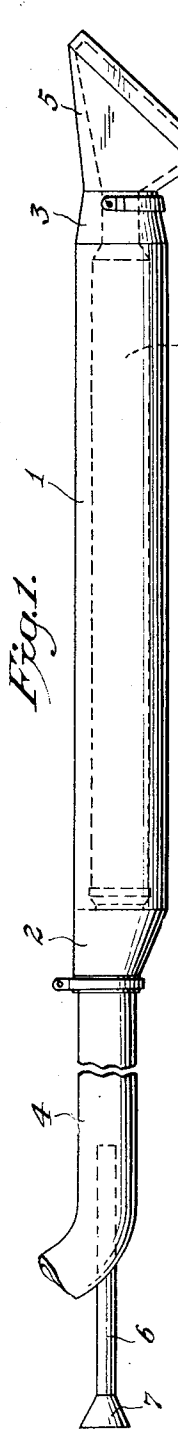
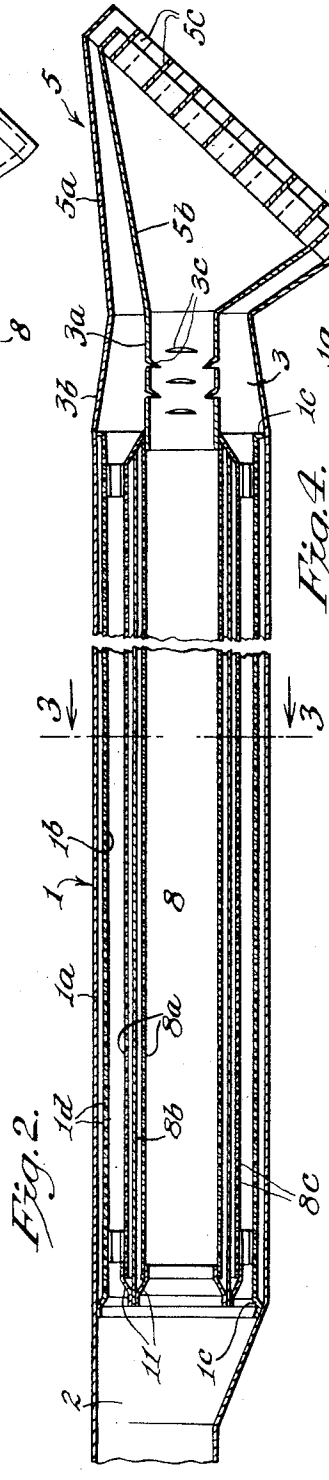
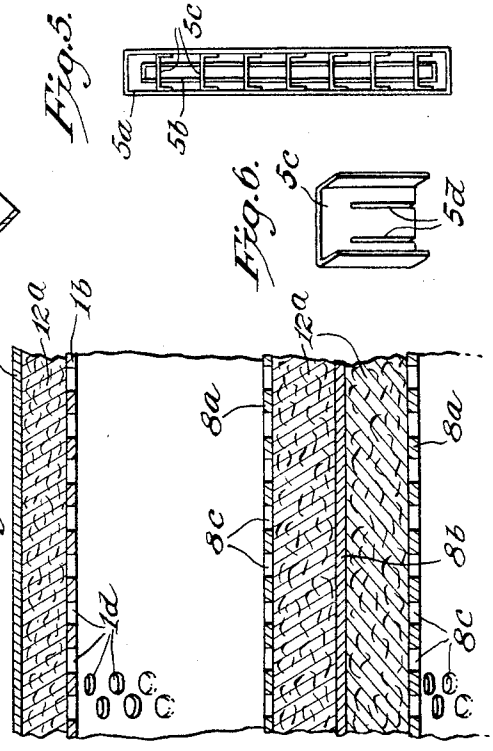
Feb. 27, 1951 E. D. LATULIPPE 2,543,461

MUFFLER WITH PLURAL SIDE BRANCH CHAMBERS

Filed July 20, 1949 2 Sheets-Sheet 1







INVENTOR.
EDDY D. LATULIPPE
BY Kenyon & Kenyon
ATTORNEYS

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Filed July 20, 1949 2 Sheets-Sheet 2

Fig. 7.

