleaning and silencing is concerned in the same manner as the structure seen in Figs. 1 and 2. However, in this instance the entire upper portion of the casing is removable along with the filter element of the air cleaner when servicing is needed. To that end, it will be noted that the upper marginal part of the lower portion 5 of the casing is channeled as indicated at 48 to form a seat for a gasket 49, which gasket and channeling extend entirely around this lower portion of the casing. The upper portion of the casing, here designated 6a, has integral with it a cover portion 17a, and this upper portion is not lock sealed to the lower portion, but the lower edge of the upper portion 6a is rolled or beaded as at 50 entirely therearound to seat on the gasket 49. The outer wall 19 of the filter holding shell is spot welded or equivalently secured to the inside of the top part of the upper portion 6a, rather than being lock sealed to the separate cover 17 described in connection with Figs. 1 and 2.

With the arrangement of Fig. 6, when servicing is required, and the wing nut 24 is removed, the entire upper portion of the overall casing is lifted off the gasket 49, carrying the entire filter element therewith. The lower portion 5 of the casing may then be lifted off the carburetor flange 2 and the dirty liquid dumped from the liquid cup 14—15. Preferably, the air inlet duct 30 is carried by the upper portion 6a of the overall casing.

While an air cleaner-silencer assembly constructed in various sizes and in accordance with one of the structures hereinbefore explained is highly efficient and satisfactory for cleaning incoming air and effecting intake silencing for substantially any internal combustion engine, one unusually rare and unique situation with a particular automobile engine has been noted. All attempts to effectively silence that particular engine by silencing means heretofore known and made in a size to fit the allowable space proved ineffective until the advent of the instant

invention. The explanation for the distinctly and curiously peculiar sound production from this individual engine appears to be that the engine developed a relatively deep tone other than the fundamental tone, and that the intake manifold, providing a constant volume, was inadvertently and unintentionally constructed so as to be tuned to this other tone and function as a Helmholtz amplifying resonator upon the opening of the intake valve to a cylinder. Such unexpected amplification of the second engine tone, in effect made that tone the predominant one, and it obviously would be particularly significant when the fundamental tone was silenced. Whether or not that second amplified tone was of the frequency sufficiently close to the fundamental tone to be effectively attenuated by any of the structures illustrated in Figs. 1 to 6, inclusive, is of no moment, since the unexpected strengthening of the tone by amplification apparently rendered it irresistible to joint silencing along with the fundamental tone.

However, even this singular but objectionable phenomenon was effectively overcome by a slight modification of the instant invention, illustrated in Fig. 7. The general structure is substantially the same as shown in Figs. 1 and 2. In this instance, however, there is an added partition 52 which has a marginal portion secured in the lock seam 7 entirely around the casing, and the inner marginal portion spot welded or equivalently secured to the wall 15 of the liquid cup 14-15, as indicated at 53. This partition, therefore, effectively divides the lower portion of the overall volume chamber into a separate true resonator chamber 54 which, in the illustrated instance, comprises all of the contents of the lower portion 5 of the casing, and a part of the volume within the upper portion 6. The resonator chamber 54 is acoustically coupled to the path of sound waves emanating from the engine through the carburetor by means of a series of apertures or openings 55 in a partition 12a which corresponds to the partition 12 described in connection with Fig. 2, but which in this instance has an outwardly turned margin secured to the bottom of the casing. Preferably, a tuning skirt 56 is also utilized to define a passageway 57 between itself and the partition 12a, the tuning skirt being concentric with the partition 12a, but having a flared upper end so that it may be secured to the wall 12a at the top. The lower end of the tuning skirt or tube 56 is merely open. Varying the width of the passage 57 and lengthening or shortening the skirt or tube 56 effects desirable tuning for the resonator chamber 54.

With this arrangement, the amplified tone emanating from the engine is at once attenuated by the resonator chamber 54, and the sound waves of this tone do not reach the filter element 21 and ultimately the main volume chamber in the upper part of the casing. The main volume chamber above the partition 52 attenuates other tones from the engine and is tuned by the branched tuning tube formed with the partition 29, in the same manner as above described in connection with the showing in Figs. 1 and 2.

From the foregoing it is apparent that we have provided an air cleaner-intake silencer assembly of a character that will house or receive therein the major portion of the carburetor, and yet which may be effectively, easily, and economically tuned over a great range of sound frequencies without altering the overall dimensions of the structure. Further, it will be apparent that we have provided an intake silencer of a new type which attenuates a greater range of sound frequencies upon a single tuning than was heretofore possible, and which also may be tuned to more than one sound wave having frequencies widely apart. The instant invention also eliminates the need of the hiss pads formerly used inside the covers of silencer or air cleaner arrangements, and effectively and economically, by a simple change in construction, may be made to neutralize or attenuate even

totally unexpected engine noises. The entire assembly is even more economical than assemblies of similar character heretofore known, possesses many more advantages, is highly durable, and easily installed and serviced.

It will be understood that modifications and variations may be effected without departing from the scope of the novel concepts of the present invention.

We claim as our invention:

1. An air cleaner and intake silencer assembly, including a casing having a clean air outlet opening through which sound waves to be attenuated enter the casing, air cleaning means in said casing, means sealing off said outlet opening except by way of a path through said air cleaning means, said casing extending laterally well beyond said air cleaning means to define a volume attenuating chamber disposed substantially around said air cleaning means and sized for the attenuation of sound waves of different frequencies, said casing having an inlet opening, and tuning tube branches communicating with and extending both ways from said inlet opening with their outer ends opening into said chamber, incoming air passing through said tube branches, said branches being sized to tune said chamber for attenuation of a predetermined range of sound frequencies.
2. An air cleaner and intake silencer assembly, including a casing having a clean air outlet opening through which sound waves to be attenuated enter the casing, air cleaning means in said casing, means sealing off said outlet opening except by way of a path through said air cleaning means, said casing extending laterally well beyond said air cleaning means to define a volume attenuating chamber disposed substantially around said air cleaning means sized for the attenuation of sound waves of different frequencies, said casing having an inlet opening, and a plurality of tuning tubes for said chamber carried by said casing, said inlet opening leading to said tuning tubes only, and the free ends of said tubes opening into said chamber, said tubes being sized to tune said chamber for the attenuation of sound waves of a predetermined range of frequencies.
3. An air cleaner and intake silencer assembly, including a casing having a clean air outlet opening through which sound waves to be attenuated enter the casing, air cleaning means in said casing, means sealing off said outlet opening except by way of a path through said air cleaning means, said casing extending laterally well beyond said air cleaning means to define a volume attenuating chamber disposed substantially around said air cleaning means sized for the attenuation of sound waves of different frequencies, a channel shaped member secured to the wall of said casing to define with said wall a tuning tube for said chamber with both ends thereof opening into said chamber, and said casing having an inlet for contaminated air which opens into an intermediate part of said tuning tube, said tuning tube being sized to tune said chamber for the attenuation of a predetermined range of sound waves.
4. In an air cleaner and intake silencer assembly, a casing having an air outlet opening in the bottom of a size to receive the upper portion of a carburetor, said casing having an opening in the top thereof, a removable cover for said top opening, annular air cleaning means beneath said cover, means sealing off said outlet opening except to air passing through said cleaning means, said casing defining therein a volume sound attenuating chamber in open communication with said cleaning means and sized for the attenuation of sound waves of different frequencies, a tuning tube for said chamber carried by the casing and extending along the wall of said casing a predetermined distance and opening into said chamber, and said casing having an air inlet opening into an intermediate part of said tube, said tube tuning said volume chamber for a predetermined range of sound frequencies.
5. An air cleaner and intake silencer assembly, comprising a casing enclosing a volume chamber sized for

11

attenuating a relatively wide band of sound waves, said casing having an air inlet opening and an unimpeded air outlet opening, means defining a path of travel for air through the casing, filter means in said path, said path and said filter means communicating directly with and said path forming a part of said volume chamber inside said casing, said path defining means including tuning tube means carried by said casing and communicating directly with said air inlet opening at an intermediate point and extending both ways therefrom with the ends thereof opening freely into said chamber, said tuning tube means being sized to tune said chamber for the attenuation of a predetermined narrower band of sound waves.