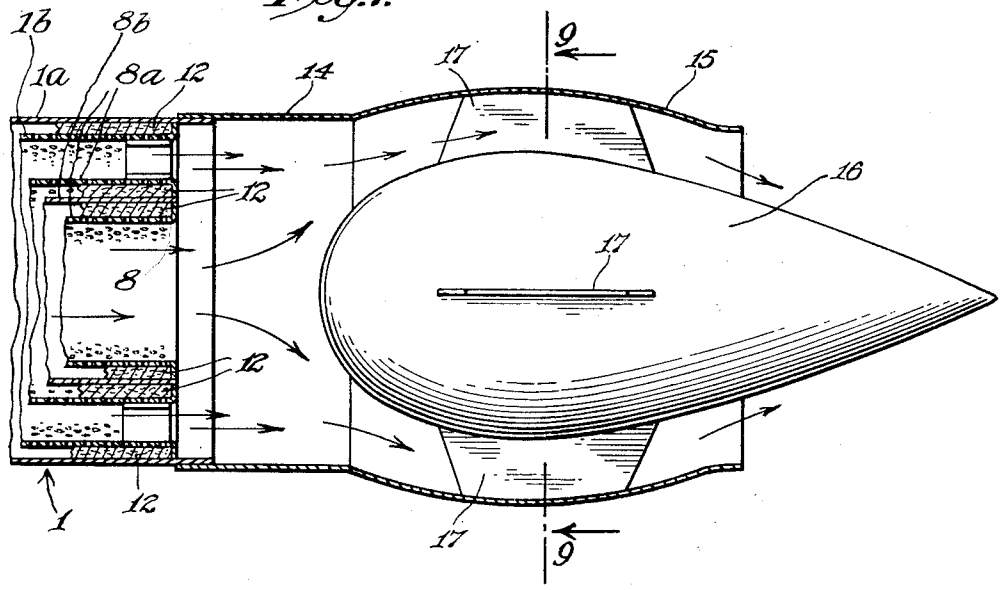


Fig. 8.

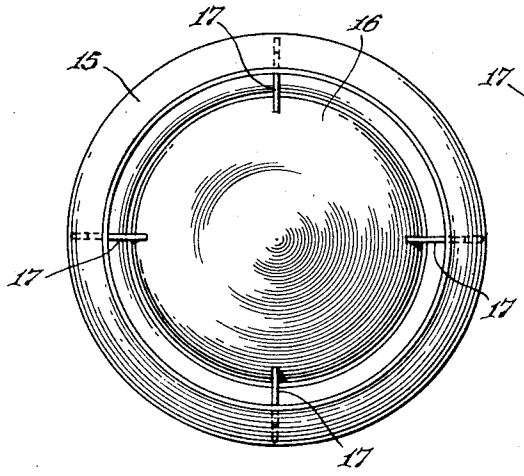
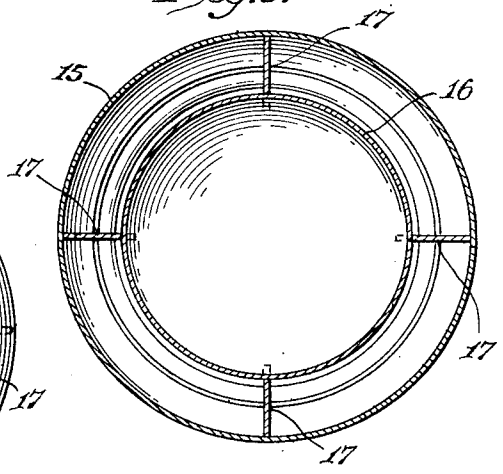


Fig. 9.



INVENTOR.
EDDY D. LATULIPPE

BY Kenyon & Kenyon

ATTORNEYS

Patented Feb. 27, 1951

2,543,461

UNITED STATES PATENT OFFICE

2,543,461

MUFFLER WITH PLURAL SIDE BRANCH CHAMBERS

Eddy D. Latulippe, Englewood, N. J., assignor to Aero-Sonic Corp., New York, N. Y., a corporation of New York

Application July 20, 1949, Serial No. 105,686

9 Claims. (Cl. 181—42)

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This invention relates to exhaust mufflers of the type disclosed by the E. D. Latulippe Patent No. 2,158,030 issued May 9, 1939. This type may be used to muffle any exhaust creating an acoustical disturbance. It is particularly adapted for application to aircraft having engines producing exhausts which it is desirable to muffle to make their characteristic noise less disturbing. This type may be produced in a light-weight form producing relatively little back pressure while effectively muffling.

One of the objects of the present invention is to improve on this type of muffler to produce a light-weight muffler that muffles even more effectively with even less back pressure. When back pressure is exerted against an exhaust from an engine the engine cannot operate at its maximum power. It is undesirable to decrease the maximum power of an aircraft engine. Another object is to improve on this type of muffler to produce a muffler that may be more easily manufactured and which is constructed so its parts are less likely to shake loose during the heavy vibration and generally severe service conditions encountered in aircraft applications. Other objects may be inferred from the following.

A specific example of a muffler constructed in accordance with the present invention is illustrated by the accompanying drawings and described hereinbelow for the purpose of disclosing the principles and operation of this invention. No unusual manufacturing problems are involved and anyone skilled in the art who knows the principles and operation of the invention may construct this exemplary muffler. Such familiarity will permit changes in the specific details shown and will enable the production of various modifications. One suggestive modification is illustrated by the drawings and described herein.

In these drawings—

Fig. 1 is a side elevation of the muffler;

Fig. 2 is a longitudinal, vertical section with the parts clarified by a scale enlargement which requires the muffler to be broken because of space limitations;

Fig. 3 is an enlarged cross section of the muffler taken on the line 3—3 in Fig. 2;

Fig. 4 is an enlargement of a segment of Fig. 2 for the purpose of further clarifying the details;

Fig. 5 is an end view looking directly up the tail of the muffler and is on a scale comparable to that of Fig. 2;

Fig. 6 is an enlarged perspective of a detail of the tail piece;

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Fig. 7 is a view similar to Fig. 2, but is on a relatively enlarged scale and shows the tail piece in modified form;

Fig. 8 is an end view of Fig. 7, and

Fig. 9 is a vertical transverse cross section taken on the line 9—9 in Fig. 7.

Referring to Fig. 1 the muffler has an elongated outer casing in the form of a cylindrical tube. The inlet end of this casing 1 has a tapering inlet chamber 2, and the outlet end of the casing 1 has a tapering outlet chamber 3. The exhaust pipe 4 connects with the inlet chamber 2 while as part of the muffler to tail piece 5 extends backwardly and downwardly at an angle from the outlet chamber 3. The exhaust pipe 4 is shown with an air inlet pipe 6 provided with an air funnel 7 so the movement of the aircraft drives air through the pipe 6 into the exhaust pipe 4 to keep enough air in the exhaust and muffler system to prevent an explosion hazard in the event the aircraft engine misfires and fills the system with unburnt fuel.

It is to be assumed that the muffler is applied to an aircraft. The device is long and relatively slender and so has little wind resistance when installed on the outside of the aircraft where it is exposed.

The muffler's internal construction is shown by Fig. 2. In addition to the outer casing 1 the muffler has an elongated inner casing 8. The outer casing 1 and the inner casing 8 are mutually spaced and are respectively constructed and mutually arranged to conduct the exhaust between the casings 1 and 8 and inside of the inner casing 8. This inner casing 8 is also shown as a cylindrical tube and it is concentrically arranged inside the outer casing 1. The casing 8 is of smaller diameter than the casing 1 so its outside is mutually spaced from the inside of the casing 1 to provide a tube-like space extending longitudinally of the muffler. The inside of the inner casing 8 provides another longitudinally extending space.

The outer casing 1 has superimposed and mutually spaced outer and inner walls. The outer wall 1*a* is substantially gas-tight and may comprise a sheet metal tube. It joins with the chambers 2 and 3 in a gas-tight manner. The inlet chamber 2 is connected with the exhaust pipe 4 in a gas-tight manner and the tail piece 5 is connected with the outlet chamber 3 in a gas-tight manner. All of these parts of the muffler may be made from sheet metal that is free from openings.

The outer casing's inner wall 1*b* is perforated

throughout its entire extent. It may comprise a sheet metal wall having sufficient perforations to give it the characteristic of a screen. The ends of this inner wall 1*b* have outwardly projecting annular flanges 1*c* by which it is connected with the outer wall 1*a* of this outer casing 1.