6. An air cleaner and intake silencer assembly, comprising a casing enclosing a volume chamber of predetermined size relatively to sound waves to be attenuated therein, air cleaning means in said casing, said casing having an unimpeded outlet opening for clean air leading from said air cleaning means and through which sound waves to be attenuated enter said volume chamber, means carried by said casing defining diverging open-ended tuning channels with the ends thereof farthest from the diverging point in free and unimpeded communication with said volume chamber and having adjacent ends at the diverging point in confronting and aligned relationship to in effect acoustically short circuit said volume chamber, and said casing having an air inlet opening communicating abruptly with the confronting ends of said channels.

7. An air cleaner and intake silencer assembly, comprising a casing enclosing a volume chamber of a predetermined size relatively to sound waves to be attenuated therein, air cleaning means in said casing, said casing having a free and unrestricted outlet opening for clean air leading from said air cleaning means and through which sound waves to be attenuated enter said volume chamber, means carried by said casing defining a double-branched tube open at the free ends for free and unimpeded communication with said chamber, and said casing having an air inlet opening abruptly into the junction of the tube branches at an angle exceeding 45° between the axis of the inlet and the axis of the tube, whereby the impedance to passage of sound waves outwardly through said air inlet is far greater than the impedance in a direction from one branch of said tube toward the other.

8. An air cleaner and intake silencer assembly, comprising a casing enclosing a volume chamber sized for the attenuation of a relatively wide band of sound waves of different frequencies, said casing having an air inlet opening and an air outlet opening, air cleaning means including a filter in said casing, means sealing off said outlet opening except by way of a path through said air cleaning means, said path communicating directly with said volume chamber inside said casing, and tuning tubes carried by said casing and communicating with and extending both ways along the casing wall from said inlet opening with their separated ends opening into said chamber, said tubes being sized to tune said volume chamber for the attenuation of a predetermined narrower band of sound waves.

9. An air cleaner and intake silencer assembly, comprising a casing enclosing a volume chamber sized for the attenuation of a relatively wide band of sound waves of different frequencies, said casing having an air inlet opening and an air outlet opening, air cleaning means including a filter in said casing, means sealing off said outlet opening except by way of a path through said air cleaning means, said path communicating directly with said volume chamber inside said casing, and means connected to the wall of said casing defining a channel in open communication with and extending sidewise both ways from said inlet opening with the ends of the channel

12

opening into said volume chamber, said channel being sized to tune said volume chamber for the attenuation of sound waves of a predetermined narrower band of frequencies.

10. An intake silencer for connection with the intake of a device needing an air supply, comprising a casing defining a volume chamber therein sized for the attenuation of a predetermined relatively wide band of sound waves, said casing having an opening for the discharge of air and through which sound waves from the device enter the casing, and a tuning tube carried by said casing with both ends thereof opening into said chamber, said casing having an air intake opening leading into an intermediate part of said tube, and said tube being otherwise imperforate and sized to tune said chamber for the attenuation of a predetermined narrower band of sound waves, said tube being longer on one side of said air intake opening than on the other.

11. An air cleaner and intake silencer unit, comprising a casing having a clean air outlet opening and through which sound waves to be attenuated enter the casing, air cleaning means in said casing communicating with said outlet opening, said casing defining an interior volume attenuating chamber with which said air cleaning means are in open communication and which chamber is sized to attenuate a predetermined relatively wide band of sound waves, tuning means for said chamber carried by said casing and sized to tune said chamber for the attenuation of a predetermined narrower band of sound waves, said tuning means forming a flow passage open at both ends and entirely independent of said chamber, and said casing having an inlet for contaminated air opening directly into the flow passage formed by said tuning means intermediate the ends thereof.