The inner casing 8 has superimposed and mutually spaced outer and inner perforated walls 8*a* which are similar to the wall 1*b* of the outer casing. The inner casing also has a central substantially gas-tight wall 8*b* which is substantially like the outer wall 1*a* of the outer casing 1. Where reference is here made to walls being substantially alike it is to be understood that different diameters are involved and that the ends are slightly modified in the respective instances. Thus the ends of the perforated walls 8*a* of the inner casing are joined together at their front ends by inner and outer rings 11 which have flanges connecting with these walls 8*a* and which taper inwardly to provide flanges which are interconnected by being fastened to the gas-tight wall 8*b* which has its end sandwiched between them. At the outlet end of the device the outer one of the perforated walls 8*a* is tapered inwardly and fastened to the inner one of the walls 8*a* with the gas-tight central wall 8*b* butted against the tapering end of the outer perforated wall.

In Fig. 2 the perforated insides of the inner walls of the outer and inner casings respectively are shown perforated only in the cross-sectioned portions. This is done to avoid confusion which results when the holes are shown throughout the curving halves illustrated in elevation. Fig. 4 is provided to clarify the construction, and in this the perforations in the walls 1*b* are marked 1*d* and those in the walls 8*a* of the inner casing are marked 8*c*. All of the perforations 1*d* in the elevation portion of this figure are not shown but a few are indicated to show their distribution. In all cases the perforations are relatively small and there are a relatively large number of them, the walls being completely filled with the perforations in each instance.

As shown particularly well by Fig. 3, the inner casing is positioned inside the outer casing by the use of short channel sections 12 having their webs radially arranged and their flanges fastened to the wall 1*b* and the outer one of the walls 8*a* respectively. Sufficient of these channel sections are used to secure rigidly and they are shown only at the ends of the two casings.

Fig. 3 also shows that the various walls are formed by cylindrically bending metal sheets and overlapping and fastening their ends. Butt joints could also be used if the joints are made adequately permanent.

The tail piece 5 of the device is shown in maximum detail by Figs. 2 and 5. This tail piece includes superimposed, gradually flattening tail conduits 5*a* and 5*b* which extend backwardly from the chamber 3 in a gas-tight manner as previously explained. Conduit 5*b* connects with the inside of the inner casing 8 through an inner short casing 3*a* that extends through the outer casing 3*b* of the chamber 3 as a short tubular cylinder part having its inner end fastened to the tapering wall of the outer one of the walls 8*a* of the inner casing. Thus the chamber 3 comprises the outer short casing 3*b* and the inner short casing 3*a*. This latter casing 3*a* is provided with a plurality of partial punches 3*c* which are formed as inwardly projecting scoops pointing in the direction the exhaust comes from the inner casing. This inner short casing 3*a* positions the inner end of the conduit 5*b* within the tail piece and the outer end of the conduit 5*b* is rigidly positioned therein by a plurality of short channel sections 5*c*. These sections are arranged with their webs transversely between the outer flat end of the outer tail conduit 5*a* with their flanges fastened to its insides. These sections have slots 5*d* receiving the flattened end of the inner tail conduit 5*b*. The parts are assembled in a rigid manner.

The outlet chamber 3 and the tail piece 5 follow the general arrangement of the comparable parts disclosed by the mentioned Latulippe patent. They differ from it in that a larger number of the openings or scoops 3*c* are used and in that these openings are arranged directly inside of the outlet chamber 3*b* rather than farther back in the tail piece. The tail piece is also shown angling downwardly because this is generally a better arrangement for many aircraft installations.

As shown in Fig. 2 the spacing between the walls of the respective casings is considerably less than the spacing between the two casings proper. Sound absorbent material 12*a* is positioned between the mutually opposed surfaces of the gas tight walls and the perforated walls respectively. Thus this sound absorbent material is positioned between the walls 1*a* and 1*b* and between the walls 8*a* and 8*b*. The absorbent material may comprise stainless steel wool or other refractory fibrous material capable of resisting the vibration. This material is packed relatively compactly between the respective walls. The material should be acoustically absorbent respecting at least the dominant frequencies of the exhaust's vibration.