12. An intake silencer for connection with the intake of a device needing an air supply, comprising a casing defining a volume chamber therein sized for the attenuation of a predetermined relatively wide band of sound waves, said casing having an opening for the discharge of air and through which sound waves from the device enter the casing, a tuning tube carried by said casing with both ends thereof opening into said chamber, said casing having an air intake opening leading into an intermediate part of said tube, and said tube being otherwise imperforate and sized to tune said chamber for the attenuation of a predetermined narrower band of sound waves, said casing being cylindrical, and said tuning tube being longitudinally curvate to follow the curvature of the cylindrical casing with radii from the open ends of the tube defining an angle of at least 120° which angle includes the tube itself.

13. An intake silencer for the intake of a device requiring an air supply, comprising a casing having an air inlet opening in the wall thereof, said casing enclosing a volume chamber of sufficient size for the attenuation of a relatively wide band of sound waves, partition means in said casing defining with the inside of the casing wall tuning channels opening freely into said volume chamber and extending in opposite directions in a lateral plane from said inlet opening and in communication with said inlet opening, the adjacent ends of said channels confronting each other at said inlet opening to in effect and conjointly define a path for sound waves substantially at right angles to the air path through said inlet opening, said channels being sized to tune said volume chamber for the attenuation of a narrower band of sound waves, and said casing having an unimpeded opening from said volume chamber for the exit of air and the entrance of sound waves to be attenuated.

14. An intake silencer for connection with the air intake of an internal combustion engine, comprising a casing enclosing a volume attenuating chamber of sufficient size for the attenuation of a relatively wide band of sound waves, said casing having an air inlet opening, and tuning means communicating at a point intermediate the ends

thereof with said opening and defining flow passages for incoming air extending in different directions from said opening, said flow passages opening freely and unimpeded into said volume chamber, said flow passages being sized to tune said volume chamber for the attenuation of a narrower band of sound waves, said casing having an unimpeded outlet opening for the discharge of air and through which sound waves to be attenuated enter the casing in opposition to the direction of travel of air, and connecting means to connect the silencer with the air intake of an engine with said outlet opening communicating with the opening in the engine air intake.

15. An air cleaner and intake silencer unit, comprising a casing having a clean air outlet opening and through which sound waves to be attenuated enter the casing, air cleaning means in said casing communicating with said outlet opening, said casing defining an interior volume attenuating chamber with which said air cleaning means are in open communication and which chamber is sized to attenuate a predetermined relatively wide band of sound waves, tuning means for said chamber carried by said casing and sized to tune said chamber for the attenuation of a predetermined narrower band of sound waves, said tuning means forming a flow passage entirely independent of said volume chamber and with both ends communicating with said chamber, and said casing having an inlet for contaminated air opening directly into the flow passage formed by said tuning means intermediate the ends thereof, and means cooperating with said casing to define a resonator chamber in addition to said volume chamber, said resonator chamber having an acoustic coupling to permit entry of sound waves entering said casing.

16. An intake silencer for association with the intake of a device needing an air supply, comprising a casing having an air outlet opening and an air inlet opening spaced therefrom, said casing defining a volume attenuating chamber therein in open communication with said openings and sized for the attenuation of sound waves of different frequencies, a conduit extending into said casing around said outlet opening, means in said casing defining a flow path for outgoing air through said conduit, and partition means in said casing cooperating therewith in defining and sealing off a resonator chamber around said conduit which is closed except for an acoustic coupling between the path through said conduit and said resonator chamber, and tuning tube means carried by said casing for said volume chamber.

17. An intake silencer for association with the intake of a device needing an air supply, comprising a casing having an air outlet opening and an air inlet opening spaced therefrom, said casing defining a volume attenuating chamber therein in open communication with said openings and sized for the attenuation of sound waves of different frequencies, a conduit extending into said casing around said outlet opening, means in said casing defining a flow path for outgoing air through said conduit, partition means in said casing cooperating therewith in defining and sealing off a resonator chamber around said conduit which is closed except for an opening in the wall of said conduit to establish an acoustic coupling with said resonator chamber, a tuning tube for said resonator chamber concentric with said conduit, and tuning means carried by said casing for said volume chamber.

18. An intake silencer for association with the intake of a device needing an air supply, comprising a casing having an air outlet opening and an air inlet opening spaced therefrom, said casing defining a volume attenuating chamber therein in open communication with said openings sized for the attenuation of sound waves of different frequencies, a conduit extending into said casing around said outlet opening, means in said casing defining a flow path for outgoing air through said conduit, partition means in said casing cooperating therewith in

defining and sealing off a resonator chamber around said conduit which is closed except for an acoustic coupling between the path through said conduit and said resonator chamber, a tuning tube for said resonator chamber concentric with said conduit adjacent said acoustic coupling, and tuning means carried by said casing for said volume chamber.

19. In an oil bath air cleaner assembly a housing enclosing an oil sump and filter element, an annular inlet in the housing for dirty air, a silencer chamber surrounding the housing and enclosing the annular inlet, an air inlet orifice in the silencer chamber, a partition in the silencer chamber masking the inlet orifice nad extending a substantial distance on each side of it to provide arcuate tuning tubes, and an outlet in the assembly for clean air.

20. In a hat type oil bath air cleaner, an annular housing having an oil sump and filter element concentrically disposed therein, an annular inlet formed in the housing so that dirty air may communicate with the oil sump and filter element, an outlet formed in the housing for clean air, an annular silencer chamber surrounding the housing, the annular air inlet opening into the silencer chamber, the housing forming an annular depression in the silencer chamber, an inlet orifice for the silencer chamber, and inlet tuning channels leading from the inlet orifice a predetermined distance along the sides of the silencer chamber.

21. In a liquid bath hat-type air cleaner and silencer assembly, a filter housing enclosing a liquid sump and a filter medium, an annular inlet in the filter housing for dirty air in communication with the liquid sump and filter medium, a silencer housing around the filter housing defining a silencer chamber with it, the annular inlet in the filter housing for dirty air opening into the silencer chamber, an air inlet orifice on the side of the silencer housing opening into the silencer chamber to provide for the flow of dirty air through the silencer chamber to the annular inlet in the filter housing, an outlet in the assembly for clean air in communication with the filter medium, and an arcuate partition in the silencer chamber conforming generally to the inner surface of the silencer housing and masking the inlet orifice in the side of the silencer housing, the arcuate partition extending a substantial arcuate distance on each side of the inlet orifice and providing inlet tuning tubes leading from the inlet orifice a predetermined distance around each side of the silencer housing opening into the silencer chamber generally on opposite sides of the filter housing.

22. In a liquid bath air cleaner assembly, a filter housing enclosing a liquid sump and a filter medium, an annular inlet in the housing for dirty air, an outlet in the housing for clean air, a silencer chamber around the housing enclosing the annular inlet, and tuning passages around the wall of the silencer chamber of a predetermined length in communication with the outside and opening into the silencer chamber, the tuning passages being generally arcuate and conforming generally to the silencer chamber.

References Cited in the file of this patent

UNITED STATES PATENTS

1,521,400	Shaw	Dec. 30, 1924
1,953,543	Rensink	Apr. 3, 1934
2,114,783	Kowitt	Apr. 19, 1938
2,705,546	Chaffey	Apr. 5, 1955

FOREIGN PATENTS

72,776	Norway	Dec. 11, 1945
129,232	Australia	Sept. 21, 1948
258,548	Italy	May 2, 1928
664,624	Great Britain	Jan. 9, 1952