With the muffler connected with the exhaust pipe and with the latter carrying the exhaust creating the disturbing noise the operation of the muffler is as follows.

The exhaust gases enter the inlet chamber 2 and are thereby connected with both the space between the two casings and the space inside the inner casing. The chamber 2 functions to equalize the pressure between these two spaces. The exhaust travels through both spaces and into the outlet chamber 3 through which it passes to exit through the tail piece 5. This tail piece functions to impede the flow of the exhaust gases from the outlet chamber to provide a very slight back pressure which slightly increases the normal pressure of the exhaust traveling through the casings of the muffler. The openings 3*c* in the short inner casing 3*a* of the outlet chamber 3 also interconnect the spaces between the casings and inside the inner casing to assure pressure equalization therebetween. The flattening of the respective tail piece conduits should be adequate to provide this slight back pressure effect, but not sufficient to impede the exhaust so much as to materially affect the power output of the engine producing the exhaust.

Since the pressures in the two spaces provided by the two casings are the same the exhaust gases tend to travel uniformly through both spaces. As the exhaust gases travel through the spaces the exhaust gases are confined by the double walled construction shown and described. The gases tend to penetrate the perforated wall so that the sound absorbent material 12 functions as a sound absorbent wall carrying the exhaust gases. As a result the acoustical energy is effectively muffled out by absorption. This is done without abrupt

changes of the flowing direction of the exhaust gases or in any other way impeding the exhaust gases flow materially to result in high back pressure.

The muffler illustrated is relatively small. In the case of larger mufflers intended for larger engines the number of multiple walled casings may be increased to provide more effective sound absorption from the traveling exhaust gases.

The slight taper of the exhaust chamber 35 is in some instances by itself sufficient to impede the exhaust flowing from the muffler to a sufficient extent to materially increase the sound absorption properties. Where adequate sound absorption is provided in this fashion the tail piece 5 may be eliminated. The tail piece may also be eliminated in cases where the muffler is made longer to maintain the exhaust gases in contact with the sound absorbent material for a longer period of time than in the case of the shorter muffler illustrated.

Since the exhaust is simply carried straight through the muffler the parts may be made very light in weight by using relatively thin-gauged sheet metal such as thin stainless steel. Any pulsations in the exhaust are rapidly damped out by the sound absorbent material 12 so that the muffler is not subjected to material vibration due to the exhaust.

In the modification shown by Figs. 7 through 9 a straight cylindrical outlet chamber 14 is substituted for the tapered chamber 3 of the muffler assembly shown by Figs. 1 through 5. This performs all the functions previously described. The various walls of the inner casing are somewhat differently arranged but this difference is relatively slight and need not be described since it is apparent from the drawings.

The modified tail piece 15 has an outer casing shaped somewhat like an egg and internally provided with a tear drop shell 16 positioned with its large end pointing towards the flow of exhaust gases and with its outside spaced from the inside of the shell 15 by struts 17 turned edgewise to the flowing exhaust gases. The casing and shell correspond generally in contour.

With this modified arrangement the tear drop shell 16 provides a slight flow impedance to build up the slight back pressure back in the main portion of the muffler. Although the shell 16 is directly impinged by the exhaust gases leaving the inner casing its general shape is such that it does not have to provide much reaction to these gases. The shell's shape makes it inherently rigid. Furthermore it is receiving the exhaust gases after the vibration energy has been largely removed by being absorbed by the sound absorbing material between the multiple walls of the various casings.

It is to be noted that the construction is such that the exhaust gases cannot enter between the various walls of the respective casings 1 and 8 through any spaces between their end edges. The effect is substantially that of conducting the exhaust gases through a plurality of straight sound absorbent passageway walls with the exhaust uniformly distributed throughout the various passageways without any localized pressure nonuniformities. The uniform distribution of the pressure throughout the entire device not only affects maximum sound dampening or muffling but has the further advantage of preventing the formation of localized hot spots in the muffler construction.

The acoustical absorbent material permits some penetration by the exhaust. The acoustical energy in the absorbed exhaust is reflected back and forth between the respective casing walls and thus damped out. This effect is obtained when the sound absorbent material is eliminated. When using the material the effect increases the sound absorption efficiency.

As shown by Fig. 7 the tail of the tear drop shell 16 is long and projects well beyond the back end of the outer casing 15. The outlet end of the casing 15 has substantially the same inside diameter as that of the inlet chamber 2 of the muffler where it connects with the exhaust pipe 4. The contours of the casing 15 and shell 16 follow each other as much as possible with the foregoing qualifications. This construction produces a jet effect providing thrust for pushing the aircraft.

I claim:

1. An exhaust muffler including mutually spaced outer and inner elongated casings constructed and arranged to conduct the exhaust therethrough between said casings and inside said inner casing, said outer casing having superimposed and mutually spaced outer and inner walls with said outer wall substantially gas-tight and said inner wall perforated, and said inner casing having superimposed and mutually spaced outer and inner perforated walls and a central substantially gas-tight wall interposed therebetween.

2. An exhaust muffler including mutually spaced outer and inner elongated casings constructed and arranged to conduct the exhaust therethrough between said casings and inside said inner casing, said outer casing having superimposed and mutually spaced outer and inner walls with said outer wall substantially gas-tight and said inner wall perforated, and said inner casing having superimposed and mutually spaced outer and inner perforated walls and a central substantially gas-tight wall interposed therebetween, sound absorbent material being positioned between the mutually opposed surfaces of said substantially gas-tight walls and said perforated walls respectively.

3. An exhaust muffler including mutually spaced outer and inner elongated casings constructed and arranged to conduct the exhaust therethrough between said casings and inside said inner casing, said outer casing having superimposed and mutually spaced outer and inner walls with said outer wall substantially gas-tight and said inner wall perforated, and said inner casing having superimposed and mutually spaced outer and inner perforated walls and a central substantially gas-tight wall interposed therebetween, said casings having an inlet chamber at their exhaust-inlet ends with the latter and said chamber constructed and arranged to interconnect the respective insides of said casings and to introduce the exhaust thereto, and said casings having an outlet chamber at their exhaust-outlet ends with the latter and said outlet chamber constructed and arranged to interconnect their respective insides and to carry the exhaust therefrom.

4. An exhaust muffler including mutually spaced outer and inner elongated casings constructed and arranged to conduct the exhaust therethrough between said casings and inside said inner casing, said outer casing having superimposed and mutually spaced outer and inner walls with said outer walls substantially gas-tight and said inner wall perforated, and said inner casing having superimposed and mutually spaced outer

and inner perforated walls and a central substantially gas-tight wall interposed therebetween, said casings having an inlet chamber at their exhaust-inlet ends with the latter and said chamber constructed and arranged to interconnect the respective insides of said casings and to introduce the exhaust thereto, and said casings having an outlet chamber at their exhaust-outlet ends with the latter and said outlet chamber constructed and arranged to interconnect their respective insides and to carry the exhaust therefrom, sound absorbent material being positioned between the mutually opposed surfaces of said substantially gas-tight walls and said perforated walls respectively.

5. An exhaust muffler including mutually spaced outer and inner elongated casings constructed and arranged to conduct the exhaust therethrough between said casings and inside said inner casing, said outer casing having superimposed and mutually spaced outer and inner walls with said outer wall substantially gas-tight and said inner wall perforated, and said inner casing having superimposed and mutually spaced outer and inner perforated walls and a central substantially gas-tight wall interposed therebetween, said casings having an inlet chamber at their exhaust-inlet ends with the latter and said chamber constructed and arranged to interconnect the respective insides of said casings and to introduce the exhaust thereto, and said casings having an outlet chamber at their exhaust-outlet ends with the latter and said outlet chamber constructed and arranged to interconnect their respective insides and to carry the exhaust therefrom, said outlet chamber connecting with means for at least slightly impeding the exhaust flow therefrom.

6. An exhaust muffler including mutually spaced outer and inner elongated casings constructed and arranged to conduct the exhaust therethrough between said casings and inside said inner casing, said outer casing having superimposed and mutually spaced outer and inner walls with said outer wall substantially gas-tight and said inner wall perforated, and said inner casing having superimposed and mutually spaced outer and inner perforated walls and a central substantially gas-tight wall interposed therebetween, said casings having an inlet chamber at their exhaust-inlet ends with the latter and said chamber constructed and arranged to interconnect the respective insides of said casings and to introduce the exhaust thereto, and said casings having an outlet chamber at their exhaust-outlet ends with the latter and said outlet chamber constructed and arranged to interconnect their respective insides and to carry the exhaust therefrom, sound absorbent material being positioned between the mutually opposed surfaces of said substantially gas-tight walls and said perforated walls respectively, said outlet chamber connecting with means for at least slightly impeding the exhaust flow therefrom.

7. An exhaust muffler including mutually spaced outer and inner elongated casings constructed and arranged to conduct the exhaust therethrough between said casings and inside said inner casing, said outer casing having superimposed and mutually spaced outer and inner walls with said outer wall substantially gas-tight and said inner wall perforated, and said inner casing having superimposed and mutually spaced outer and inner perforated walls and a central substantially gas-tight wall interposed therebetween, said casings having an inlet chamber at their exhaust-inlet ends with the latter and said chamber constructed and arranged to interconnect the respective insides of said casings and to introduce the exhaust thereto, and said casings having an outlet chamber at their exhaust-outlet ends with the latter and said outlet chamber constructed and arranged to interconnect their respective insides and to carry the exhaust therefrom, sound absorbent material being positioned between the mutually opposed surfaces of said substantially gas-tight walls and said perforated walls respectively, said outlet chamber connecting with means for at least slightly impeding the exhaust flow therefrom, said outlet chamber including a substantially gas-tight outer short casing extending from said outer elongated casing and an inner short casing having gas ports and positioned inside and spaced from said outer casing and extending from said inner elongated casing.

8. An exhaust muffler including mutually spaced outer and inner elongated casings constructed and arranged to conduct the exhaust therethrough between said casings and inside said inner casing, said outer casing having superimposed and mutually spaced outer and inner walls with said wall substantially gas-tight and said inner wall perforated, and said inner casing having superimposed and mutually spaced outer and inner perforated walls and a central substantially gas-tight wall interposed therebetween, said casings having an inlet chamber at their exhaust-inlet ends with the latter and said chamber constructed and arranged to interconnect the respective insides of said casings and to introduce the exhaust thereto, and said casings having an outlet chamber at their exhaust-outlet ends with the latter and said outlet chamber constructed and arranged to interconnect their respective insides and to carry the exhaust therefrom, sound absorbent material being positioned between the mutually opposed surfaces of said substantialy gas-tight walls and said perforated walls respectively, said outlet chamber connecting with means for at least slightly impeding the exhaust flow therefrom, said outlet chamber including a substantially gas-tight outer short casing extending from said outer elongated casing and an inner short casing having gas ports and positioned inside and spaced from said outer short casing and extending from said inner elongated casing, said means including superimposed gradually flattening tail conduits respectively extending from said outer and inner short casings.

9. An exhaust muffler including mutually spaced outer and inner elongated casings constructed and arranged to conduct the exhaust therethrough betwen said casings and inside said inner casing, said outer casing having superimposed and mutually spaced outer and inner walls with said outer wall substantially gas-tight and said inner wall perforated, and said inner casing having superimposed and mutually spaced outer and inner perforated walls and a central substantially gas-tight wall interposed therebetween, said casings having an inlet chamber at their exhaust-inlet ends with the latter and said chamber constructed and arranged to interconnect the respective insides of said casings and to introduce the exhaust thereto, and said casings having an outlet chamber at their exhaust-outlet ends with the latter and said outlet chamber constructed and arranged to interconnect their respective insides and to carry the ex-

haust therefrom, said outlet chamber connecting with means for at least slightly impeding the exhaust flow therefrom, said means including a generally egg-shaped casing with a generally tear drop shaped body mounted therein and spaced therefrom with its tail pointing backwardly and projecting beyond the outlet end of the said egg-shaped casing.

EDDY D. LATULIPPE.

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841,993	France	June 2, 1939

Certificate of Correction

Patent No. 2,543,461 February 27, 1951

EDDY D. LATULIPPE

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows:

Column 2, line 13, for the words "muffler to" read *muffler a*; column 4, line 23, for "in" read *by*; column 8, lines 11 and 59, for "betwen" read *between*; line 44, same column, for "substantialy" read *substantially*;

and that the said Letters Patent should be read as corrected above, so that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 1st day of May, A. D. 1951.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.

Certificate of Correction

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[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.